# Governance and planning of landscapes that emerge from a mix of natural and social processes

**Habilitation thesis**

to obtain the academic degree

**Dr. rer. nat. habil.**

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**Faculty of Natural sciences III**

**of the**

**Martin Luther University Halle-Wittenberg**

by

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*Land as capital, heritage, nature, as investment, inspiration, home.*
*All finite, all requiring care.*
*So, add planning and ecology as wisdom,*
*for nature's future, our future.*

Forman, R.T.T. (2008): Urban Regions: Ecology and Planning Beyond the City, Cambridge University Press, Cambridge, UK

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# List of publications and implemented research projects that form the basis of this habilitation thesis

**Table 1** List of publications that form the basis for habilitation thesis

| # | Reference name | Journal 5-year IF |
|---|---|---|
| I | **Spyra, M**. (2014). **The feasibility of implementing cross-border land-use management strategies: a report from three Upper Silesian Euroregions**. IForest, 7, 396–402, https://doi.org/10.3832/ifor1248-007 | 2.082 |
| II | **Spyra, M**. (2014). **Ecosystem Services and Border Regions. Case Study from Czech – Polish Borderland.** TeMA Journal of Land Use, Mobility and Environment, 7(3), 921-932, http://dx.doi.org/10.6092/1970-9870/2543 | - |
| III | La Rosa, D., **Spyra, M.,** & Inostroza, L. (2016). **Indicators of Cultural Ecosystem Services for urban planning: A review**. Ecological Indicators, 61(1), 74-89, http://dx.doi.org/10.1016/j.ecolind.2015.04.028 | 5.172 |
| IV | Frank, S., **Spyra, M.**, & Fürst, C. (2017). **Requirements for cross-border spatial planning technologies in the European context.** Change and Adaptation in Socio-Ecological Systems, 3(1), 39–46, https://doi.org/10.1515/cass-2017-0004 | - |
| V | Geneletti, D., La Rosa, D., **Spyra, M.**, & Cortinovis, C. (2017). **A review of approaches and challenges for sustainable planning in urban peripheries.** Landscape and Urban Planning, 165, 231-243, http://dx.doi.org/10.1016/j.landurbplan.2017.01.013 | 6.852 |
| VI | La Rosa, D., Geneletti, D., **Spyra, M.,** & Albert, C. (2017). **Special issue on sustainable planning approaches for urban peripheries.** Landscape and Urban Planning, 165, 172-176, Landscape and Urban Planning 165 (2017) 172–176, http://dx.doi.org/10.1016/j.landurbplan.2017.04.004 | 6.852 |
| VII | La Rosa, D., Geneletti, D., **Spyra, M.,** Albert, C., & Fürst, C. (2018). **Sustainable planning for peri-urban landscapes.** In P. Ajith H., U. Peterson, G. J. M. Pastur, & L. R. Iverson (Eds.), Ecosystem Services from Forest Landscapes: Broadscale Considerations (pp. 89–126), https://doi.org/10.1007/978-3-319-74515-2_5 | - |
| VIII | **Spyra, M.,** Inostroza, L., Hamerla, A., & Bondaruk, J. (2019). **Ecosystem services deficits in cross-boundary landscapes: spatial mismatches between green and grey systems.** Urban Ecosystems, 22, 37-47, https://doi.org/10.1007/s11252-018-0740-3 | 3.032 |
| IX | **Spyra, M**., Kleemann, J., Cetin, N. I., Vázquez Navarrete, C. J., Albert, C., Palacios-Agundez, I., Ametzaga-Arregi, I., La Rosa, D., Rozas-Vásquez, D., Esmail B.A., Picchi, P., Geneletti, D., König, H.J, Koo, H., Kopperoinen, L., Fürst, C. (2019). **The ecosystem services concept: a new Esperanto to facilitate participatory planning processes?** Landscape Ecology, 34, 1715–1735, https://doi.org/10.1007/s10980-018-0745-6 | 3.843 |
| X | **Spyra, M.,** La Rosa, D., Zasada, I., Sylla, M., & Shkaruba, A. (2020). **Governance of ecosystem services trade-offs in peri-urban landscapes.** Land Use Policy, 95, 104617, https://doi.org/10.1016/j.landusepol.2020.104617 | 5.525 |
| XI | **Spyra, M**., Kleemann, J., Caló, C. N., Schürmann, A., & Fürst, C. (2021). **Protection of peri-urban open spaces at the level of regional policy-making: Examples from six European regions.** Land Use Policy, 107, 105480, https://doi.org/10.1016/j.landusepol.2021.105480 | 5.525 |
| XII | **Spyra, M.,** & Hamerla, A. (2021). **Bicycle Accessibility to Cultural Ecosystem Services in a Cross-Boundary Landscape**. In D. La Rosa & R. Privitera (Eds.), Lecture Notes in Civil Engineering Innovation in Urban and Regional Planning (Vol. 1, pp. 91–99), https://doi.org/10.1007/978-3-030-68824-0_10 | - |
| XIII | Palacios-Agundez I., Rodríguez-Loinaz G., Hagemannd N., Sylla M. and **Spyra M.** (2022). **Teaching the ecosystem service concept: experience from academia.** Ecology and Society, 27(3): 2, https://doi.org/10.5751/ES-13286-270302 | 4.363 |

**Table 2** List of implemented research projects that are the basis for habilitation. Abbreviations: ELI: European Land use Institute; GLP: Global Land Program; IALE: International Association of Landscape Ecology

| Project name, year, founding organization, role in the project | Contribution to habilitation development | Relation to the articles | Relation to the scientific networks |
|---|---|---|---|
| **School without borders**: Polish-Czech border region through the eyes of future architects from Ostrava and Opole; 2012-2013; co-financed from European Regional Development Found, Cil3/Cel3 2007-2013; coordinator from the Polish partner of the project. | *Principal investigator*<br>Analysis of the example of cross-boundary landscape related to Silesia Euroregion. Governance recommendations for this cross-boundary landscape. Contribution to answering research question #1. | I, II | ELI |
| **KOPR**: Development strategy for the Czech – Polish cross-border area; 2013; co-financed from European Regional Development Found, Cil3/Cel3 2007-2013; project coordinator. | *Principal investigator for PL*<br>Analyze of the example of cross-boundary landscape related to Pradziad Euroregion. Governance recommendations for this cross-boundary landscape prepared together with local governance actors. Contribution to answering research question #1. | I, II | ELI |
| **Edu2Work**: Cooperation between schools and public institutions on the Czech-Polish border in the area of education creates better opportunities in the labor market; 2013 – 2015; European Union Regional Development Found CZ-PL, Cel 3, 2007-2013; project expert. | Social network analysis and assessment of economic development aspects of cross-boundary landscape located in Pradziad Euroregion. Governance recommendations for this cross-boundary landscape prepared together with local actors. Contribution to answering research question #1. | I, II | ELI |
| **SERVICES**: Social-ecological research and technological innovations for improved integration of cultural ecosystem services in participatory planning processes; 2017-2019; German Aerospace Center (DLR); project expert. | Analyze of usefulness of ecosystem services concept in participatory planning. Contribution to answering research question #3. | IX | ELI, GLP |
| **INTERact**: INTEgrated Landscape Assessment for Sustainable Resource Management; 2017-2019; German Aerospace Center (DLR); project leader. | Analysis of different governance and spatial planning approaches for peri-urban landscapes. Contribution to answering research question #2. | XI | ELI, GLP |
| **INLAND**: Innovative environmental governance for sustainable peri-urban landscapes; 2019-2020; Bundesministeriums für Bildung und Forschung (BMBF); project coordinator. | *Principal investigator*<br>Analysis of different governance and spatial planning approaches for peri-urban landscapes. Contribution to answering research question #2. | X, XI | ELI, GLP, IALE |
| **RENATUR**: Improving regional policies to better protect natural heritage of peri-urban open spaces; 2019-2023, INTERREG Europe; project coordinator. | *Principal investigator*<br>Analysis of different governance and spatial planning approaches for peri-urban landscapes. Contribution to answering research question #2. | XI | ELI, GLP, IALE |

# Synopsis

The habilitation thesis is divided into five main sections, following Introduction, Methods, Results, Discussion and Conclusions structure.

**Section one** of the thesis describes the general motivation for my research. Several of the concepts and notions that are most important for the habilitation thesis are introduced in this section. This includes governance, planning together with differences between both notions and implementation of the ecosystem services concept in landscape governance and planning. Moreover, the detailed notion of cross-border and peri-urban landscapes is described to exemplify what the transitioning landscapes are that emerge from a mix of natural and social processes.

At the end of this section, the following are explained as well: the research gap and the scope of this thesis that relates to displaying the advancements of my research in the field of landscape governance and planning. Lastly the research questions are described.

**Section two** presents methods that were implemented in my research. This section starts with a detailed description of the quantitative methods used in my research data sources. The quantitative methods encompass spatially explicit indicators and other GIS based approaches. Moreover, the section two describes qualitative methods that were implemented in my research that encompass different kinds of surveys, scientific sessions, stakeholders' workshops and structured literature reviews. The methods description ends with an explanation of case studies analyzed during my research.

**Section three** of this thesis presents obtained results. This presentation is structured around the thesis research questions. First part of this section presents the *key steps* related to governance and planning for sustainable development of landscapes that emerge from a mix of natural and social processes. The key steps are the following: establishing trust, planning in the framework of multilevel cooperation, coordination of governance and planning activities in the framework of cross-boundary planning document, implementation of context specific governance mixes, assessment of landscapes asymmetries to inform landscape governance and planning, application of socio-ecological landscape monitoring systems, involvement of support squads in governance and planning processes, implementation of foresight methods and using the concept of green infrastructure. Second part of results sections presents insights into aspects that hamper usability of governance and planning approaches for landscapes that emerge from a mix of natural and social processes. These detailed insights are divided into description of internal limitations, external barriers (obstacles), conflicts and trade-offs. It also explains transferability of approaches from one context to the other. The last part of results section describes how to make use of the ecosystem services concept to enhance sustainable governance and planning of landscapes. Moreover, this part shows how to improve ecosystem services concept understanding among various governance actors. This part ends with considerations about ecosystem services indicators usable for landscape governance and planning.

**Section four** provides a detailed discussion concerning what was obtained during my research results. Initially the aspects addressed in the *key steps* are discussed. This part shows how the *key steps* approaches are described, implemented and critically assessed in existing scientific literature. Based on this, some considerations related to soft planning of landscapes are presented later. Section four finishes with critical thoughts pertaining to the continued pathway for the ecosystem services concept to support landscape governance and planning.

**Section five** presents conclusions and outlook that include detailed explanations of further research directions concerning my studies of landscapes' governance and planning.

Manuscripts that form the basis for this habilitation thesis are listed in Table 1, while Table 2 provides an overview of various research projects which have contributed to the aforementioned manuscripts.

*Die Habilitationsschrift ist in fünf Hauptabschnitte gegliedert, die der Struktur Einleitung, Methoden, Ergebnisse, Diskussion und Schlussfolgerungen folgen.*

***Abschnitt eins** der Arbeit beschreibt die allgemeine Motivation für meine Forschung. Einige der für die Habilitationsschrift wichtigsten Konzepte und Begriffe werden in diesem Abschnitt vorgestellt. Dazu gehören die Begriffe Governance und Planung sowie die Unterschiede zwischen beiden Begriffen und die Umsetzung des Konzepts der Ökosystemleistungen in der Governance und Planung von Landschaften. Darüber hinaus wird der detaillierte Begriff der grenzüberschreitenden und stadtnahen Landschaften beschrieben, um zu veranschaulichen, was die Übergangslandschaften sind, die aus einer Mischung aus natürlichen und sozialen Prozessen hervorgehen.*

*Am Ende dieses Abschnitts werden auch die Forschungslücke und der Umfang dieser Arbeit erläutert, die sich auf die Darstellung der Fortschritte meiner Forschung auf dem Gebiet der Governance und der Planung von Landschaften bezieht. Abschließend werden die Forschungsfragen beschrieben.*

*In **Abschnitt zwei** werden die Methoden vorgestellt, die ich bei meiner Forschung eingesetzt habe. Dieser Abschnitt beginnt mit einer detaillierten Beschreibung der quantitativen Methoden, die in den Datenquellen meiner Forschung verwendet wurden. Die quantitativen Methoden umfassen räumlich explizite Indikatoren und andere GIS-basierte Ansätze. Darüber hinaus werden im zweiten Abschnitt die qualitativen Methoden beschrieben, die ich im Rahmen meiner Forschung eingesetzt habe, darunter verschiedene Arten von Umfragen, wissenschaftliche Sessions, Workshops für Interessengruppen und strukturierte Literaturrecherchen. Die Beschreibung der Methoden endet mit einer Erläuterung der Fallstudien, die während meiner Forschung analysiert wurden.*

*Im **dritten Teil** dieser Arbeit werden die erzielten Ergebnisse vorgestellt. Diese Präsentation ist um die Forschungsfragen der Arbeit herum aufgebaut. Im ersten Teil dieses Abschnitts werden die wichtigsten Schritte im Zusammenhang mit Governance und Planung für eine nachhaltige Entwicklung von Landschaften vorgestellt, die aus einer Mischung aus natürlichen und sozialen Prozessen hervorgehen. Die wichtigsten Schritte sind die folgenden: Aufbau von Vertrauen, Planung im Rahmen einer Multi-Level-Kooperation, Koordinierung von Governance- und Planungsaktivitäten im Rahmen eines grenzüberschreitenden Planungsdokuments, Umsetzung kontextspezifischer Governance-Mixe, Bewertung von Landschaftsasymmetrien zur Information über Landschafts-Governance und -Planung, Anwendung sozio-ökologischer Landschaftsmonitoringsysteme, Einbeziehung von Unterstützungsgruppen in Governance- und Planungsprozesse, Umsetzung von Foresight-Methoden und Verwendung des Konzepts der grünen Infrastruktur. Der zweite Teil der Ergebnisse gibt Einblicke in Aspekte, die die Anwendbarkeit von Governance- und Planungsansätzen für Landschaften, die aus einer Mischung aus natürlichen und sozialen Prozessen entstehen, erschweren. Diese detaillierten Erkenntnisse sind unterteilt in die Beschreibung interner Beschränkungen, externer Barrieren (Hindernisse), Konflikte und Kompromisse. Außerdem wird die Übertragbarkeit der Ansätze von einem Kontext auf den anderen erläutert. Der letzte Teil des Abschnitts zu den Ergebnissen beschreibt, wie das Konzept der Ökosystemleistungen genutzt werden kann, um die nachhaltige Governance und Planung von Landschaften zu verbessern. Darüber hinaus zeigt dieser Teil, wie das Verständnis des Konzepts der Ökosystemleistungen bei den verschiedenen Governance-Akteuren verbessert werden kann. Dieser Teil endet mit Überlegungen zu Indikatoren für Ökosystemleistungen, die für die Landschaftspolitik und -planung verwendet werden können.*

*Der **vierte Abschnitt** enthält eine ausführliche Diskussion über die Ergebnisse meiner Forschungsarbeit. Zunächst werden die in den Schlüsselschritten angesprochenen Aspekte erörtert. Dieser Teil zeigt, wie die Ansätze der Schlüsselschritte in der vorhandenen wissenschaftlichen Literatur beschrieben, umgesetzt und kritisch bewertet werden. Darauf aufbauend werden später einige Überlegungen zur weichen Planung von Landschaften vorgestellt. Abschnitt vier schließt mit kritischen Überlegungen zum* *weiteren Weg des Konzepts der Ökosystemleistungen zur Unterstützung von Governance und Planung von Landschaften.*

***Abschnitt fünf*** *enthält Schlussfolgerungen und einen Ausblick, die detaillierte Erläuterungen zu weiteren Forschungsrichtungen im Zusammenhang mit meinen Studien zur Governance und Planung von Landschaften beinhalten.*

*Die Manuskripte, die die Grundlage für diese Habilitationsschrift bilden, sind in Tabelle 1 aufgeführt, während Tabelle 2 einen Überblick über die verschiedenen Forschungsprojekte gibt, die zu den genannten Manuskripten beigetragen haben.*

# 1. Introduction

## 1.1. Motivation and the research streams of the work

My interest in governance and planning of landscapes started with a deep fascination and study of dynamic changes in post-industrial and heavily urbanised landscapes related to my home region of Upper Silesia. In the course of my work, my perception of Upper Silesian landscapes included very important cross border aspects that are related firstly to the Upper Silesia region between Poland and Czech Republic and secondly to the multi-cultural influences shaping this landscape over many years that include not only the Polish and Czech cultures but the German one as well. Studying this landscape allowed me to uncover various sociological and ecological processes that stand behind the visible shape of a landscape, foster its transition and that need to be taken into consideration during planning and governance processes. Later, I started an international cooperation related to landscape research and planning with different institutions situated in Germany (Internationale Bauausstellung IBA Fürst-Pückler-Land and Kassel University), Norway (Oslo School of Architecture and Design), Czech Republic (Technical University of Ostrava, Olomouc University) and most of all European Land use Institute (ELI, Germany). This cooperation facilitated expansion of my understanding of landscapes' governance and planning processes, the shift from qualitative to more quantitative research and to comprehension of an interdisciplinary approach to research sustainable governance as well as planning practice. During that period, the search for sustainable approaches to respond to governance and planning challenges related to landscapes borders, boundaries and intensive landscape (peri) urbanization became the main personal motivation behind my research works.

The habilitation thesis, summarizing my research works concerning governance and planning of landscapes emerging from a mix of social and natural processes, is built around three main research streams (Figure 1). The **first** (**overall) stream** of my work relates to research about the ecosystem services (ES) concept. My interest in this concept concerns practical implementations of it in planning, policymaking and academic teaching. Importance of this aspect was confirmed during implementation of several research projects (Edu2Work, INTERact, SERVICES and RENATUR). Implementation of these projects showed, for example, that to make the ES concept better suited for governance and planning, such services need to be measured in a spatially explicit way. This aspect inspired my further studies related to ES indicators (# III La Rosa et al., 2015). Implementation of my research and consultancy projects showed importance of consensus among various governance actors. To get better insights into this aspect, I have analyzed how ES concept can contribute to participatory planning processes (# IX Spyra et al., 2018). This study checks if the ES concept can be used as a universal tool – a new kind of Esperanto – to obtain consensus about governance and planning issues among various actors. Such an approach could be supported by raising awareness of ES built upon excellent teaching of the ES concept in different groups of society and with proper teaching methodologies (# XIII Palacios-Agundez et al., 2022). Knowledge about ES is useful for reducing trade-offs related to them (# X Spyra et al., 2020) and for better understanding how to approach them in planning ES deficit areas in urbanized landscapes (# VIII Spyra et al., 2019).

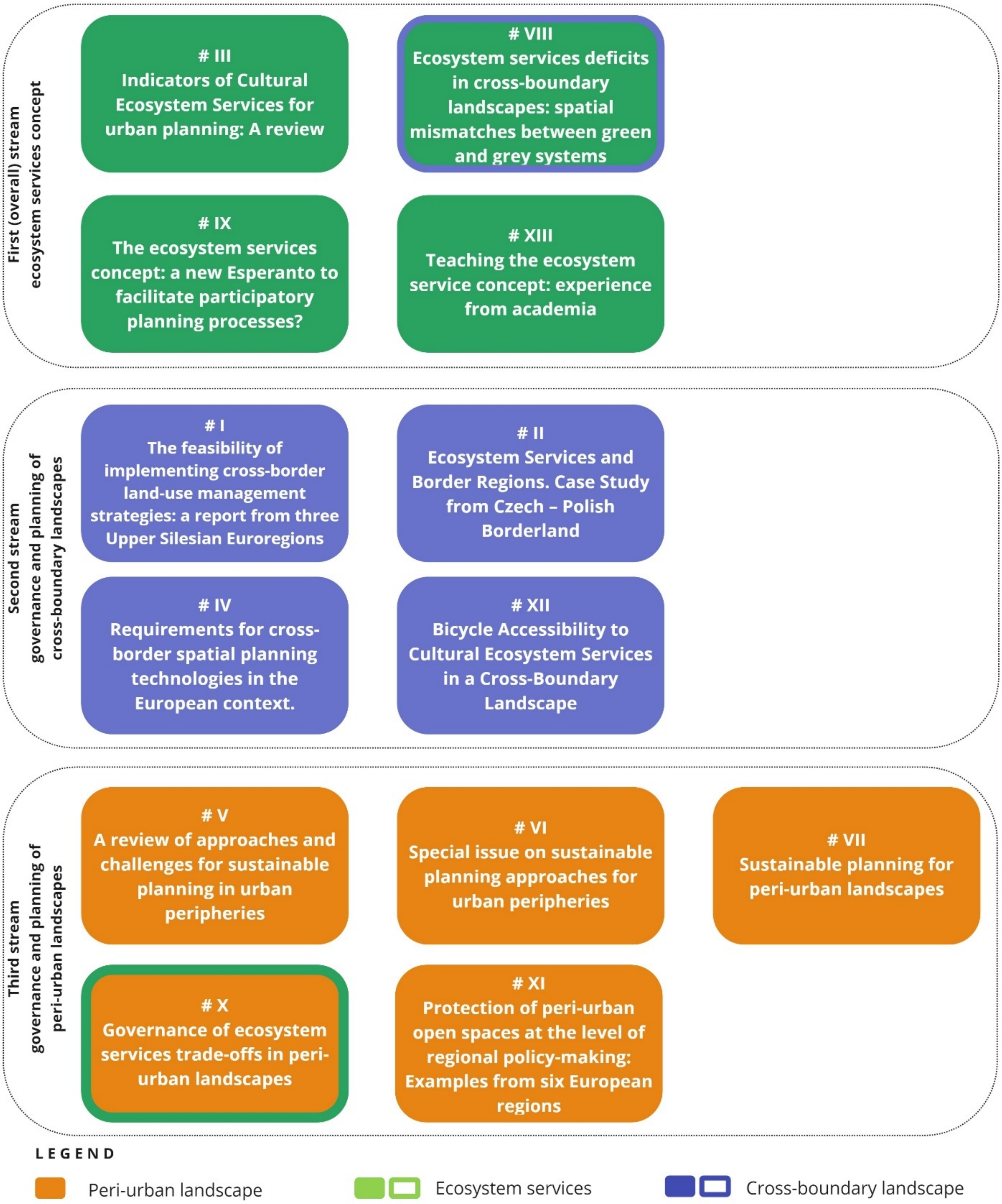


**Figure 1** Concept map showing research streams and their connections to publications. Source: own elaboration

The **second stream** of my work relates to cross-boundary landscapes (CBLs). The idea to work with CBLs was born in year 2013 with implementation of two Czech-Polish research projects related to Silesia Euroregion (research project School without Borders) and to Pradziad Euroregion (research project KOPR and Edu2Work). During implementation of these projects, I discovered that governance and planning concerning the national borders on the regional scale remains challenging in many ways (# I Spyra 2014), and that such challenges are often related to asymmetries within CBLs (# II Spyra 2014). Moreover, many CBLs suffer from marginalization and socio-economic problems (Bondaruk et al., 2015). Thus, such landscapes need optimal governance and planning approaches that are tailored to their specificity and supported with spatial planning technologies (# IV Frank et al., 2017). Moreover, various aspects of ES, such as ES deficit areas (# VIII Spyra et al., 2019), or accessibility to such services (#XII Spyra & Hamerla, 2021) need to be better addressed in governance and planning of CBLs.

This stream of my research has been implemented also on the interface between university teaching and researching (research project Edu2Work). I organized or co-organized several Czech-Polish student workshops addressing aspects of CBL planning (Obracaj & Spyra, 2012; Spyra, 2013b, 2013f, 2013d). Feedback received after those workshops shows that this topic was interesting for students and gave them the opportunity to analyze complex governance and planning problems in an interdisciplinary and international environment. To make the workshop projects useful for governance and planning processes, consultations were organized with planners and policymakers coming from the Czech-Polish borderland (Spyra, 2013a).

The **third stream** of my work concerns aspects of peri-urbanization of landscapes. Initial inspiration for this research was related to two reports prepared by ESPON. The first one, titled “FOCI Future Orientation of Cities” published in 2010 concludes that one of the most significant risks for landscape sustainability are suburbanization processes (Espon, 2010). The second one titled “Inner Peripheries: a socio-economic territorial specificity” published in 2013 elucidated peripheralization and marginalization processes taking place in different landscapes. These processes were introduced also from the point of view of urban landscapes, where new urban peripheries are constantly emerging, taking different shapes and being to various dynamic socio-economic drivers (ESPON, 2013). Both reports provide inspiration to work on a review of approaches and challenges for sustainable planning of urban peripheries (# V Geneletti et al., 2017). Moreover, those reports inspired work on the special issue of Landscape and Urban Planning journal, where I was a member of the guest editor team (# VII La Rosa et al., 2017). Topic of this special issue was related to sustainable planning approaches for urban peripheries.

Third research stream was built upon two research projects prepared, submitted and coordinated by me (research project INLAND and RENATUR). Both projects addressed governance and planning aspects of peri-urban landscapes (PULs). Specifically, an on-going RENATUR project offered me a possibility to directly work with regional policymakers about issues related to PULs and to protection of natural heritage of peri-urban open spaces. Thanks to this project, I have had an excellent opportunity to work in the interface between science and practice (here policy-making) and to implement outcomes on this work into my research activities concerning ES trade-offs in PULs (# X Spyra et al., 2020) and governance approaches to protect peri-urban open spaces (# XI Spyra et al., 2021).

PULs, due to diversity of governance problems and a variety of governance actors affiliated to various administrative units and their transitional character, are offering an excellent laboratory for testing different research ideas. Some of these ideas have been implemented in the framework of the International Association of Landscape Ecology (IALE) working group “Urban and Peri-urban governance”. Since 2018 I have been the leader of this working group. This has offered me an excellent opportunity to obtain international feedback concerning the topic of peri-urbanization and to organize several scientific sessions and workshops related to it.

My research and university teaching has also been joined by consultancy work stretching across various landscapes and scales. Representation of different general fields of my work is shown in the

Figure 2, which is inspired by a "pattern language" approach where each pattern describes a specific issue that is pertinent to landscape governance and planning (Alexander et al., 1977). The addressed topics in these general figure fields were elaborated in the framework of various research projects (Table 2), but also in the context of a few consultancy and planning works mostly implemented just after obtaining the PhD title. The two types of works are differentiated in Figure 2.

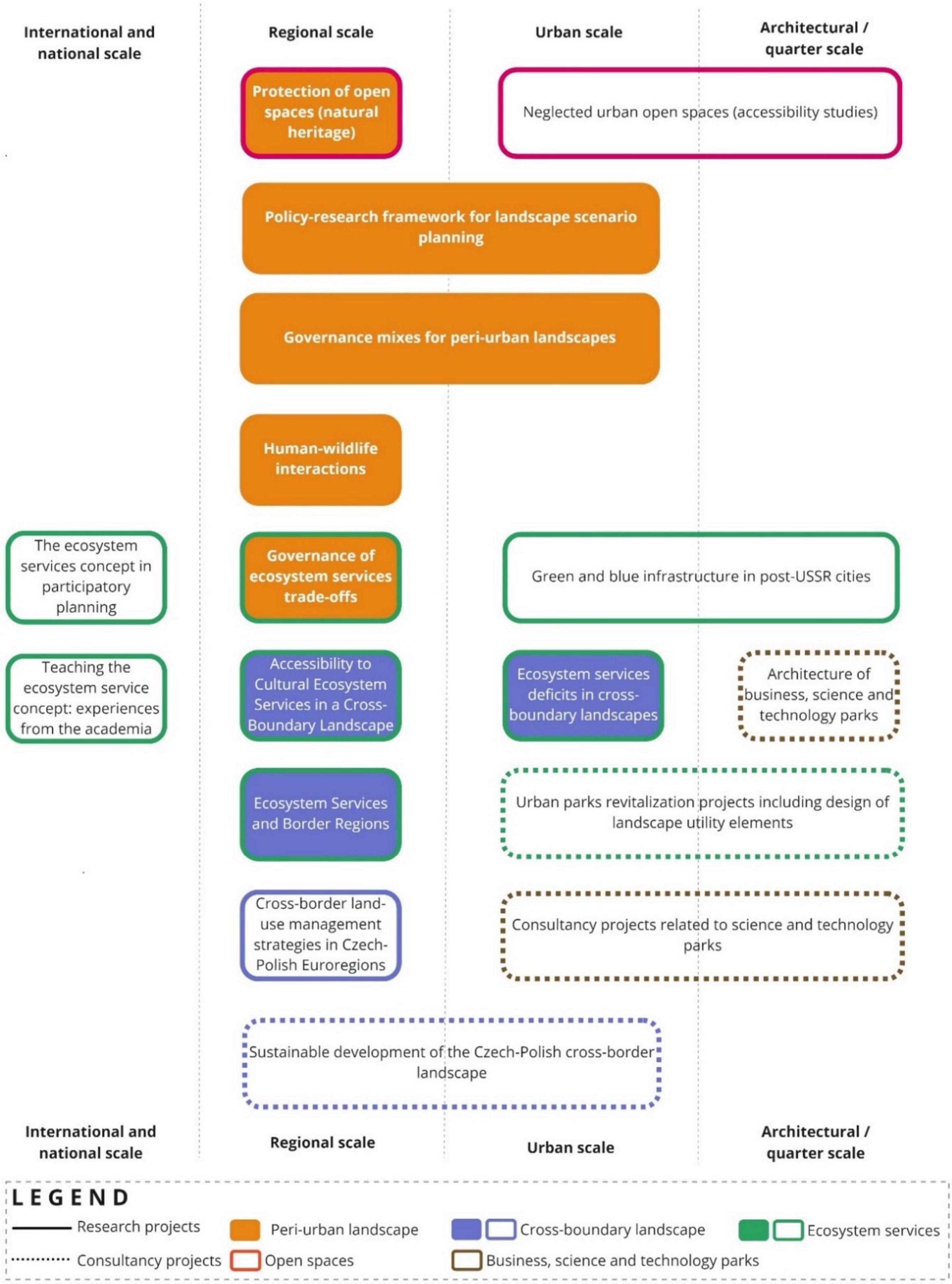


**Figure 2** Pattern language explaining different general fields of research and consultancy work, finalized or on-going, implemented in the time of working with habilitation. Source: own elaboration.

## 1.2. Governance and planning

The concept of governance offers a good possibility to serve as an overarching term that includes different activities related to taking and implementing decisions. It is also more general compared to terms of policymaking and planning. The definition of governance is most likely based on UN-Habitat which defines governance as "the sum of the many ways individuals and institutions, public and private, plan and manage the common affairs of the city. It is a continuing process through which conflicting or diverse interests may be accommodated and cooperative action can be taken."[1] Similarly, for (Fukuyama, 2013) the concept of governance is related to the "government's ability to make and enforce rules (…) and the performance of agents in carrying out the wishes of principals." While governments are responsible for ensuring a certain set of services, the provision of these services is a task that should be distributed among government, private sector and civil society who benefit from the same services. Moreover, Lemos and Agrawal (2006, p. 298) refer to governance as "the set of regulatory processes, mechanisms and organizations through which political actors influence environmental actions and outcomes." (Lemos & Agrawal, 2006).

Governance as a concept and a term used by scientists, experts and decision-makers already has a history longer than 30 years. Nevertheless, translation of this word into other languages is still problematic since it suggests activities implemented specifically by different official governing bodies (Nadin et al., 2018).

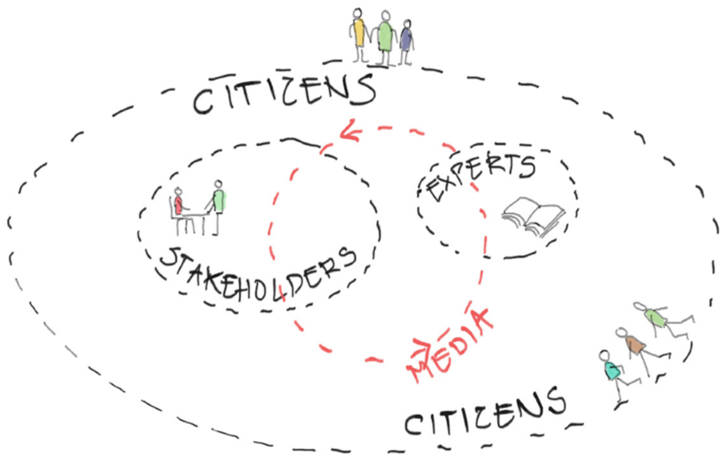


**Figure 3** Interactions of three groups of governance actors: citizens, stakeholders and experts. Source: own elaboration

Governance provides answers concerning how to solve a specific problem and at the same time who should solve it. Thus, this concept also relates to interactions of different actors, who take part in decision-making processes, or have a say in such processes. Since more than 10 years landscape governance has become an "arena for scientists" (Beunen & Opdam, 2011), but surely landscape governance is not limited only for them. In landscape governance processes we distinguish three main groups of governance actors: (a) experts/scientists defined as objective knowledge holders; (b) stakeholders defined as having a particular interest as they represent a community or group interest (stake); and (c) citizens/laymen as the group being affected, but not organized to represent a shared interest (# IX Spyra et al., 2019) (Figure 3).

There are specific risks related to governance processes. This includes for example: missing institutional and administrative "cover" in governance process, lack of financial and human resources (Dahiya, 2003), unclear and non-binding legislation either influencing governance processes, or

[1] Source: https://unhabitat.org/fr/node/142498 accessed July 2022

prepared in the framework of it, lack of political will (Romero, 2015). Such risks could foster not only landscape degradation but also poor living conditions for its inhabitants.

Planning is related to achieving specific objectives through actions performed in a specific sequence (Hall & Tewdwr-Jones, 2011). The same authors specify that spatial planning (a type of spatial governance related specifically to a specific territory) aims to describe a spatial structure (structure of land uses) that “in some way is better than the pattern existing without planning” (Hall & Tewdwr-Jones, 2011, p. 3). In this way “plans”, as major outputs of planning, are multifunctional documents, “dealing with a combination of visionary, strategic, policy and regulation tasks” (Nadin et al., 2018, p. 76) helping to establish desired spatial structure. Contemporary planning focuses very much on a complex process. Importantly, planning processes, understood as thoughtful mixes of design and analysis methods, process-oriented approaches, tools, paradigms and concepts implemented to prepare a plan for a spatial structure, are constantly gaining in importance, while lesser focus is put on “plans” as end products of the planning process. In this way plans as such are not seen as the most valuable outputs for these processes. Since more than ten years, specifically in a European Union context, planning theory has been distinguished by “soft” planning approaches that are characterized by non-formalized and non-binding procedures aiming to achieve consensus among governance actors (Kaczmarek, 2018) whereby informal rules are negotiated in context-specific and bottom-up processes (Purkarthofer et al., 2021).

Traditionally, planning is seen as an activity “done by human beings for human beings” (Chadwick, 1978, p.25). Currently the focus in planning is put more on steering sustainable development in order to protect landscapes and the various ecosystems included within them. Thus, planning turns into ecological planning approaches (as described loosely in literature) in which biophysical and socio-cultural systems are analyzed together in order to identify the most sustainable configuration of land-uses for all (not only human) species. (Steiner, 2000). The central role in this approach is played by education and citizens’ involvement. This provided a foundation for different concepts such as landscape urbanism (Waldheim, 2006), ecological urbanism (Mostafavi & Doherty, 2010), and finally landscape ecological urbanism whose overall aim is to plan urban and peri-urban systems in order to increase the ES offered by them (Steiner, 2011). Nevertheless, all these approaches to planning need to be based on ecological wisdom that is defined by evidence-based concepts, principles, strategies, and approaches to create or sustain the longevity of sustainable landscapes (Xiang, 2014).

Differences and overlaps between governance and planning are synthetized in Figure 4. Accordingly, these synthesis governance and spatial planning processes are both dynamic processes that need to consider the interplay of various actors and networks. Moreover, both are based on collections of formal and informal institutions (arrangements, norms, discourses, values), but spatial planning is more "formalized" than governance. It means that planning is historically rooted in a language, a specific place, often described in a local law (e.g. defining guidelines about land use, environment, demography, infrastructure, heritage, economy or even design) and subsumes a complex field of site-specific policy and administration (# IV Frank et al., 2017). Nevertheless, the overall aim of spatial governance and planning is improvement of a specific territorial situation, in other words, steering landscape development in a sustainable direction.

In my research I have been working not only with landscape governance topics (# X Spyra et al., 2020), but also with aspects of land use management (# I Spyra 2014), policymaking (# XI Spyra et al., 2021), spatial planning (# IV Frank et al., 2017; # V Geneletti et al., 2017; # VI La Rosaet al., 2017; # VII La Rosa et al., 2018) and participatory planning (# IX Spyra et al., 2019). For the sake of clarity in further parts of this thesis I will speak about governance and planning.

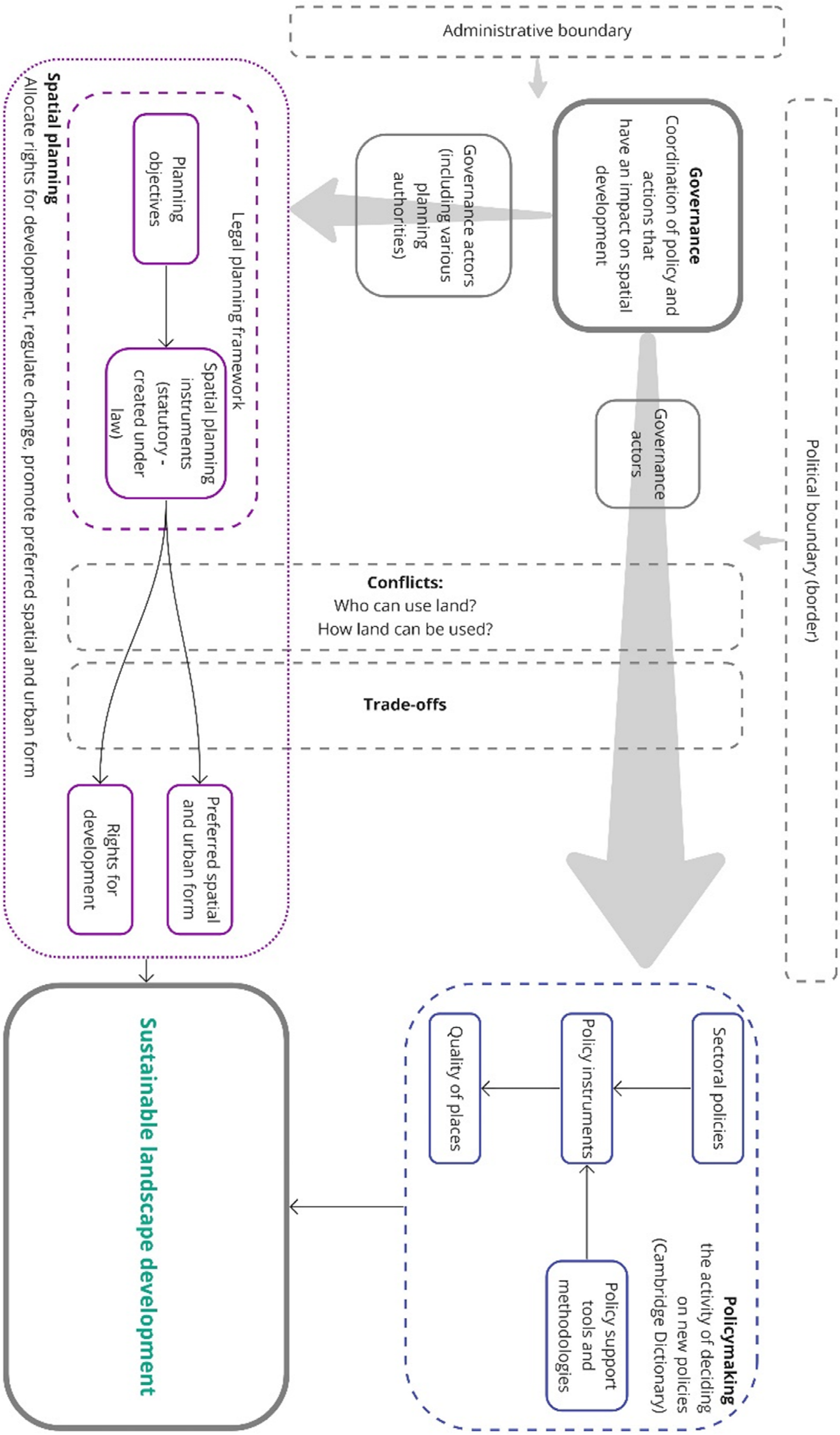


**Figure 4** Different "flows" of governance and planning processes that influence sustainable development of landscapes at different scales and across these scales. Own elaboration based on (Nadin et al., 2018).

## 1.3. Ecosystem services concept in landscape governance and planning

Landscapes are able to provide various services to a society. A capacity of landscapes to provide specific services is called landscape functions (Bolliger & Kienast, 2010). The concept of landscape functions has similarities to ecosystem services (ES) that are the benefits obtained by humans from nature. The ES concept emerged from ecological economics in the 1990s and has allowed various governance actors to jointly consider ecological processes and human activities in governance and spatial planning (Wilkinson et al., 2013).

If well introduced, the ES concept can help to overcome obstacles in governance and planning processes by finding a common Esperanto-like language among diverse governance actors (# IX Spyra et al., 2019). In this way the ES concept can be understood as a transdisciplinary boundary object that helps to achieve a cohesive understanding of various environmental challenges by different governance actors (Reyers et al., 2010; Schröter et al., 2014). For example, it can contribute to development of a common ground among actors related to understanding of planning priorities, aims, obstacles that are emerging during governance and planning processes in relation to the environment (Rozas-Vásquez et al., 2017; Woodruff & Bendor, 2016) (Dick et al., 2017), support implementation of ecosystem's management policies at the regional level (Palacios-Agundez et al., 2013) or connect social processes with ES to improve landscape management (Cowling et al., 2008). In addition, the ES concept can help various governance actors to enhance their understanding of the benefits they obtain from ecosystems. Those ideas are in line with the hope related to operationalizing ES (Folke et al., 2011), which seeks to establish a set of policies and planning tools oriented toward the support of strategic analyses of ES synergies and trade-offs, reducing the harmful impacts on human well-being and fostering economic growth under a sustainable planning scheme (MA, 2005).

Several scientific efforts have been made to analyze if and how ES are included in legally binding planning documents at different spatio-temporal scales (Cortinovis & Geneletti, 2018; Mascarenhas et al., 2014). Nevertheless, incorporating the ES concept into planning and reducing the gap between ES science, ES policy and its implementation are still critical issues that are addressed in research (Kaczorowska et al., 2015). The research indicates that the ES framework still lacks a systematic integration into planning (De Groot et al., 2010; Kabisch 2015, Albert et al. 2014), the existing integration of the ES concept into planning remains rare (Grêt-Regamey et al., 2016) or challenging (Kaczorowska et al., 2015).

The most prominent critique of the ES concept in planning is the underlying anthropocentrism, which could emphasize economic and political benefits while potentially neglecting intrinsic values within nature (Roces-Díaz et al. 2015; Wilkinson et al., 2013). Another critique is that there exist different conceptual definitions of ES, which makes it difficult for policy-makers and planners to obtain a clear orientation (Albert et al., 2014; Danley & Widmark, 2016). In addition, the valuation of ES might fluctuate according to societal and economic changes (Tammi et al., 2017; Wilkinson et al., 2013) as well as across institutional and spatial scales (Hein et al., 2006; Rozas-Vásquez et al., 2018). Furthermore, ES related values are strongly place dependent (Hauck et al., 2013). The valuation system, valuation performance and conceptualization have severe implications for the valuation itself (Hein et al., 2006; Jacobs et al., 2016; Vatn, 2009). While using the ES concept to work with different governance actors, the critical factor is the biased attention to visible and directly usable ES, which are mainly provisional and cultural ES (Rodriguez et al., 2006). This could undermine the value of regulating and maintaining ES, as well as the ES which are located far away from benefiting areas (Tammi et al., 2017).

A common challenge to utilizing the ES concept in planning processes is that the concept might be seen as too complex, does not meet the requirements for planning applications, and might be misinterpreted in practice (Balmford et al., 2011; Hansen et al., 2015; Sander et al., 2016; von Haaren et al., 2014). Thus, there is a need to limit ES complexity to specific scales in order to avoid confusion, especially if non-scientific governance actors are involved (Jacobs et al., 2016). But this approach could miss important linkages across different temporal and spatial scales (Groot et al., 2010; Harrison-Atlas et al., 2016; Sander et al., 2016; Tammi et al., 2016). For example, Konarska et al. (2002) and Grêt-Regamey et al. (2014) identified differences in ES values depending on the applied resolution.

## 1.4. Conceptualization of landscape

The notion of landscape represents different meanings and, similar to usage in the Nordic (Norwegian and Swedish) languages regarding *landskap* (or *landskab* in Danish), goes much beyond merely a "picturesque view" in that it leans toward the broader meaning that a landscape is a complex and ever-changing system (Steiner, 2000). Understanding landscape encompasses aspects such as historical developments, socio-economic aspects, purely cultural influences, psychological and religious connotations (Schama, 1995) as well as configurations of ecological components and different ecological flows in a landscape. Nevertheless, the word "landscape" has a slightly different and more subjective meaning in different socio-cultural contexts and in different languages. Also, scientific disciplines use the notion of landscape in different, sometimes contradictory ways (Nassauer, 2012). This could cause some confusion related to delimitation of a landscape and also to planning or governance approaches applied to it (Sandström & Hedfors, 2018). This underlines a role of context specific planning approaches that are tailored to different types of landscapes (# V Geneletti et al., 2017, # X Spyra et al., 2020).

The (subjective) role of a landscape observer is important for conceptualization of a landscape. European Landscape Convention (ELC) says that "Landscape means an area, as perceived by people" (p.3, chapter 1 of ELC). Thus, it is important to be aware of what portion of a plot of land we perceive before discussing its peculiarities. ELC stress the "interaction of natural and / or human factors" (p.3, chapter 1 of ELC). Such dynamic interactions result in a unique character of a landscape and are, for instance, a core attribute of peri-urbanization processes taking place in many landscapes, which are also (but not only) reflected in land use / cover changes related to them (# XI Spyra et al., 2021).

In the physical dimension landscape conceptualization is often based on a classic definition, in the context of landscape ecology, provided by Forman and Gordon whereby a landscape is a "heterogenous land area composed of a cluster of interacting ecosystems that is repeated in a similar form throughout" (Forman & Gordon, 1986, p.11). It has similarities to the recently provided definition by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)[2], wherein a landscape is an "area of land that contains a mosaic of ecosystems, including human-dominated ecosystems". Such an approach allows one to identify different physical (tangible, biophysical) "elements" that are forming a landscape. In the context of a patch-corridor-matrix model (Forman, 1995), such elements could be different types of natural, semi-natural, or urban ecosystems, or even ecotopes and biotopes. Such elements could be also understood as various types of land cover / land uses observed in different proportions (landscape composition). Those tangible elements are characterized by different spatial physiognomies, creating various landscape configurations (Arroyo-Rodríguez et al., 2016). Due to the dynamic character of landscapes, the configuration of landscape elements remains also dynamic and changing over time (Tolessa et al., 2016). Such transitioning processes are to be addressed when conducting planning or governance for any landscape (# VII La Rosa et al., 2018).

[2] https://www.ipbes.net/glossary/landscape, accessed on-line, November 2021.

In the social dimension, where a landscape could be called “socio-scape”, “power-scape” (Palang et al., 2011), or “political landscape” (Jackson, 1984) components of a landscape can also be classified as intangible (e.g. cultural elements). This allows us to focus landscape studies not only on a dimension of landscape as a spatial entity, but also as a complex mental, or temporal entity (Wu, 2013).

In the habilitation thesis I focus on **landscapes that emerge from a mix of natural and social processes.** Natural and social processes shaping landscapes are sometimes difficult to notice, thus their influence over landscapes can remain underexplored and hard to grasp in governance or planning (Nassauer, 2012). In my research I have been studying in detail two major groups of social processes that shape landscapes. The first group of such processes is related to the presence of borders and boundaries lines in a landscape that are examples of intangible landscape constituents (# VIII Spyra et al., 2019). Such lines are a representation of socio-political processes of “bordering” and “de-bordering” that significantly influence landscapes. The second group of social processes is represented in my research by peri-urbanization, which involves dynamic transformation of natural landscapes into hybrid forms of landscapes, mixing natural and anthropogenic characteristics. Both groups within the social processes, described in detail in the following sub-section, are inextricably correlated with natural ones such as water cycle, soil formation, interactions between plants and animals. These natural processes are mainly driven by human activities taking place in analyzed landscapes. It confirms that a boundary between social and ecological systems is fluid and often rendered arbitrary by humans. Thus, assessments of, for example, energy flows, water cycles, succession or many other ecological processes are influenced by outcomes of on-going various social processes.

Conceptualization of landscapes that emerge from a mix of natural and social processes shares some similarities with the concept used in ecology of socio-ecological systems as both notions are reflection of interconnected relationships between ecosystems and society (Francis & Bekera, 2014). Nevertheless, analyses in my research landscapes represent a less abstract concept comparing to socio-ecological systems. Socio ecological systems are difficult to precisely define and to delimitate due to the importance of cross-scale interactions (Nelson et al., 2010). Thus, such systems are difficult to translate into practical operations of planning and governance.

## 1.5. Border and boundaries in landscapes

Despite different socio-economic and political transformations, visible particularly in the extent of the European Union, the political border dividing sovereign countries still remains an important element influencing landscapes, society or international trade (Diener & Hagen, 2009). Thus, the border remains a very important issue from the point of view of analysis of socio-economic processes shaping landscapes and influencing their governance (# I Spyra, 2014). The essence of the border notion remains unchanged and is related to the desire to isolate oneself from others in order to cope with the fear of this “otherness” (Scott & van Houtum, 2009) and as a barrier limiting or preventing mobility (Spierings, 2013). A border divides territories in terms of administrative and geopolitical aspects, but also cultural, economic and social ones (Haselsberger, 2014). In this context a border is not only a two-dimensional line, a result of political processes represented on a map, but is a vertical surface crossing this line and dividing three-dimensional space of one country from similar space belonging to the other. To describe an area located close to a border, human geography is using terms like borderland (an area located close to a boundary), political frontier, or even settlement frontier (Newman & Paasi, 2013). In this context a border line divides areas characterized by various political, legislative, administrative, cultural, social, institutional, environmental ownership (Balawajder, 2013).

Originally, the state border was determined by naturally shaped landscape elements (mountain ranges, rivers, deserts) and had the form of a border strip, which also served as a defensive line. This type of border is referred to as the "good" border (Minghi, 1963; Prescott, 1987; Van Houtum, 2005).

Over time, with the development of societies and under the influence of transformations among national states (shifting state borders, formation of new states), the spatial form of the border also changed. The border area become tighter, and has gradually evolved towards the borderline known today (Balawajder, 2013). In this sense we speak about a political border that could be based on an artificially delineated lines in the landscape. This type of artificially drawn line in the landscape is sometimes described as the "bad" border (Minghi, 1963; Prescott, 1987; Van Houtum, 2005), or a „chasm" in a landscape (Heidegger, 1995). It strongly separates two parts of a landscape causing socio-economic development disturbances (Kilburn et al. 2013), a reduction in the interaction between places, or even leads to "urbanism of exception" as in the case of Jerusalem (Boano & Martén, 2013). Such processes taking place in a landscape are called re-bordering (Herzog & Sohn, 2014).

As Van Houtum (2005) notes, "the debate about boundaries turns away from labeling them natural (…); every state or political border is a work of man". In specific socio-political circumstances a de-bordering process can take place (Herzog & Sohn, 2014) where a permeability of border increases (Balawajder, 2013) and a border becomes more a "filter", a "contact zone" (Lezzi, 1994), or a "bridge" that joins citizens living on both sides of it (Heidegger, 1995). Then it becomes important for local governance initiatives implemented over a border (# I Spyra, 2014), or for local (cross-border) inhabitants' well-being (# XII Spyra & Hamerla, 2021). Such a "positive" border could be an important symbolic element for a city or a region, underlining its international character (Spyra, 2013f, 2014). Such a positive contact zone border can be understood (delimitated, described) differently depending on the scale of an analysis. Its impact on a landscape can therefore be analyzed on a regional scale relating to a specific cross-border region and in an urban scale relating to a specific urban system (e.g. metropolitan area) (Inostroza et al., 2019). Moreover, border impact can also relate to a specific city (# VIII Spyra et al., 2019).

Less strict and emotional discussions are related to administrative boundaries located within a country that are lines dividing different administrative units like federal states in Germany, voivodeships in Poland, or smaller administrative units like communes. Nevertheless, some peculiarities of a state border are similar to administrative boundaries. They are related to separation of specific land, delimitating a jurisdictional outrange, or sometimes also a cultural (in the case of regions) outrange and influence that they have over a local economy.

For the sake of clarity, I will further in this thesis use only the term "boundary". My research has focused on aspects of national and administrative boundaries without directly addressing directly another aspect of landscape components boundaries that is pertinent for landscape conceptualization, which is an important aspect in landscape ecology approaches (Forman & Gordon, 1986).

"Landscape is no respecter of territorial or administrative borders and is a highly pertinent policy-praxis arena within which cross-border cooperation can progress." This sentence written by McClelland (2020) reflects the issue of borders and boundaries in the landscapes in a clear way. Using this perspective, a **cross-boundary landscape (CBL)** is a cohesive unit from an ecological point of view but is divided into two or more administrative units. This mismatch between the ecological and political structures of a CBL renders its quantitative assessment challenging (#VIII Spyra et al. 2018). Thus conceptualization of CBLs stands between the physical and social dimension of the landscape notion since its analysis requires an understanding of what has been done to them in the past and what their current status is (Palang et al., 2011).

CBLs are characterized by specific asymmetries (# II Spyra, 2014; # VIII Spyra et al., 2019). Such asymmetries are related to a boundary that divides a landscape and does not necessarily follow ecological functions (Brüll et al., 2017). The spatial asymmetries of a CBL are the measurable differences in landscape configuration and composition identified on both sides of the boundary line

(#2 Spyra 2014). Asymmetries in CBLs are also related to differences in landscape legislation that is binding on both sides of a boundary line (# II Spyra, 2014).

CBLs emerge in several phases. If a CBL is located inside a cross-boundary region (a region that stretches across two or more sovereign countries), then it is possible to speak about four stages of its creation: (1) alienation phase; (2) coexistence phase; (3) significant interdependence phase; (4) an integration phase (Krakover, 2011; Martinez, 1994).

## 1.6. Peri-urbanization of landscapes

Peri-urbanization is a process of expansion of artificial areas into untilled (open) areas, accompanied by diverse socio-economic transformations, taking place beyond urban boundaries (# XI Spyra et al., 2021). It is a multifaceted and dynamic process characterized by dynamic land use/cover changes, changing socio-economic conditions. The process relates to constant colonization of agricultural and forest landscapes through different urban land use changes (# V Geneletti et al., 2017), a sharp increase in built-up areas (Alipbeki et al., 2020), or growth of informal settlements resulting in unauthorized land conventions (Adam, 2014) taking part also in violent encounters between settlers and representatives of local government (Lombard, 2016). Peri-urbanization of landscapes is fostered by presence of dynamically developing cities that are hotspots of urbanization. In this case not only a proximity to such a hotspot matters, but also a level of its socio-economic development matters. Peri-urbanization of landscapes relates also to socio-economic changes. For example such changes are processes of social segregation and decomposition of social structures of the existing landscapes (Woltjer, 2014). Nevertheless, perception of peri-urbanization challenges varies in different socio-cultural contexts. For instance, the processes of urbanization of rural areas that can be understood as a type of peri-urbanization process, despite its ecological challenges, are also seen as having positive socio-economic outcomes. Such positive outcomes are for example related to processes of reduction in rural marginalization and poverty in rural areas through improved accessibility to diversified labor market, health services and public transportation, reducing proportions of child labor and reduction of population living in slums or unofficial settlements (Guo et al., 2022).

Such processes foster creation of a specific and transitional type of landscape a **peri-urban landscape** (PULs) (# X Spyra et al. 2020). PULs are territories that are partly located outside the more compact part of a city and can spread to the surrounding rural or forest areas following low-density patterns of development (# VII La Rosa et al., 2018; # X Spyra et al., 2020). PULs are characterized by low density and a mixture of diverse land uses, including non-urban, semi-natural uses, agricultural and forest areas (Gallent & Shaw, 2008; # X Spyra et al., 2020). Two major types of PULs are peri-urban forests and peri-urban agriculture (# VII La Rosa et al., 2018). PULs are often vernacular landscapes, designed to be changed by their users, and peri-urban land uses are the fastest growing land use type in North America, for example (Nassauer, 2012). Changing, dynamic, complex and heterogenous nature of PULs fosters problems with delimitation of such landscapes. Existing methods for PULs delimitation covers, for example, using population density of particular classes of Corine land use/land cover and logistic regression models (Zasada et al., 2013), implementing views and attitudes of different governance actors affiliated to PULs (Žlender, 2021), or using a mix of demographic census data, commuting data and administrative boundaries data (Cattivelli, 2020). Experiences gathered during stakeholder workshops implemented in the frame of RENATUR project point out that, from the point of view of local stakeholders, a densely populated metropolitan area of Bilbao (Spain), or many parts of Flanders (Belgium) are fully covered by either urban or peri-urban landscapes.

PULs are complex systems (#VI La Rosa et al., 2017). Complexity of PULs have been observed in different contexts by many scholars: in the context of the large global metropolis of Beijing (Zhao, 2013), or interlinked agricultural and peri-urban systems (Butt, 2013), or to introduce peri-urban ambiguity in Australia (Amirinejad et al., 2018). Addressing complexity of PULs in governance and spatial planning needs to be based on acknowledgement of the high unpredictability of such systems and on dissemination of knowledge related to PULs peculiarities related mainly to their transitional (ambiguity) character (# X Spyra et al., 2020).

PULs are examples of "soft spaces" meaning new, emerging, non-statutory, informal spaces that are overlapping, intersecting or complementing other spaces (Jacuniak-Suda et al., 2015; Purkarthofer et al., 2021). They differ from formal spaces that are traditional statutory, well delimitated spaces addressed by existing governance and planning legislation (Haughton & Allmendinger, 2007). Moreover PUL's boundaries, just like soft spaces boundaries, are fuzzy (Stead, 2014).

PUL is a specific **type of urban periphery** along with areas like urban fringes, urban edges, suburban areas, exurban areas (# V Geneletti et al., 2017, #VI La Rosa et al., 2017). Nevertheless, there are overlaps of PUL terminology with other terminologies explaining urban peripheries (# X Spyra et al., 2020). Other studies explain that "urban-rural fringe", "urban fringe", "city fringe", "rural-urban interface", "edgelands", or "exurban" are actually synonyms for "peri-urban" (Mortoja et al., 2020). Such overlap of notions is characteristic also for a different term that is close to the PUL notion, namely urbanized rural areas, which indicates similarities with desakota, urbanized villages, town villages, hidden urbanization, or in-situ urbanization. Thus, there is an overlap between several terms is a specific issue characteristic for transitioning landscapes and areas. A graphical representation and regulation of the terminology issue related to "peri-urban" is presented in Figure 5.

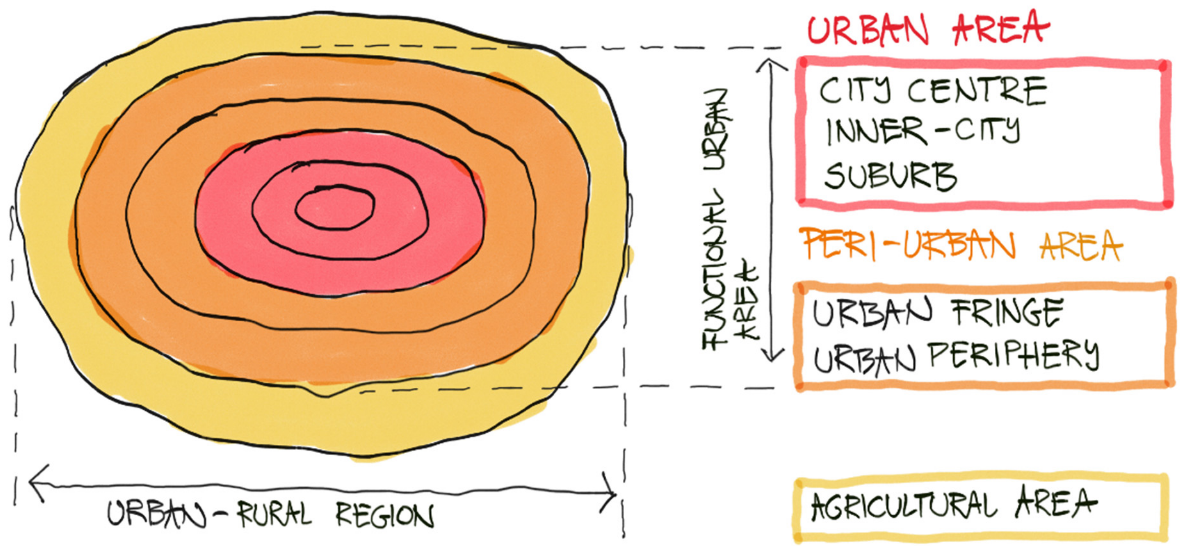


**Figure 5** Structure of urban and peri-urban areas. Own elaboration based on PRULER project report (Piorr, Ravetz, & Tosics, 2011) and on the sketch prepared by Cedric Price, titled "Three Eggs Diagram".

## 1.7. Research gap

Landscapes that emerge from a mix of natural and social processes and span over several administrative boundaries, or even national borders, and are often not addressed by a cohesive policy or planning documents that refer to all specific challenges of such landscapes (# X Spyra et al., 2020; # XI Spyra et al., 2021). Such challenges introduced above are context specific and difficult to address in the frame of sustainability planning and governance. Moreover, overall research (meaning that it addresses cross-cutting issues) about governance and planning approaches suited for such types of landscapes is still limited, leaving important governance and planning good practices in niches related to specific, context-oriented case studies (# V Geneletti et al., 2017; # VI La Rosa et al., 2017). The dynamic and transitional character of such landscapes calls for constant research activities that address them. I have been studying such landscapes based on examples of CBLs and PULs located in the European context and beyond. My research contributes to closing this gap by describing and discussing the *key steps* on how to govern and plan landscapes that emerge from a mixture of natural and social processes in a sustainable way (# I Spyra, 2014; # IV Frank et al., 2017; # V Geneletti et al., 2017; #VI La Rosa et al., 2017; # XI Spyra et al., 2021) and on how to use the ES concept in such planning and governance practices (# VIII Spyra et al., 2019; # XI Spyra et al., 2019; # X Spyra et al., 2020; # XII Spyra and Hamerla, 2021).

Quantitative landscape assessment methods suited for landscapes emerging from a mix of sociological and natural processes, exemplified here by CBLs and PULs, despite the isolated efforts of certain institutions such as the European Environment Agency (# IV Frank et al. 2017; # I Spyra, 2014), are still lacking. My works contributed to filling this research gap by introducing and implementing spatially explicit methods to assess such landscapes (# VIII Spyra et al., 2019; # XI Spyra et al., 2021).

Even if the ES concept is well described from different angles in scientific literature, its practical implementation in governance and planning practices still remains a challenge for some governance actors. It is usually not a challenge for experts, or scientists, who are aware of it, but more often for planners, or quite often for various stakeholders or citizen groups (RENATUR research project). My research contributes to closing this gap by analyzing the following: how the ES concept could become an "Esperanto" language among governance actors (# IX Spyra et al., 2019), how it could be useful for governance of PULs (# X Spyra et al., 2020) and how this concept could be used to a landscape spatial asymmetry assessment (# VIII Spyra et al., 2019). Moreover, my research analyses how the ES concept should be taught at universities and high schools to increase understanding among different groups within society (# XIII Palacios-Agundez et al., 2022).

## 1.8. Scope and research questions

The overall scope of this habilitation thesis is to display what the advancements of my research in the field of landscape governance and planning are – with a specific focus on landscapes emerging from a mix of social and natural processes. The thesis spans the bridge over the research streams (Figure 1) represented by publications (Table 1) that are attached as full texts in the annex to this thesis.

Moreover, the thesis addresses the following bridging **research questions**:

(1) What are the key steps towards improved governance and planning for sustainable development of landscapes that emerge from a mix of natural and social processes?

(2) What kind of aspects hamper usability of governance and planning approaches for landscapes that emerge from a mix of natural and social processes?

(3) How can we make use of the ecosystem services concept to enhance sustainable governance and planning in the above contexts?

## 1.9. Manuscript contributions into the chapter 1 "Introduction"

**Table 3** Description of the manuscripts' contributions into the chapter 1 "Introduction"

| # | Title of the manuscript | Manuscript contribution |
|---|---|---|
| I | The feasibility of implementing cross-border land-use management strategies: a report from three Upper Silesian Euroregions | This paper presents several comments concerning land-use management strategies for three Czech-Polish Euroregions: Pradziad, Silesia and Cieszyn Silesia. Using this example, the manuscript discusses the notion of CBL and provides some recommendations related to governance and planning of such landscapes.<br><br>Thanks to this contribution it was possible to explain in this chapter that borders, and boundaries are effects of social processes transforming various landscapes. Moreover, it was possible to enrich here a conceptualization of the CBL notion and to explain that specific approaches are needed within the framework of governance and planning to address landscapes that emerge from a mix of natural and social processes. |
| II | Ecosystem Services and Border Regions. Case Study from Czech – Polish Borderland | The research presents a spatially explicit characterization of an example of a CBL located in Czech – Polish borderland. The characterization was implemented using land cover analyses of this landscape. Moreover, the research presented in this manuscript studied Czech and Polish land-use strategies, which are binding at NUTS 4 and 5 level in the analyzed CBL.<br><br>Results of the research indicate asymmetry in the CBL of the analyzed region. The asymmetry is indicated by different types, biodiversities and areas of ecosystems identified on both sides of the boundary. It is also identified by differences in land-use strategies concerning the region.<br><br>Thanks to this, the manuscript has contributed to the notion of CBL described in this chapter as an example of specific landscape emerging from a mix of natural and social processes. It has also been possible here to enrich the notion of governance and planning in cross-boundary contexts. |
| III | Indicators of Cultural Ecosystem Services for urban planning: A review. | --- no contribution to this chapter --- |
| IV | Requirements for cross-border spatial planning technologies in the European context. | The research presented in this manuscript uses as a case study CBLs located in the European Baltic Sea Region. The manuscript reflects on the notion of spatial planning in cross-boundary contexts and shows how planning practices in such contexts could be supported with spatial planning technologies. The manuscript provides arguments that there is no efficient cross-border spatial planning without engagement from various stakeholders, supported by novel spatial planning technologies.<br><br>Contributions to this manuscript made it possible to enhance the definition of planning presented in this chapter and to show differences between |

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| | | governance and planning in the specific context of landscapes that emerge from a mix of natural and social processes. |
| V | A review of approaches and challenges for sustainable planning in urban peripheries | The manuscript explored approaches and challenges related to the application of sustainable planning to various urban peripheries. Results of this research showed, for example, that peripheral urban and peri-urban landscapes are difficult to synthesize in operative classifications. This contributed to the definition of PUL, presented in this chapter, as an example of transitioning and landscapes that are difficult to delimitate which emerge from a mix of social and natural processes.<br><br>Moreover, the manuscript shows that PULs are not central in the discourse on sustainable planning approaches. Existing planning approaches related to PULs are context-specific and solution-oriented. The research described uncertainties about the transferability of landscape planning approaches from one landscape context to the other. In this manner, this manuscript contributed to conceptualization of governance and planning, presented in this chapter, and to the description of the research gap, displayed at the end of it. |
| VI | Special issue on sustainable planning approaches for urban peripheries | The manuscript provided description of some characteristics and peculiarities of urban peripheries worldwide. In this manner, it contributed to the definition of PUL, as a specific example of urban periphery, provided in this chapter. |
| VII | Sustainable planning for peri-urban landscapes. | The manuscript presented a definition and peculiarities of PULs. This definition was discussed as the basis for several examples of such landscapes coming from various international contexts. The research described different types of PULs and reflects on various natural and social processes that are the drivers of dynamic changes in PULs. Examples of such processes are sprawl, peri-urbanization, and farm abandonment, resulting in colonization of agricultural and forest landscapes by PULs, for example.<br><br>Thanks to this, the manuscript contributed to the general conceptualization of landscape, presented in this chapter. Specifically, it contributed to the conceptualization of PULs as examples of landscapes that emerge from a mix of natural and social processes. |
| VIII | Ecosystem services deficits in cross-boundary landscapes: spatial mismatches between green and grey systems. | The research was implemented in the CBL of the cities of Cieszyn (in Poland) and Český Těšín (in the Czech Republic), which form one urban system that is divided by a national boundary. The manuscript presented a spatially explicit assessment of this CBL. Results of this research explained significant spatial asymmetries of this CBL, indicated inter alia by the share of grey and green systems and distribution of ES deficit areas.<br><br>Described in the manuscript, research made it possible to better conceptualize CBLs that are a type of landscape emerging from a mix of |

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| | | social and natural processes. Moreover, the results presented in this manuscript made it possible to explain specific asymmetric spatial configurations that are outcomes of natural and social processes shaping landscapes.<br><br>Moreover, this manuscript provided critical thoughts concerning governance of CBLs. This part of the manuscript contributed to the explanation of landscape governance and planning notions, presented in this chapter. |
| IX | The ecosystem services concept: a new Esperanto to facilitate participatory planning processes? | The manuscript provided recommendations on how to use the ES concept in participatory planning processes related to various landscapes. It also introduced and described three main groups of governance actors: stakeholders, experts and citizens. The manuscript discussed whether ES can become an Esperanto style language among various governance actors, helping them to achieve a consensus during governance and planning processes.<br><br>With this it contributed to the notion presented in this chapter of landscape governance and planning. Moreover, it contributed to interactions described here between three groups of governance actors and showed how the ES concept has been used in governance and planning practices. Specifically, outcomes of this research were the basis for explaining in this chapter the ES concept in landscape governance and planning. |
| X | Governance of ecosystem services trade-offs in peri-urban landscapes. | The manuscript provided an extensive overview of the notion of governance in the peri-urban contexts. In this manner, the manuscript contributed to the definition presented in this chapter of governance and planning of landscapes that emerge from a mix of natural and social processes.<br><br>The manuscript described in detail peculiarities of PULs as examples of landscapes emerging from a mix of natural and social processes. This contributed to the conceptualization of PULs described in this chapter.<br><br>Moreover, contributions of this manuscript were related to the description of several social processes that are interlinked with natural ones and together are responsible for the specific dynamic and transitional character of PULs. |
| XI | Protection of peri-urban open spaces at the level of regional policy-making: Examples from six European regions. | The manuscript provided in depth conceptualization of PULs, based on examples coming from six European regions. Diminishment of peri-urban open spaces, analyzed in this research, is a significant example of a socio-natural process characteristic for transitioning landscapes. In this way findings of this research contributed to conceptualization of landscapes that emerge from a mix of natural and social processes presented in this chapter. |
| XII | Bicycle Accessibility to Cultural Ecosystem | The manuscript analyzed a specific example of CBL located between Czech Republic and Poland. This research made it possible to enhance the conceptualization of landscape presented in this chapter. Moreover, |

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| | Services in a Cross-Boundary Landscape. | recommendations presented in this manuscript for cross-boundary planning and governance contributed to the landscape governance and planning notions described in this chapter. |
| XIII | Teaching the ecosystem service concept: experience from academia. | --- no contribution to this chapter --- |

# 2. Methods

The overarching methodological framework of my research was based on implementation of mixed methods. They are based on quantitative methods like Geographical Information Systems (GIS) and remote sensing. Moreover, the methods are based on qualitative methods advocated for use in planning research (Silvermann, 2015). The qualitative methods encompass mainly structured literature and planning documents reviews, scientific workshops/sessions and on surveys. Details on the applied methods follow below.

## 2.1. Quantitative methods

Data for the quantitative analyses were obtained from different sources. For GIS analyses CORINE Land Cover data[3] was used. This data was implemented to characterize morphology of CBLs (# II Spyra, 2014), in order to analyze land conventions from peri-urban open spaces into non-peri-urban open spaces in six European regions (# XI Spyra et al., 2021) and to delimitate ES providing and benefitting areas in Czech-Polish CBL (# XII Spyra & Hamerla, 2021). For some of the GIS analyses more detailed data was also prepared according to INSPIRE regulations (Infrastructure for Spatial Information in the European Community). It was prepared to calculate accessibility over the road network between cultural ES providing and benefitting areas in Czech-Polish CBL (# XII Spyra & Hamerla, 2021), to assess the spatial structure of urban green and grey systems located within a CBL of Český Těšín (Czech Republic) and Cieszyn (Poland), and to delimitate ES deficit areas in those cities (# VIII Spyra et al., 2019). The administration boundaries in my studies were delimitated also based on INSPIRE data (# II Spyra, 2014; # VIII Spyra et al., 2019) and on Eurostat (2016 version) data (# XI Spyra et al., 2021).

My research uses several spatially explicit indicators. The spatial structure assessment of green and grey systems in a CBL was supported with Technomass, i.e., a spatially explicit indicator calculated for each cell with a following equation (# VIII Spyra et al., 2019):

$$\Psi = \frac{\sum_{i=1}^{n}(bh)_i \quad + 1/2\sum_{j=1}^{n}(r_j)}{A}$$

Ψ is Technomass $[m^3/m^2]$, b is the building's surface, h is the building's height, r is the roads and other sealed surfaces and A is the total sample area (Inostroza, 2014). This indicator was used in a combination with remote sensing approach indicator Normalized Difference Vegetation Index (NDVI).

$$NDVI = \frac{(NIR - Red)}{(NIR + Red)}$$

This combination was used to formulate a novel indicator for ES deficit areas that is calculated with the following formula:

$$C_m = \frac{\Psi_m \ I_m}{NDVI_m}$$

Cm is the ES deficit factor in hexagonal cell m, $\Psi_m$ is the Technomass amount in hexagonal cell m $[m^3/m^2]$, $NDVI_m$is the NDVI value in hexagonal cell m and $I_m$is the number of inhabitants in hexagonal cell m.

Moreover, this study incorporates two other indicators: the shortest distance of the centroid of hex cell i to the borderline [m] and the number of inhabitants per hexagonal cell. All the indicators were calculated for a single hexagonal cell, being a part of the grid of hexagonal cells covering the case study area.

[3] For details, see: https://land.copernicus.eu/pan-european/corine-land-cover, accessed November 2021.

My GIS based research methods also incorporated accessibility studies between ES providing and benefitting areas located in CBLs (# XII Spyra & Hamerla, 2021). In this case the accessibility was calculated in buffers designated from cultural ES benefitting areas and over the road network between cultural ES benefitting and providing areas.

## 2.2. Qualitative methods

In my research I have also implemented research methods based on surveys. I implemented an explorative survey to analyze the need for, possible contents and preparation methods of cross-boundary land use management strategies (# I Spyra, 2014). In this case the survey with open ended questions was performed with local policy-makers affiliated to Czech-Polish Euroregions that are located within historical boundaries of the Upper Silesia region. Other than in the cross-boundary context, the survey, together with a focus group discussion, was used to derive technology requirements for cross-border spatial planning (# IV Frank et al., 2017).

The survey method was also used to characterize the participatory planning context in which the ES concept was applied: to analyze common advantages and risks of using the ES concept in different participatory planning contexts and to show how the ES concept can be operationalized to successfully support participatory planning processes (# IX Spyra et al., 2019). In this case the survey was complemented with two analytical tools. The first was a comparative criteria table that facilitated characterization of case studies. The second was Balanced Score Card (Fürst, Opdam, Inostroza, & Luque, 2014) a tool helpful to assess the advantages and risks of using ES concept in participatory planning.

Explorative survey was also used to identify policy improvements that could be helpful to protect peri-urban open spaces (# XI Spyra et al., 2021). In this case the survey was performed with policy-makers affiliated to six regions located in the European Union (# XI Spyra et al., 2021). After the policy improvements were identified, together with my co-authors I organized four thematic scientific sessions to perform prioritization of recommendations for regional policy-makers to better tackle protection of peri-urban open spaces. This exercise was based on a semi-quantitative survey with closed questions in a Likert scale.

In order to analyze how the ES concept is taught by academics from universities and research centers and to discuss further steps and research directions to support teaching the ES concept together with my co-authors, we designed a research method based on an *ad hoc* web-based survey (Reynolds et al., 2006). This method aimed at addressing academics from universities and research centers around the world who teach the ES concept (# XIII Palacios-Agundez et al., 2022).

Methods based on surveys have been supported through organization of thematic scientific sessions or workshops that contributed to a focus-group format. Organization of these events have been related to my active contributions to international scientific organizations, namely International Association of Landscape Ecology (IALE) where I am the leader of the working group "Urban and peri-urban governance", Global Land Program (GLP) where together with my co-authors I am responsible for the European Nodal Office. Moreover, I actively contribute to the European Land Use Institute (ELI) and Ecosystem Services Partnership (ESP). All scientific sessions and workshops organized or co-organized by me intended to discuss topics that are important for my research with representatives of the international scientific community and policy-makers and planners. In most cases, these discussions were supported through active engagement of session/workshop participants with selected tools described in "The MSP Tool Guide. Sixty Tools to Facilitate Multi-Stakeholder Partnerships" prepared by Wageningen University and Research[4].

Input from such meetings gave me and my co-authors an opportunity to work on an editorial for special issue of Landscape and Urban Planning journal addressing sustainable planning approaches for urban peripheries (# VI La Rosa et al., 2017), and to contribute to a paper addressing sustainable planning approaches for PULs (# VII La Rosa et al., 2018) and to prepare an essay addressing ES trade-offs in PULs (# X Spyra et al., 2020). Moreover, a scientific session addressing the topic of ES concept teaching was a starting point for research related to this topic and allowed our co-author group to establish exploratory on-line survey addressing of it (# XIII Palacios-Agundez et al., 2022).

A policy-oriented workshop was co-organized by me at 19th European Week of Regions and Cities. I have co-organized this workshop together with other colleagues from Italy (University of Padova), Spain (Forest Sciences and Technology Centre of Catalonia) and Germany (my University and European Forest Institute). This workshop was a part of RENATUR research project and allowed me to describe, present and discuss functions of regional management platforms for sustainable PULs (Figure 8). Moreover, interregional policy-oriented, exchange of experience workshops were the main methods implemented in the frame of RENATUR research project. The workshops were organized on-line in each of the regions partnering in RENATUR. The workshops lasted either four days (Flanders, Belgium), or two days (Basque Country, Spain; Gorenjska, Slovenia; Hajdú-Bihar, Hungary; Mazovia, Poland and Saxony-Anhalt, Germany). They were implemented with the help of different interactive on-line tools such as on-line questionnaires to collect input knowledge and virtual white boards that allowed participants to provide their ideas live on a screen. During the workshops policy approaches to protect natural heritage of peri-urban open spaces on a regional level were introduced and critically assessed with SWOT analyses. The workshops also included sessions dedicated to focus group discussions, moderated either by me, or another expert from RENATUR team. Based on workshops' assessments and analyses, recommendations for a region hosting the workshop were drafted (Calò and Spyra, 2022). The draft recommendations were later elaborated in detail in the framework of a workshop report. Such a report was used to prepare for each region an action plan that describes detailed changes in a regional policy instrument to better protect natural heritage of peri-urban open spaces. Moreover, the interregional exchange of experiences leads to preparation of a collection of good practices. Each good practice is an example of a policy approach that showed its usefulness to protect peri-urban open spaces. What's more, each good practice must have a good level of transferability across different European contexts.

In my studies I have also used structured literature reviews as a method. This method was used to define and describe indicators for cultural ES for urban planning (# III La Rosa et al., 2016), and to define types of urban peripheries and sustainable planning approaches and to also define, related to them, challenges and recommendations (# V Geneletti et al., 2017). These structured literature reviews were implemented with key-word word queries performed with the help of scientific data bases namely Scopus and Web of Knowledge. Results from Scopus and Web of Knowledge queries were merged to create a sound collection of manuscripts that answered specific research questions. Later, the manuscripts were analyzed in detail, and information relevant to research questions were extracted from the manuscripts, systematized in tables and analyzed.

Moreover, structured analyses of planning and governance documents related to communes located on both sides of a CBL were implemented in the extent of Czech – Polish CBL (# II Spyra, 2014). Such

[4] Source: https://edepot.wur.nl/409844 accessed November 2021.

analysis was conducted to define possible landscape asymmetries related to governance and planning documents.

## 2.3. Case studies

In my works I have been analyzing different specific case studies of CBLs and PULs (Figure 6). Analysis in regional scale case studies CBLs stretch across two sovereign states, namely Czech Republic and Poland. Three of these CBL examples are located within the expanse of Czech-Polish Euroregions, situated inside historical boundaries of the Upper Silesia region (# I Spyra, 2014). Euroregions are institutions established in Europe to stimulate cooperation of local governments and other entities on both sides of a boundary. The Association of European Border Regions, which is the biggest European organization for facilitating cooperation of border regions, defines the Euroregion as an organizational unit that allows and stimulates the cooperation of local governments and other public and private bodies on both sides of the national boundary[5]. Pradziad, Silesia, Cieszyn Silesia Euroregions were the case studies implemented to analyze need and content of cross-border land use management strategies and to propose a method suitable for preparing such a strategy (# I Spyra, 2014). Czech and Polish districts belonging to Pradziad Euroregion were used to study ES in a CBL and to assess how ES concept is represented in local strategic planning documents (# II Spyra, 2014).


**Figure 6** Location of the analyzed case studies. (1) Baltic Sea Region; (2) Basque Country (SP); (3) Cieszyn Silesia Euroregion (CZ-PL); (4) Český Těšín/Cieszyn (CZ-PL); (5) Flanders (BE); (6) Gorenjska (SLO); (7) Hajdú-Bihar (HU); (8) Mazovia (PL); (9) Pradziad Euroregion (CZ-PL); (10) Saxony-Anhalt (DE); (11) Silesia Euroregion (CZ-PL).

The regional scale was represented in an analysis of Czech-Polish CBL located inside a 10 km buffer delimitated from the border line and situated within historical boundaries of Upper Silesia cross-border region (# XII Spyra & Hamerla, 2021). This case study area was used to delimitate cultural ES providing

[5] Source: https://www.aebr.eu/library/, accessed April 2021.

and benefitting areas and to analyze accessibility between these areas. Moreover, the regional scale was represented in a study performed in the Baltic Sea Region, where seventeen institutions from this region were examined (#IV Frank et al., 2017).

Specific case studies of PULs were assessed on the regional scale as well (# XI Spyra et al., 2021 and RENATUR research project). These case studies are related to six European regions: Basque Country (Spain), Flanders (Belgium), Gorenjska (Slovenia), Hajdú-Bihar (Hungary), Mazovia (Poland) and Saxony-Anhalt (Germany). These case study regions were used to analyze land cover changes related to peri-urban open spaces, to identify and classify policy improvements that are useful to protect peri-urban open spaces at the level of regional policy-making and to provide recommendations for regional policy instruments to better tackle the protection of peri-urban open spaces. Representatives of public administration and universities from these case study regions are also partnering in the RENATUR project (Calò and Spyra, 2022).

On the urban scale the example of divided (twin) city was analyzed. The city of Český Těšín/Cieszyn located in a Czech – Polish CBL was a case study to analyze urban green and grey systems and to delimitate ES deficit areas (# VIII Spyra et al., 2019).

## 2.4. Manuscript contributions into the chapter 2 "Methods"

**Table 4** Description of the manuscripts' contributions into the chapter 2 "Methods"

| # | Title of the manuscript | Manuscript contribution |
|---|---|---|
| I | The feasibility of implementing cross-border land-use management strategies: a report from three Upper Silesian Euroregions | The manuscript contributed to the qualitative methods described in this chapter.<br>Aim of this research was to increase knowledge about the need for and content of cross-border land-use management strategies in the selected example of three Upper Silesian Euroregions.<br>The research described in this manuscript implemented a method based on a survey with open-and-closed-ended questions. The survey was divided into two parts: (1) investigating the Euroregion's current and future cross-border land-use planning initiatives; (2) evaluating the proposed method in this research land-use strategic planning based on the project matrix. The project matrix is a planning scheme that could be used as a theoretical basis to discuss and address selected general challenges for implementing cross-border land-use management in CBLs. |
| II | Ecosystem Services and Border Regions. Case Study from Czech – Polish Borderland | The manuscript contributed both to the quantitative and qualitative methods described in this chapter.<br>The research analyzes the case study of Czech – Polish CBL that encompass Nysa (PL), Prudnik (PL), Jesenik (CZ) and Krnov (CZ) communes.<br>The quantitative methods used in this manuscript are based on the analysis of the case study CBL land cover. This analysis was implemented with the help of Corine Land Cover data. The aim of this analysis was to characterize spatial patterns of the case study CBL and to explain the general potential of this landscape to supply and absorb ES.<br>Moreover, land-use strategies related to the case study CBL were analyzed in a structured way. The land-use strategies are binding planning documents for the districts located inside the case study CBL. The aim of this analysis was to describe local potentials for implementing the ES concept in strategic planning. The qualitative methods were used in this part of the research. |
| III | Indicators of Cultural Ecosystem Services for urban planning: A review. | The manuscript contributed to the quantitative methods described in this chapter.<br>Overall aim of this research was to provide a refined list of cultural ES indicators suitable for being used in urban planning. |

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| | | The methods implemented in this research were based on a structured literature review. The review was implemented with the help of Scopus and Web of Knowledge databases, which were used to search for papers and book chapters explaining cultural ES in urban contexts. Selection of these review papers and chapters was carried out in two stages: (1) initial evaluation aiming to provide a general characterization of the selected papers with relative indicators; (2) further evaluation aimed at understanding the possible use of these indicators to inform planning processes in urban contexts. |
| IV | Requirements for cross-border spatial planning technologies in the European context. | The manuscript contributed to the qualitative methods described in this chapter.<br>Aim of this research was to identify requirements for suitable spatial planning technologies in cross-boundary contexts and to provide and discuss recommendations for their future development and implementation.<br>The research described in this manuscript was based on a survey implemented with the group of experts coming from six Baltic Sea Region states. These experts acted as a focus group for fulfillment of the research aims. The survey consisted of seven questions, structured into the following four thematic groups: (1) regional differences in requirements and usability; (2) data requirements for technologies and instruments; (3) methodological approaches for spatial planning technologies; (4) users. |
| V | A review of approaches and challenges for sustainable planning in urban peripheries | The manuscript contributed to the qualitative methods described in this chapter.<br>The manuscript reviewed the existing literature on sustainable planning approaches to urban peripheries. It addressed two main research questions: (1) what types of urban peripheries and sustainable planning approaches are considered? and (2) what planning challenges and recommendations are identified?<br>The sample of reviewed papers was selected by performing a series of queries in the Scopus database using different combinations of keywords related to sustainable planning in urban peripheries.<br>After selecting the final sample of papers, the research was further implemented with the help of content analyses. Here each main research question was broken down into a set of sub-questions detailed by interpretation keys and criteria, which were used to guide the analysis of the papers and to analyze their content. |

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| VI | Special issue on sustainable planning approaches for urban peripheries | To prepare this editorial to the special issue of Landscape and Urban Planning journal no specific research methods were used, thus there is no direct contribution of this manuscript to chapter two. |
| VII | Sustainable planning for peri-urban landscapes. | To prepare this book chapter, no specific research methods were used except unstructured literature studies related to various examples of PULs. Thus, there is no direct contribution of this manuscript to this chapter. |
| VIII | Ecosystem services deficits in cross-boundary landscapes: spatial mismatches between green and grey systems. | The manuscript contributed to the quantitative methods described in this chapter.<br><br>This manuscript described the example of urban CBL located in Cieszyn (PL) and Český Těšín (CZ). This research aimed to: (1) perform a quantitative assessment of the spatial structure of urban green and grey systems located within the case study CBL and (2) to analyze ES deficit areas in the CBL.<br><br>Land cover data, which were prepared according to the INSPIRE regulations (Infrastructure for Spatial Information in the European Community), were used in this research. The analyses in this research were performed with the help of three spatially explicit indicators: (1) technomass which is the accumulated matter possible to observe and measure in a given area considering only materials with anthropogenic origin; (2) NDVI and (3) ES deficit factor which is the ratio between technomass and number of inhabitants to NDVI. ES deficit factor was used as a proxy indicator for the provision of ES in the case study CBL. Each of those indicators was calculated to the extent of hexagonal cells, forming a net covering the whole analyzed CBL. |
| IX | The ecosystem services concept: a new Esperanto to facilitate participatory planning processes? | The manuscript contributed to the qualitative methods described in this chapter.<br><br>The research presented in this manuscript aims to enhance<br><br>the understanding of options and implications of applying the ES concept in participatory planning based on evidence from several practical case studies. To fulfil the research aim, a comparative analysis of eleven case studies with diverse spatial and planning contexts, covering ten countries and four continents was implemented. The comparative analysis was implemented with the help of two analytical tools: (1) comparative criteria table and (2) balanced score card. Comparative criteria table helped to gather, characterize and compare information from the case studies. A balanced score card is a matrix with questions related to the risks and |

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| | | advantages of using the ES concept in the participatory planning process. For each case study, one principal researcher (the survey participant) who was responsible for conducting the specific study was identified and asked to participate in the research survey. |
| X | Governance of ecosystem services trade-offs in peri-urban landscapes. | This manuscript is an essay explaining governance of ES trade-offs in PULs. No specific research methods, except unstructured literature studies and discussion during the scientific session organized at the ESP Europe conference in 2018 were used to prepare this manuscript. Thus, there is no direct contribution of this manuscript to this chapter. |
| XI | Protection of peri-urban open spaces at the level of regional policy-making: Examples from six European regions. | The manuscript contributed both to the quantitative and qualitative methods described in this chapter.<br>The overall aim of this research was to analyze peri-urban open spaces in six case study regions, located in various parts of European Union.<br>The research was implemented in three parts and was based on a mixed-method approach. Firstly, the Geographical Information Systems (GIS) based method was used to analyze land cover changes related to peri-urban open spaces. Secondly, an explorative questionnaire was used to identify policy improvements that are useful to protect peri-urban open spaces at the level of regional planning. Thirdly, a semi-quantitative survey was used to make a prioritization of recommendation for regional policy-makers to better tackle the protection of peri-urban open spaces. |
| XII | Bicycle Accessibility to Cultural Ecosystem Services in a Cross-Boundary Landscape. | The manuscript contributed to the quantitative methods described in this chapter.<br>The manuscript describes a case study of CBL located between Czech Republic and Poland. The research aimed, firstly, to delimitate cultural ES providing and benefiting areas located in a case study CBL. Secondly, it aimed to analyze accessibility to cultural ES providing areas from cultural ES benefiting areas in the selected example of CBL.<br>To fulfil these aims, research methods based on GIS were implemented. Data from CORINE Land Cover, provided by European Environmental Agency (Natura 2000) and local data from Poland and Czech Republic (INSPIRE regulation) were used in this research. Research was implemented in four subsequent steps using GIS based approaches such as calculations of accessibility over road network, delimitation of buffers and selection of overlapping polygons. |

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| XIII | Teaching the ecosystem service concept: experience from academia. | The manuscript contributed to the qualitative methods described in this chapter.<br><br>This research aimed to analyze how academics taught the ES concept at universities and research centers, and to establish connections between these teaching practices and best educational practices described in educational literature.<br><br>The research was based on an ad hoc web-based survey, composed of open-ended and closed questions distributed into five parts: (1) respondent's personal information; (2) teaching experience; (3) teaching methods; (4) effectiveness of the teaching processes; and (5) interest in participating in a working group on ES teaching. |

# 3. Results

## 3.1. *Key steps* towards improved governance and planning for sustainable development of landscapes that emerge from a mix of natural and social processes

Each individual *key step* towards improved governance and planning for sustainable development of landscapes that emerges from a mix of natural and social processes is based on implementation of a specific governance or planning approach, or a combination of such approaches. The approaches could be classified as: (1) governance or planning paradigms that are overall, grounded on theoretical definition of what a sustainable landscape development is (e.g. multi-level governance); (2) governance or planning strategies and solutions that describe actions aiming to address specific issues (e.g. strategy to develop green infrastructure); (3) operational methods and tools that are "applied to operationalize planning paradigms and to implement or assess planning strategies and solutions" (e.g. assessment framework) (# V Geneletti et al., 2017, p. 234; # XI Spyra et al., 2021).

**Table 5** A set of specific challenges related to peri-urbanization defined during implementation of RENATUR project in six European regions. Own elaboration based on RENATUR communication materials prepared by Reese R., Calò N. and Spyra M. Source: https://www.interregeurope.eu/renatur/our-regions/ , accessed November 2021.

| Region name | Challenges |
|---|---|
| Basque Country, Spain | • Ineffective regulatory instruments to protect and value peri-urban open spaces;<br>• Land use exchange;<br>• Revitalization of brownfields;<br>• Forestry activities related to intensive planting of invasive species in peri-urban landscapes. |
| Flanders, Belgium | • Fragmented land use;<br>• Development pressure on open spaces;<br>• Problems related to implementation of the existing policy tool aiming to protect peri-urban open spaces related to: lack of use of this tool, complexity of its implementation procedure, deviation from land use plan. |
| Gorenjska, Slovenia | • High pressure of massive tourism on peri-urban open spaces;<br>• Various conflicts generated by green areas located in peri-urban landscapes;<br>• Investments on green-fields;<br>• Lengthy legal planning processes. |
| Hajdu-Bihar, Hungary | • Integration of ecosystem services concept in local/municipal green infrastructure concept;<br>• Communication of the significance of the ecosystem services concept to different target groups. |
| Mazovia, Poland | • Urban pressure from the national capital over the whole region;<br>• Different municipal development goals;<br>• Unstable political situation;<br>• Lack of intercommunal cooperation;<br>• Intensive competition for investment funds observed in peri-urban communes and municipalities;<br>• Investments in nature perceived mainly as costs not benefits. |
| Saxony-Anhalt, Germany | • Brownfield revitalization. Specifically: redevelopment needs, landscape and nature conservation, emission control, monument protection, ownership structure;<br>• Lack of intercommunal cooperation. |

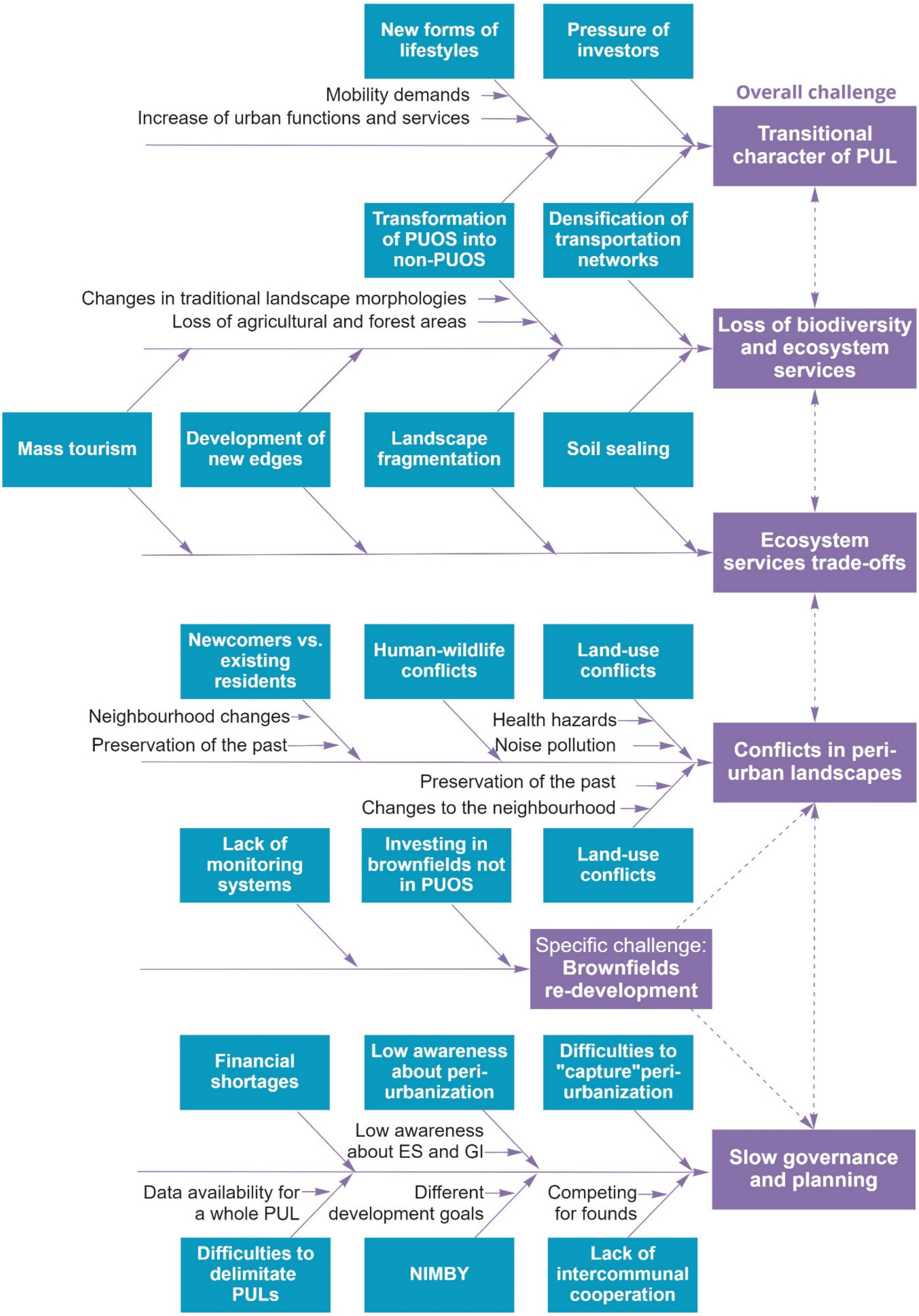


**Figure 7** Selection of challenges related to governance and planning of landscapes using the example of PULs. Source: own elaboration.

The *key steps* introduced in this part need to address specific challenges related to such types of landscapes. Those challenges are context specific and related to characteristics of a landscape. They are specifically visible in transitioning landscapes, exemplified in my works by PULs. Moreover, they are related to the quickly changing character of such landscapes (# X Spyra et al., 2020), loss of biodiversity and ES, or to various conflicts (# XI Spyra et al., 2021). A summary of such challenges related to PULs is presented in Figure 7 and Table 5.

The *key steps* are summarized in the points presented below. Each of these *key steps* is based on a specific participatory governance or planning approach or mix of such approaches that have shown their usefulness in the analysis in my research landscapes. They are described using outputs from my research.

### 3.1.1. Establishing trust between governance actors

A basic pre-condition of any sound cooperation in the context of governance and planning is trust, seen as a "foundation of a society" (Sztompka, 2007). Trust, established through the time, is described as "laying the groundwork" factor for any planning cooperation (# I Spyra, 2014). To this end trust must have been also established among representatives of regional policy-makers, who have been working together to define policy and planning approaches to protect peri-urban open spaces (# XI Spyra et al., 2021; research project RENATUR, Calò and Spyra, 2022), or to reduce ES trade-offs in PULs and support synergies among them (# X Spyra et al., 2020). Trust has also been a basic pre-condition for using ES concept as a common language among governance actors, who engaged in participatory planning activities (# IX Spyra et al., 2019), or for defined sustainable planning approaches for urban peripheries (# V Geneletti et al., 2017). Trust and honest will are basic pre-condition to "conduct the planning process and then to implement it in everyday life" (p. 44, # IV Frank et al., 2017).

Establishing trust is seen in landscapes governance and planning as a continuous process, very often being implemented between top-down and bottom-up initiatives. For example, it has been a basic precondition for any works related to cross-boundary planning, analyzed and implemented during my research works (# I Spyra, 2014). Initial establishing trust and common understanding among actors was the basic issue influencing implementation of my research project related to CBLs (Spyra, 2013a; research projects School without borders, KOPR, Edu2Work). It was supported by a series of carefully planned meetings (workshops) between engaged in the project implementation governance actors, where all attendees were given opportunity to freely describe their point of view over the related to a CBL problems. Moreover, this process was supported by several field trips exploring a CBLs that were followed by more informal gatherings (research projects School without borders, Edu2Work).

Cross-boundary and peri-urban contexts make the trust factor even more significant and complicated as it comes to building trust between governance actors belonging to different sovereign states, or (that is less complicated) to different communes, or municipalities located in one country. In the delicate context of CBL a memory about former complicated historical events could make trust establishing process even more awkward. Here the use of planning technologies that are tailored for cross-boundary context could be a great support (# IV Frank et al., 2017).

### 3.1.2. Planning in the framework of a multilevel cooperation

Addressing the challenges related to landscape governance and planning requires effective cooperation among governance actors – this thought was confirmed by the survey performed with representatives of Czech-Polish Euroregions located in Upper Silesia (# I Spyra, 2014). My understanding of cooperation in this context is related to the definition provided by Yaffee (1998) who looks at the cooperation as a continuous process of building commitment starting by raising awareness, through sharing information to cooperation in policy-making and spatial planning (Yaffee, 1998). Looking at the issue of cross-boundary cooperation in a simplistic way, it can be understood as "just" a cooperation between adjacent landowners (Rickenbach, Schulte, Kittredge, Labich, & Shinneman, 2011). Thus, in order to build an effective cooperation culture in a cross-boundary context, a preparation process is needed. Such preparation processes need to be based on dissemination and definition of important terms, while establishing joint governance or planning aims and a common understanding of the necessity for them.

Without first building awareness among the communities, any cooperation, including the one over the boundaries, will be difficult to achieve. Effective cooperation of governance actors in policy-making and planning processes is one of the most significant pre-conditions for success. Engagement of actors in governance processes could be fostered by popularity of governance or planning topics (research project Edu2Work, KOPR). The public sector needs to play a coordinative role in the process of other governance actors' engagement. This process needs to be implemented via top-down management, market mechanisms and citizen involvement (Klein, Juhola, & Landauer, 2016). On the other hand, it is important to consider specific limitations of inclusiveness of governance processes. For example, non-governance actors (e.g. citizens) are better included in governance processes in the informal ways (e.g. informal meetings) (research project Edu2Work; Evans & Sapeha, 2015). To this end it is important to provide a space for on-going exchange of thoughts in a framework of institutionalized governance. This is similar to the suggestion of establishing a cross-border platform (think-tank) as a space for exchange of thoughts about cross-boundary governance (research project Edu2Work; Bondaruk et al., 2015; # I Spyra, 2014). Meetings with governance actors organized in the framework of such a platform must be very well prepared, i.e., have clear and well-defined aims. Not the quantity, but the quality of such meeting matters. In such contexts cooperation of different governance actors should be supported by juxtaposition of different modes of governance, which could be related to local governance traditions and should reflect peculiarities of a specific context (research project KOPR). Facilitation of social exchange in the frame of such platform could be supported by a straightforward method to visualize ecological and socio-economic problems of a landscape. Such methods could be based for instance on accessibility studies implemented with the focus on a boundary line as an accessibility obstacle (# XII Spyra & Hamerla, 2021).

In the context of governance and planning of landscapes, cooperation should be related to implementation of multi-level and adaptive approaches implemented in non-hierarchical, horizontal and polycentric directions (# XI Spyra et al., 2021). Such approaches are based on setting clear policy and spatial planning objectives and supporting the resources acquisition to implement them. Implementation of such approaches requires working with three groups of governance actors: stakeholders (organized groups having a specific interest / a "stake" in an area), experts (objective knowledge holders) and citizens (# IX Spyra et al., 2019). It should also avoid working in closed cycles of "elite" policy-makers. Required in peri-urban contexts, intercommunal cooperation is the back-bone of such processes and can force policy and spatial planning decisions to be "owned" by different governance actors and lead towards consensus-oriented arrangements by acknowledging specific needs of representatives from all governance actors' groups. This can be achieved by moderating experts' negotiations among governance actors.

In peri-urban contexts that have been studied in detail, outcomes of such pluralistic processes cannot be directly attributed only to peri-urban municipalities, nor be based on a combination of governance or spatial planning approaches usable for either urban or rural areas (research project RENATUR). Thus, cooperation concerning PULs should address the urban-rural continuum and overcome decisions addressing either rural or urban landscapes and focus on a PUL as a unique type of landscape. To accomplish it, either rural, forest, or urban areas need to be addressed in the context of the entire landscape.

Sound **intercommunal cooperation** between various governance actors helps to recognize existing and foreseen barriers of sustainable development and to describe developmental directions of a PUL (research project RENATUR; Calò and Spyra, 2022). Such cooperation could take place within the framework of a platform in which negotiations between different governance actors can take place and coordination among the governance levels can be established. Coordination of these activities and coordination among different governance and spatial planning levels needs to be in the hands of either regional authorities, or (e.g. in the case of absence of a regional level) in hands of metropolitan authorities. Moreover, in these contexts reinforcement of the institutional capacities of regional governing and planning institutions in this field is needed (research project RENATUR).

Intercommunal cooperation can support the addressing of complex planning or governance problems in a cross-scale manner. For example, in order to address comprehensively the issue of landscape functions, it is important to think one scale up and one scale down from a discussed landscape function. Another example relates to the analysis of CBLs or PULs on the general regional scale and on more detailed urban or even neighborhood scales. To do this, policy-makers and planners need to work across administrative boundaries and integrate local, regional, national policy-making and spatial planning activities to integrate traditional and innovative approaches and tools. Links between different governance and spatial planning levels need to be revised and strengthened to introduce new arrangements (cooperation) within regional or metropolitan areas where a PUL is situated (# V Geneletti et al., 2017).

Nevertheless, implementation of all pluralistic approaches needs to be based on established regulatory and normative frameworks. Lack of such frameworks could lead to unwanted "anarchic" situations in PULs and could strengthen the described above unwanted NIMBY syndrome. To this end my research shows a large potential for further improvements in regulatory instruments and a risk related to the fact that implementation of outdated regulatory instruments could in fact promote unsustainable peri-urbanisation (# XI Spyra et al., 2021).

### 3.1.3. Coordination of governance and planning activities in the framework of cross-boundary planning documents

Both cooperation and trust in governance and planning processes are the foundations for required coordination of different governance and planning initiatives or documents that are binding for different parts of a landscape (# XII Spyra & Hamerla, 2021). My research shows that such coordination could be supported by cross-boundary land-use management strategies (# I Spyra, 2014). A cross-boundary land-use management strategy in this context could be a document that explains sustainable goals related to land-use on both sides of a boundary line, meaning along the entire expanse of a CBL. Such a strategy could help to identify local common ideas and priorities for land-use planning throughout a landscape and help to coordinate them. Moreover, it could support fulfilling the general goal of European land-use planning: facilitation of the decentralization process, which means shifting of power from central governments to the local governance levels (# I Spyra, 2014). Implementation of such strategies could make cooperation in cross-boundary contexts smoother and thus have a positive impact on protection of both natural and cultural heritages of landscapes.

Preparation of cross-boundary land-use management strategies should be based on methodological approaches that are harmonized for all administrative units described in a landscape data set and that also show usefulness in cross-boundary contexts (# IV Frank et al., 2017). Concerning data sets, it is less complicated in the European Union since reliable data are provided by the Copernicus program, for example, which is the European Union's Earth observation program.

### 3.1.4. Implementation of context specific governance mixes

The governance and planning approaches must acknowledge the local ecological, social, historical and political context by several means (# X Spyra et al., 2020 & # XI Spyra et al., 2021), and thus must be context specific (# VI La Rosa et al., 2017). To this end, local, context specific legislation frameworks must be taken into consideration (# V Geneletti et al., 2017). In planning practices such official frameworks could be joined with various bottom-up initiatives to create a specific mix of top-down and bottom up governance and planning approaches. Such frameworks could form a governance mix that is broader than a combination of different policy instruments and planning documents and indicate a thoughtful and complex mix of different, top-down and bottom-up governance and planning approaches, which are introduced at different administrative levels, bringing different formal and informal outcomes and are discussed and implemented by the wide range of governance actors. Such a mix needs to acknowledge also interactions between its components (approaches). It should also include a strategic component, meaning it should be related to a coherent developmental vision of a landscape.

Firstly, implementations of governance mixes should also reflect on context specific historical, social and political issues. For example, using traditional governance approaches (meaning historically used in the extent of a specific landscape) can not only increase acceptance by local actors for proposed solutions, but more specifically it can also support a method for ES trade-offs towards ES synergies. In this way, various ES are “fine-tuned” with support of scenario planning (Allocco et al., 2018), and are connected to market-oriented mechanisms (# XI Spyra et al., 2021). Such “ecological approaches” can support social and environmental justice and pave the way towards more equitable governance, thus support framing landscapes as socio-ecological rather that socio-economical spaces.

Secondly, implementation of such governance mixes is to be based on careful identification of local networks of local governance actors and their context specific needs. This could be done in the framework of social network analysis. Such approaches allow one to map and assess formal and informal relationships between governance actors, find out about their needs, analyze their level of influence over a specific planning or governance issue, better address the knowledge flow in a network, and plan usage of this knowledge.

Thirdly, any context specific boundaries between urban and rural areas located in a landscape need to be considered as fluid/flexible and not strictly related to administrative boundaries between cities and villages (# XI Spyra et al., 2021). It is because urban areas located within a landscape often times expand their coverage in cost of other types of land covers (# XI Spyra et al., 2021).

Lastly, governance mixes need to contribute to reducing specific trade-offs that emerge in the extent of landscapes. Examples relate to ES trade-offs (# X Spyra et al., 2020), or other trade-offs related to implementation of Sustainable Development Goals.

### 3.1.5. Assessing landscapes asymmetries to inform landscape governance and planning

Landscape asymmetries are to be discovered in a landscape that is divided into two or more parts by a boundary line (# VIII Spyra et al., 2019). The most evident example of this is CBLs where a boundary line between two or more countries is the main component of this landscape notion. In my studies, landscape’s asymmetries have been analyzed from two perspectives: firstly, a spatial perspective where there are differences related to a landscape morphology observed on both sides of a boundary line (# II Spyra, 2014; # VIII Spyra et al., 2019). In this case asymmetries related to CBL morphology can be detected with simple analyses of land cover / land use of a CBL, or detection of them can be based on spatially explicit indicators, e.g. Technomass, that provide opportunities for quantification of urbanization degrees of a landscape (Inostroza et al., 2019). Such analyses allow one to compare landscape morphology on both sides of a boundary line. Secondly, governance landscape asymmetries can be defined as differences in addressing similar planning issues by binding on both sides of a boundary governance or planning legislature (# II Spyra, 2014). In this case the asymmetries are shown by a structured analysis of governance or planning documents that are binding in administrative units (e.g. municipalities, regions) that are located on both sides of a boundary line.

Moreover, asymmetries in CBL contexts are also related to economic aspects (e.g. welfare gaps between parts of a CBL), sociological issues (e.g. lack of historical memory of common past among CBL inhabitants), cultural issues (e.g. languages spoken in the CBL that are different and not related to each other), or urban development disproportions on both sides of a boundary line (Spyra, 2013a). Such asymmetries can be analyzed by detailed socio-economic studies of a landscape.

Assessing various landscape asymmetries can inform landscape governance and planning in different ways. For example, landscape asymmetries diagnosis was acknowledged as an element of gaining interdisciplinary knowledge about a landscape (# I Spyra, 2014). It can support understanding of the interface between the socio-political system of a cross-border region and a landscape (# VIII Spyra et al., 2019). Moreover, assessment of landscape asymmetries could relate to aspects of ES provision and demand. In this case a landscape asymmetry was assessed with help of accessibility studies. Accessibility was calculated between tourism green sites (cultural ES providing areas) and urban settlements (cultural ES benefitting areas) that are located on both sides of a boundary line understood as an accessibility barrier that needs to be overcome with support of governance or planning approaches (# XII Spyra & Hamerla, 2021). Understanding processes behind a landscape asymmetry should be based on detailed studies of history, demography, culture, and economic development characterizing parts of a landscape located on different sides of a boundary line. Such studies can be implemented with the help of qualitative research methods such as literature research, study visits or surveys conducted in a landscape (Obracaj & Spyra, 2012). Such site-specific knowledge is a key element in state-of-the-art analyses related to a planned or governed landscape.

### 3.1.6. Application of socio-ecological landscape monitoring systems

Assessments of landscape asymmetries can be an element of a socio-cultural landscape monitoring system that integrates landscape observations with governance and planning feedback loops and modelling. Landscape monitoring systems should allow observation of effects and influences of planning decisions in environmental and social components of a landscape by measuring both biophysical and socio-economic aspects. Such a system needs to make use of quantitative knowledge, but also qualitative knowledge obtained from, for example, different design workshops (# V Geneletti et al., 2017). This system needs to monitor a subject, meaning changes in the physical components of a landscape, and the processes taking place between those elements. Such a monitoring system can inform adaptive governance or planning cooperation in the extent of a landscape. To do this it is important to guarantee a constant flow of reliable and context specific data, obtained with help of performance indicators, expressing transitions taking place in a landscape (# X Spyra et al., 2020), or collected with help of citizen science approaches (research projects Edu2Work and RENATUR).

A specific example of such a tool, studied in my research, is related to the peri-urban monitoring system. Such a monitoring system needs to be performance based, which means it is focused on results required by policy-makers or planners, can inform decision-making and is adapted to emerging facts and challenges (research project RENATUR). It is for instance very useful to support a re-development of peri-urban brownfields and could contain information on individual brownfields, gaps between abandoned buildings and potential available investment sites[6]. Specifically, such a monitoring system can contain detailed data explaining physical dimensions of a site, infrastructure and other service's accessibility, contamination level, or post-industrial monument protection. Important data are related to the ownership structure of a peri-urban brownfield and possible options for its area parceling (options to share or combine properties to make them smaller or bigger). Moreover, the data can cover specific characterization of ecosystems, ES, biodiversity and general characterization of a peri-urban brownfield surrounding area. Such a monitoring system should be a "living tool", meaning it needs to be constantly updated and managed and its objectives must be well defined and understandable for various governance actors. For example, detailed geo-location of peri-urban conflicts to inform governance and spatial planning could be included in such a monitoring system as well.

Implementation of landscape monitoring systems, specifically in peri-urban contexts could support important performance-based planning (# V Geneletti et al., 2017). Performance-based planning is visionary, oriented towards a long-term perspective, and based on fewer regulations compared to traditional planning approaches. Moreover, it is faster in its implementation and incorporates dialogue among governance actors. Impacts of such approaches are constantly being assessed against their outcomes (# X Spyra et al., 2020).

Based on this system, local/regional governance actors can, for instance, reduce obstacles of development by preparing instruments for the re-use and marketing of peri-urban brownfields. Moreover, such systems can support detection of new transitioning areas located in urbanized rural areas. In this case identification of such areas is necessary for a better distribution of centrally governed funds in rural regions, meaning that the centrally governed funds can be better assigned according to a specific demand in a part of a rural region (Guo et al., 2022).

Socio-ecological landscape monitoring systems can be supported by implementation of spatial planning technologies that make use of spatially explicit data that is harmonized across different administrative units (# IV Frank et al., 2017). Comparability of such data is particularly relevant in cross-boundary contexts where it should facilitate, for example, implementation of landscape monitoring on both sides of a national border. Moreover, the data used for monitoring systems needs to have a high thematic resolution that is suitable for taking governance and planning decisions in a sound way. Such data must also be prepared and made available in the most possible transparent manner. Such data sets are provided in European context CORINE data, Functional Urban Areas data, or other spatially explicit data prepared according to INSPIRE regulations (Infrastructure for Spatial Information in the European Community)[7]. Nevertheless, from this set only INSPIRE regulation data has a high thematic resolution covering not only detailed land uses, but also outlines and basic characteristics of built structures.

### 3.1.7. Involving support squads in governance and planning processes

Governance and planning of landscapes could be supported by establishing "support squads". My research shows that such "support squads" could be formed from groups of middle-school pupils and/or university students, working under supervision of a planner and/or researcher (# I Spyra, 2014). Involvement of such support squads could be implemented via planning workshops organized at different stages of a planning process. For instance, university students could take part in analyzing landscape morphology, helping to define landscape spatial asymmetries (# II Spyra, 2014; research project Edu2Work), support defining sustainable development principles (Spyra, 2013f; research

[6] Source: https://www.interregeurope.eu/renatur/news/news-article/11059/revitalisation-of-inner-city-brownfields/, accessed November 2021.

[7] https://inspire.ec.europa.eu/inspire-legislation/26 , accessed February 2022.

project School without Borders), or support defining economic development opportunities (Spyra, 2013c; research project KOPR). Work in such "support squads" could be implemented in the framework of scenario planning based on qualitative imagery and storytelling. It is because visual thinking and storytelling are approaches that are useful both for university teaching processes, being positively evaluated by university students (Spyra, 2013d), and are appreciated as elements of governance and planning specifically in urbanized contexts (Söderström, 1996). In my research, such approaches have been tested with university students. This testing integrated university teaching based on active learning approaches with my research (Spyra, 2013a; Spyra, 2013c; research projects School without Borders, KOPR and Edu2Work). Moreover, in research project RENATUR one of the good practices identified in it relates to a design workshop implemented with students and interdisciplinary experts. Here the "support squad" helped to brainstorm new planning ideas on how to protect peri-urban open spaces located in Curange-les-bains in Hasselt in De Wijers (Flanders, Belgium). This workshop was implemented in the framework of Life+ project Green4 Grey managed by Flemish Land Agency[8].

### 3.1.8. Implementing foresight methods

Collaborative governance and planning approaches described above can be classified as belonging to foresight 2.0 methods (# I Spyra, 2014). Such methods proved their usefulness in describing a general development vision of a landscape (research project School without borders), searching for consensus among governance actors related to directions of landscape sustainable development (research project KOPR), or more specifically discussing aspects of local labor market development, its influence over a landscape and vice versa (research project Edu2Work; Bondaruk et al., 2015).

Foresight 2.0 methods compared to "traditional" foresight methods are more open, based on digital-collaborative approaches (Schatzmann et al., 2013) and put more emphasis on leadership rather than on management over the whole planning process (# I Spyra, 2014; # II Spyra, 2014). Foresight 2.0 tools are acknowledged as useful for decision-making in various contexts and useful for reduction of complexity. The aspect of complexity reduction implemented in the framework of foresight 2.0 tools could be useful for tackling complex landscape challenges. The digital character of such methods could fit very well into various on-line workshop formats, which have recently become a standard in everyday working, also planning arrangements.

Implementation of foresight 2.0 methods can be seen as an element supporting a shift from traditional "end state" governance and planning into more flexible and process-oriented governance and planning approaches (# VIII Spyra et al., 2019). In such processes neither the scale of their implementation nor the final results thereof are the most important aspects; rather, a process of steering sustainable changes through feedback loops should matter the most. Arguments for such an approach are delivered by a study of green and grey systems in Czech-Polish CBL. Results of this study show that static planning approaches fail to address transitional and asymmetric character of this specific landscape (# VIII Spyra et al., 2019).

### 3.1.9. Using the concept of green infrastructure

Examples of context specific governance and planning strategies and solutions analyzed in my research are: planning and design of peri-urban greenery, ES based planning, nature-based solutions and green infrastructure and planning of new forms of agriculture in PULs. They proved to be effective approaches to support governance and planning specifically in peri-urban contexts, offering sustainable, cost-effective, multipurpose and flexible solutions enhancing resilience of PULs and

[8] https://www.interregeurope.eu/good-practices/design-workshops-for-open-spaces-in-peri-urban-areas , accessed April 2022.

increased accessibility to cultural and provisioning ES (# VII La Rosa et al., 2018). Among those approaches, particular attention was given to the concept of green infrastructure (Calò and Spyra, 2022) which is defined as "all natural, semi-natural and artificial networks of multifunctional ecological systems within, around and between urban areas, at all spatial scales" (Tzoulas et al., 2007). Green infrastructure concept was discussed many times among various governance actors during implementation of the research projects (research projects INLAND and RENATUR).

This approach was specifically well acknowledged in a cross-boundary context by politicians and planners (# IV Frank et al., 2017). In addition to this, implementation of green infrastructure has a specific role in peri-urban contexts. Development of new and enhancement of existing peri-urban green infrastructures contribute to provision of cultural ES in close proximity to peri-urban inhabitants (# VII La Rosa et al., 2018). During the RENATUR project, green infrastructure was proposed to be implemented as an approach to limit negative influence of massive tourism over peri-urban open spaces natural heritage in Gorenjska region (Slovenia) (Calò and Spyra, 2022)[9]. Recommendations on how green infrastructure could be used for such purposes, prepared by the RENATUR project workshop attendees, covered preparation of a strategic planning document for this infrastructure as a tool to protect peri-urban open spaces. Such a strategy would facilitate coordination of different planning activities and needs of governance actors. Other recommendations suggested connection of the green infrastructure concept with sustainable mobility and activation of the regional private sector. All such activities need to be implemented in the framework of close intercommunal cooperation. Moreover, implementation of RENATUR workshop showed that the green infrastructure concept is easy to understand for different governance actors who see at least one potential benefit related to its implementation. Thus, their willingness to implement it is relatively substantial.

A specific good practice identified in RENATUR relating to green infrastructure shows that a green belt created around a city, connecting green areas beyond the city boundaries with green areas inside the city, can be a very effective tool to prevent uncontrolled peri-urbanization and to protect peri-urban open spaces located in different municipalities (Vitoria-Gasteiz City Council, 2020)[10]. In this example, developed in and around the city of Victoria-Gasteiz (Basque Country, Spain) sustainable transportation infrastructure was combined with a green belt joining peri-urban and urban landscape of this city. This green belt is also combined with an agricultural belt that surrounds Victoria-Gasteiz.

## 3.2. Regional management platform

The *key steps* described so far can be coordinated by a platform that could take the form of an institutionalized regional management institution (Figure 8) that is able to bring all governance actors to a common table and to develop operational solutions. The need for establishing such a platform was indicated several times in the course of my research (# I Spyra, 2014; # IV Frank et al., 2017; # X Spyra et al., 2020; # XI Spyra et al., 2021).

This platform could manage a systemic, strategic, long-term and vision-oriented process of landscape development via implementation of different governance mixes that are based on an existing or newly established legal governance framework. Activities of this platform need to be based on excellent knowledge about local governance actors, their needs and ideas and their different top-down and bottom-up planning or governance initiatives. This would allow these actors to combine bottom-up and top-down initiatives in a form of oriented towards whole CBL or PUL governance mixes.

[9] Source: https://www.interregeurope.eu/renatur/events/event/3784/interregional-online-workshop-for-gorenjska-region/ , accessed November 2021.
[10] https://www.interregeurope.eu/good-practices/green-belt-of-vitoria-gasteiz , accessed April 2022.

Engagement and consolidation of local governance actors needs to be one of the most important activities in this platform. In this process, activation of different stakeholders, in particular a private sector, could be highly important, as often this sector has significant investment capacities that contribute to peri-urban or cross-boundary transitions. Consolidation of local governance actors needs to be built upon raising awareness regarding different processes taking part in landscapes (e.g. peri-urbanization and cross-boundary developments) and supported with transfer of opinion, knowledge and experiences related to governance of landscapes. Consolidation of governance actors could also be implemented via simple workshops addressing different but always well explained and introduced aspects of CBL and PUL development (e.g. ambiguity of such landscapes, conflicts and delimitation). Also, delivering simple messages in the form of infographics or social media activities could be helpful in increasing awareness of sustainable development of a landscape. This could be done, for example, by focusing stakeholder's attention on nature-based solutions, green infrastructure, or the role of ES for inhabitant's well-being. It is important that the engagement of governance actors is seen also as a long-term process and is implemented in a continuous way. Consistent implementation of such activities could support an increase in trust and interest about aspects related to governance and planning of landscapes. It is particularly important to build trust and understanding between private sector (investors) and public decision-makers related to a landscape.

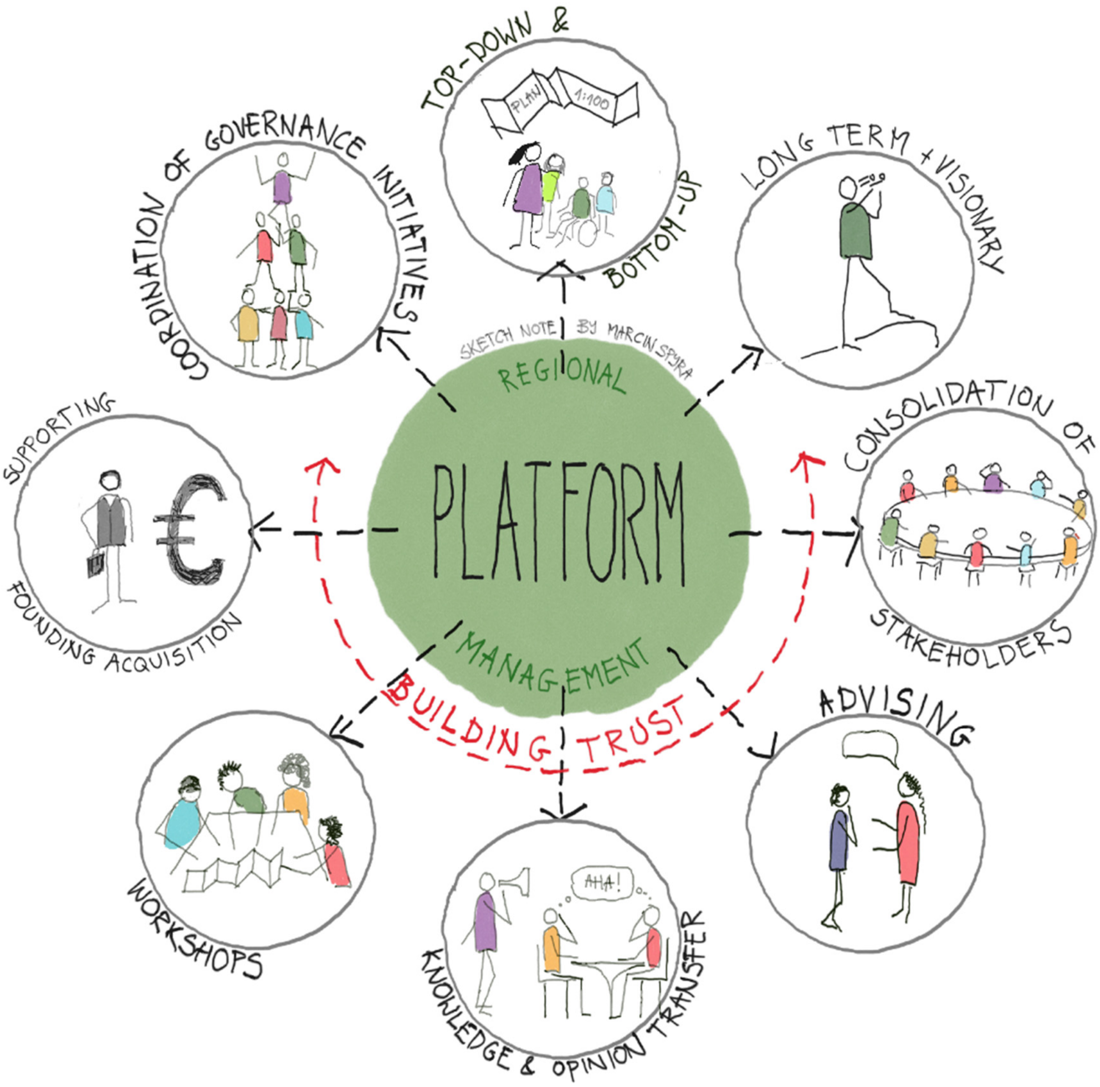


**Figure 8** Functions of a regional management platform that can coordinate governance and planning of landscapes. Source: own elaboration.

Once the trust among governance actors is established, it would be possible to involve them in more detailed workshops and the platform could offer advisory services for them. This could be implemented hand-in-hand with coordination of existing and planned development strategies, plans etc. and supporting funding acquisition for newly planned projects or development tasks.

Establishment of such a platform might be more complicated in CBL due to the necessity of having a consensus among administrative units (e.g. regions, or municipalities) belonging to two different countries. Nevertheless, running such a platform could be a task for Euroregions that have cross-boundary organizations which group stakeholders from different countries (# I Spyra, 2014) and could benefit from planning technologies tailored to the cross-boundary context (# IV Frank et al., 2017).

## 3.3. Aspects that hamper usability of governance and planning approaches for landscapes that emerge from a mix of natural and social processes

During implementation of my research I have indicated several limitations of the *key steps* introduced above. Such limitations are critical elements in the relationship between governance or planning approaches and landscapes that emerge from a mix of natural and social processes. Following Geneletti et al., 2017 (# V), such limitations are divided into: (i) internal limitations, (ii) external barriers (obstacles) that hinder the effectiveness of existing governance and planning approaches in addressing landscapes, (iii) risks and trade-offs arising from their application and (iv) transferability from one socio-ecological context to the other.

### 3.3.1. Internal limitations

Internal limitation occurs when an approach fails to support sustainable development of a landscape due to its low effectiveness related to the very way an approach functions (e.g. static Euclidean zoning cannot secure the longer-term sustainable development of a constantly transitioning landscape). Summary of this in the previous chapter explaining the *key steps* towards different internal limitations is presented in Table 6. On the other hand, a set of general internal limitations is described in the paragraphs below.

Low flexibility is often a basic characteristic of many existing governance and planning processes in landscapes (# XI Spyra et al., 2021). One of the examples of it identified during my research comes from Belgium. In this country a regional land use plan was prepared in 1970’s for the entire Belgian territory (RENATUR research project). This land use plan clearly defined generic land use rights by precisely indicating the activities allowed or prohibited in each type of zone. At that time, it seemed to be a good solution safeguarding sustainable development of the country. Obviously, governance and planning conditions now are different from the ones in 1970’s, so this land-use plan has become more a challenge than a helpful tool to secure sustainability of a landscape. Revision of planning systems in Flanders (the biggest region in Belgium) started only in 1999 and allowed preparation of local land use plans that can change the original land use allocation described in the general plan from 1970’s. Further improvements started in 2018 when the Flemish Government approved the strategic vision of the Spatial Planning Policy Plan Flanders. Nevertheless, the entire Flanders is still not covered by updated policies and spatial planning procedures which hampers, for example, protection of natural heritage of open spaces in this region[11].

[11] Source: https://www.interregeurope.eu/renatur/events/event/3263/first-interregional-workshop-for-flanders-online/ , accessed October 2021.

**Table 6** Vulnerability of a governance/planning approach towards internal limitations and external barriers (obstacles). 1 – approach is vulnerable; 0 – approach is not vulnerable.

| Name of a key governance or planning step | Internal limitations | | External barriers (obstacles) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Limited flexibility and ability to respond quick for landscape transitions | Approach based explicitly on a patch-corridor-matrix model | Lack of inter-communal cooperation & cooperation among governance levels; governance fragmentation | Problems with governance actor's involvement | Lack of financial resources; difficulties to constantly secure financial resources | Lack of awareness among governance actors about peri-urbanization processes and their impacts on a landscape | Lack of coordination between different policy instruments or planning documents | Resistance (for political or bureaucratic reasons) to normative innovation |
| Establishing trust between governance actors | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| Planning in the frame of a multilevel cooperation | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Coordinating of governance and planning activities in the framework of cross-boundary planning documents | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| Implementation of context specific governance mixes | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| Assessing landscapes asymmetries to inform landscape governance and planning | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Implementing socio-ecological landscape monitoring systems | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 |
| Involving support squads into governance and planning processes | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| Implementing foresight methods | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| Using the concept of green infrastructure | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| Regional management platform | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |

Often governance and planning procedures are too slow to respond to fast land use/cover changes, or socio-ecological transformations of a landscape (# XI Spyra et al., 2021). The reason for specific "slow nature" of planning is threefold. Firstly, planning should be implemented in the framework of official legislation, secondly some governance actors have a poor understanding of why it is important to act fast and flexible in governance and planning, and thirdly "slow nature" relates to an unstable political situation related to a policy environment (e.g. cadence of public administration). Another reason for this could be related to ineffective regulatory instruments that fail to protect open spaces in landscapes (# XI Spyra et al., 2021). Thus, is it difficult to "capture" either in traditional governance procedures or in spatial planning documents (very often based on land-use Euclidean zoning), the quick transitions taking place in landscapes (# VI La Rosa et al., 2018).

On the other hand, it is difficult to assess effectivity of existing spatial planning approaches in increasing sustainability of a landscape (# VI La Rosa et al., 2018).

Moreover, in participatory governance and planning approaches, the time needed to find consensus among governance actors is long and the process of getting such consensus is complicated and expensive (# V Geneletti et al., 2017).

A specific example of slow landscape planning and governance response is related to brownfield re-development (# XI Spyra et al., 2021). Re-development of brownfields is a complex process that involves various governance actors and financial resources. It is not easy to effectively (quickly) convince investors to invest rather in brownfield re-development than in building on a green field. Even regional policy-makers are not fully convinced of such ideas and prefer to offer green-fields to new investors in order not to discourage them with unexpected problems, or high costs related to brownfield redevelopment (research project RENATUR)[12]. For example, in Germany transformation of former mining landscapes needs to be financed by mining companies, but these requirements are often fulfilled at the minimum level (# XI Spyra et al., 2021). Moreover, complex and "investor-friendly" monitoring systems of peri-urban brownfields that can quickly and efficiently provide a set of reliable information, are not yet in place.

Qualitative assessments of various landscapes are often implemented using common patch-corridor-matrix models built upon landscape conceptualization proposed by Forman and Gordon (Forman & Gordon, 1986). Although national and administrative boundaries that are among the most significant signatures of the human modification of space that could be seen in landscapes are not fully incorporated in such models (# VIII Spyra et al., 2019). Modifications related to boundaries are particularly important and visible in human-dominated, anthropogenized landscapes. My research showed that implementation of models based on hexagonal cells allows more precise assessments of CBLs and for delimitation of landscape asymmetries (# VIII Spyra et al., 2019) that can be related also to urban-rural dichotomies (Inostroza et al., 2019).

### 3.3.2. External barriers (obstacles)

Implementation of some of the key steps introduced in the previous chapter is hampered by a single or a set of barriers related to external and objective (not related to the design of a *key step*) obstacles (Table 7)[13].

Most of the external barriers identified in my research are related to limited governance actors' awareness of significant influences of human activities on sustainability of landscapes. For example, many governance actors affiliated to different sectors are not aware of that role that borders and boundaries play in landscapes governance and planning. CBL from the ecological perspective is a cohesive unit. Nevertheless, from the point of view of governance and spatial planning it is not, since it is divided into smaller spatial units by the national boundary (# VIII Spyra et al., 2019; # XII Spyra & Hamerla, 2021). Such spatial units, located in independent states, have been shaped by different national traditions, heritages, cultures and political systems. Any human activity in such contexts have left their traces behind, such as buildings of various size and quality, different infrastructures or other human made elements that have formed a specific cultural heritage of such landscapes. This heritage

[12] Source: https://www.interregeurope.eu/renatur/events/event/3640/interregional-online-workshop-for-saxony-anhalt/ , accessed November 2021.

[13] Names of those external barrier clusters were used in two on-line surveys implemented with local policy-makers and experts affiliated to PULs. The first survey was implemented in the years 2020-2021 and covered twenty-four case study PULs. The second survey was implemented in the year 2021 and covered fifty case study PULs. In both surveys the case study PULs were distributed in different regions worldwide. For more details please refer to sections "Quantification of governance mixes tailored for peri-urban landscapes" and "Analysis of ecosystem service trade-offs in peri-urban landscapes in 20 regional case studies" presented in Conclusions and outlook at the end of this thesis.

has been integrated into the natural heritage of such landscapes to varying degrees (Spyra, 2013d). This situation creates an interesting field for research concerning governance and spatial planning that is still underexplored in scientific literature (# VIII Spyra et al., 2019).

Governance actors have also limited knowledge of landscape transformations (e.g. peri-urbanization processes) and their impact upon a landscape's sustainability (# XI Spyra et al., 2021). For example, the notion of "peri-urbanization" sometimes sounds too "abstract" for them and creates confusion during policy-making or planning processes (research project RENATUR). Moreover, the impact of peri-urbanization upon a landscape is hard to grasp and to delimitate, which makes selection of governance actors who are important for peri-urbanization processes difficult. Notions of CBLs and PULs are also ambiguous not only for citizens and stakeholders, but also for experts. Thus, while working with such specific types of landscapes, notions describing those landscapes need to be carefully explained to governance actors e.g. in the framework of different planning workshops. This can help to get from them information about how such landscapes are addressed by current policy or planning documents.

If the knowledge about landscapes' transformations is limited, then awareness of ES trade-offs emerging, particularly in PULs and the influence of such trade-offs, into sustainability of a landscape is also not considerable (# X Spyra et al., 2020). It is also related to low understandability of the ES concept and low or not effective inclusion of this concept into existing governance and planning documents.

Like low governance actors' awareness, a very frequent external barrier hampering process of governing and spatial planning of landscapes is "not-in-my-backyard" (NIMBY) syndrome (# I Spyra, 2014). That syndrome "refers to intense, often emotional and usually organized opposition to sitting proposals that residents of a local community believe will result in adverse impacts" (Wexler, 1996, p.92). Since the 1980's, NIMBY is described as an "international phenomenon" and emotional, parochial and self-serving reaction of a community (Popper, 1985). It is not difficult to imagine such reactions in cross-boundary contexts, where one national community thinks about their own interest and could try to neglect in their thinking different (even if they are common) needs of the "other" community situated on the other side of a boundary. In such situations the willingness of various governance actors to participate in governance or planning processes is low and is a significant barrier for their implementation (# IV Frank et al., 2017). Challenges related to the NIMBY syndrome were also identified in my studies related to Czech-Polish Euroregions, where survey respondents pointed it out as an obstacle in preparation and implementation of cross-border land-use management strategies (# I Spyra, 2014).

An example of NIMBYism is the engagement of governance actors, or more specifically Euroregions members, in governance or planning initiatives in over a border line (# I Spyra, 2014). Usually governance actors show little interest in such a process due to their lack of understanding (why do we need it?), lack of clarity (what are the aims?) and simply lack of time. This situation becomes even more complicated when communication among governance actors shifted, in some cases, into on-line meetings. Such challenges have been encountered during implementation of the RENATUR research project that is based on intensive exchange of experience among diverse governance actors. Similar challenges, but on a smaller scale, occurred during implementation of the KOPR research project and Edu2Work research project.

Moreover, NIMBYism shows itself to be a significant limitation for governance and planning of landscapes that are highly fragmented by an ownership structure (RENATUR research project). Such a situation occurs in many types of landscapes in the European Union but is even more significant in non-European cross-boundary contexts where governance actors are situated in two or more sovereign countries. Good examples of such landscapes are forests, where one larger part of a forest could be owned by several land-owners coming from different countries. Similar situations could be observed in rural landscapes where a single landscape, from an ecological point of view, is divided into several territories owned by different national stakeholders.

NIMBY syndrome is also closely related to a lack of intercommunal cooperation, cooperation among different governance levels and governance fragmentation as such.

A type of NIMBY syndrome in governance and planning is a lack of coordination between different policy instruments and planning documents that are binding for specific administrative units. Such a situation has a very negative impact on sustainable development of a whole landscape that encompasses several administrative units, due to, for example, various ecological flows and interlinkages between landscape elements that do not stop through an administrative boundary. Moreover, the lack of such coordination hampers effectivity of planning activities related to, for example, peri-urbanization undertaken in the extent of one community, if the neighboring community has a different planning approach to such challenges.

Significant limitation relates to the vulnerability of a governance or planning approach vis-à-vis pressure of investors. It is often indicated with transformation of landscape open spaces, meaning non-sealed areas, into build-up areas (# XI Spyra et al., 2021). An example of such pressures are transformations taking part in the extent of PULs. In this case pressures are indicated by constantly emerging new forms of lifestyles related to new inhabitants, mobility demands of peri-urban inhabitants, fast land use / land cover transformation rates resulting with an increase in built-up surfaces and soil sealing, or emerging new transportation infrastructures resulting in densification of infrastructure networks (# X Spyra et al., 2020). All such changes can contribute to changes in traditional morphologies of rural landscapes and, hence, to a loss of cultural heritage thereby (Guo et al., 2022).

Implementation of most of the governance and planning approaches requires significant amounts of financial resources. Such financial resources are a prerequisite for starting intercommunal cooperation in governance and planning (# IV Frank et al., 2017). Moreover, to make governance and planning approaches effective also on the further stages of such processes, the constant flow of financial resources to support them is needed. It is related particularly to those approaches that implementation is extended over time (needs a lot of time) and where different governance actors need to be constantly involved (# VI La Rosa et al., 2018). The other example relates to the flow of financial resources that is needed for all phases of a policy cycle, as defined by IPBES: design, implementation, monitoring and assessment[14]. This is a particularly significant challenge for public authorities who are responsible for a landscape while experiencing budget shortages and operating on different administrative levels.

Together with a lack of financial resources, a missing legal basis that can support inter communal cooperation in governance and planning is seen as an obstacle (# IV Frank et al., 2017). In such a case it is difficult to describe outcomes of such processes in a binding way, meaning in a way that they can have a real impact on landscape sustainability. This obstacle is similar to resistance (for political or bureaucratic reasons) to normative innovation described in my studies related to ES trade-offs in PULs.

On the other hand, the previously introduced *key steps* that have been responsible for a landscape are not only vulnerable to specific limitations and barriers, but their implementation also contributes to solving external barriers or obstacles as well (Table 7).

[14] Source: https://www.ipbes.net , accessed October 2021.

**Table 7** Contribution of a governance/planning approach for solving external barriers (obstacles). 1 – contribution exists; 0 – contribution does not exist.

| **Name of a key governance or planning step** | **External barriers (obstacles)** | | | | | |
|---|---|---|---|---|---|---|
| | Lack of inter-communal cooperation; lack of cooperation among governance levels; governance fragmentation | Problems with governance actors' involvement | Lack of financial resources; difficulties to constantly secure financial resources | Lack of awareness among governance actors regarding peri-urbanization processes and their impacts on a landscape sustainability | Lack of coordination between different policy instruments or planning documents | Resistance (for political or bureaucratic reasons) to normative innovation |
| Establishing trust between governance actors | 1 | 1 | 1 | 1 | 1 | 1 |
| Planning in the frame of a multilevel cooperation | 1 | 0 | 0 | 1 | 1 | 1 |
| Coordinating of governance and planning activities in the frame of cross-boundary planning documents | 1 | 0 | 0 | 1 | 1 | 1 |
| Implementation of context specific governance mixes | 1 | 1 | 1 | 1 | 1 | 1 |
| Assessing landscape asymmetries to inform landscape governance and planning | 1 | 0 | 0 | 1 | 1 | 1 |
| Implementing socio-ecological landscape monitoring systems | 1 | 1 | 0 | 1 | 1 | 1 |
| Involving support squads into governance and planning processes | 1 | 0 | 0 | 1 | 1 | 1 |
| Implementing foresight methods | 1 | 1 | 0 | 1 | 1 | 1 |
| Using the concept of green infrastructure | 0 | 0 | 0 | 0 | 0 | 0 |
| Regional management platform | 1 | 1 | 0 | 1 | 1 | 1 |

### 3.3.3. Conflicts and trade-offs

Conflicts and trade-offs introduced here could arise from implementation of governance or planning approaches to a landscape. Various conflicts are confronted when landscapes are in a transitional stage. Longman English Dictionary defines conflict as "a state of disagreement or argument between people, groups, countries, etc."[15]. The transitioning stage of a landscape fosters various conflicts that emerge during different stages of governance or planning process (# X Spyra et al., 2020). Sustainable governance and planning of landscapes require continuous identification of such conflicts. It can be based on a sound socio-ecological monitoring system that is in place and that detects, and monitors planned and un-planned changes in the socio-ecological structure of a landscape (research project RENATUR).

[15] On-line Longman Dictionary available at https://www.ldoceonline.com/ , accessed August 2021.

In the context of my research concerning CBLs I have identified conflicts between the needs for nature protection and the needs of local inhabitants to have a better accessibility to cultural ES (# XII Spyra & Hamerla, 2021). ES deficit areas located in a CBL could also be the source of a conflicting situation (# VIII Spyra et al., 2019). In both cases the conflict could be fostered by a risk of “over-using” ES providing areas for touristic needs (Calò and Spyra, 2022) and non-established or blurred ES connecting areas (areas joining ES providing and ES benefitting areas). The conflict here could emerge between people searching for various cultural ES and local residents, and also between touristic development of an area and conservation policies related to it.

Another example of landscapes studied in detail by me that are characterized by intensive conflicts are PULs. The most common group of conflicts in such contexts are the ones related to land-use (#XI Spyra et al., 2021). They could be classified as “noise pollution”, “health hazards”, “preservation of the past”, or “changes to the neighborhood” (Von Der Dunk et al., 2011). Land use conflicts are the source of other conflicts with more sociological background, like conflicts between newcomers in PULs and the peri-urban older residents. In this situation the newcomers are perceived as “aliens” in a PUL. Another group of conflicts that emerges in PULs are human-wildlife conflicts. In this case humans tend to “compete” with wild-life for similar resources, services, or areas (König et al., 2021). This group of conflicts is particularly difficult to address as there might even be a strong disagreement between, for example, the need for nature protection (and the way it works) and peri-urban food production or even security of PULs residents (in the case of more aggressive wildlife species).

In the scientific literature, conflicts are studied close to trade-offs emerging in different types of landscapes (Peña et al., 2018). A trade-off is a situation where it is necessary to balance two opposing (conflicting) situations or qualities (# X Spyra et al., 2020). My studies show that implementation of sustainable planning approaches in landscapes can also lead to various trade-offs like social inequality (# VI La Rosa et al., 2017), or ES trade-offs. The second example is specifically related to ES trade-offs that are a significant threat to landscape sustainability. The basic reason for such trade-offs is the process of dynamic land use changes observed specifically in anthropogenized landscapes (# X Spyra et al., 2020). On the other hand, ES trade-offs are not yet effectively addressed by governance and planning (# X Spyra et al., 2020). This is because it is challenging to incorporate the ES concept into binding landscape policy and planning documents. Moreover, regional policy and decision makers see investment in green areas as an “unnecessary cost” that could be generated through planning decisions (Table 5).

An example of such an ES trade-off in PULs could be a situation in Basque Country (Spain) where native species are replaced in forests by invasive species to increase timber provision, which causes loss of regulatory and cultural ES (RENATUR research project). Another example observed in the Gorenjska region (Slovenia) is related to the trade-off between cultural ES and other types of ES such as regulatory and provisioning (Calò and Spyra, 2022). Such a situation is typical for massive tourism that emerges in different landscapes (Table 5). Another specific ES trade-off was identified in the RENATUR project, whereby the proposed re-location of shopping centers from peri-urban areas into urban infrastructural nodes could generate an unwanted trade-off with the provision of urban ES[16].

Specific trade-offs fostered by governance and planning approaches can also be related to equity issues. For example, implementation of some eco-compatible planning approaches could hamper the existing socio-environmental milieu by fostering unwanted social group segregation (# V Geneletti et

[16] Source: https://www.interregeurope.eu/renatur/events/event/3263/first-interregional-workshop-for-flanders-online/ , accessed October 2021.

al., 2017), or limiting accessibility to cultural ES (# XII Spyra & Hamerla, 2021). Such a situation is neither socially equitable nor environmentally sustainable.

Another example of a trade-off can be seen regarding to implementation of Sustainable Development Goals in the extent of urbanized rural areas. In this case, the alleviation of local poverty related to the development of urbanized rural areas induces negative consequences for the mitigation of land degradation, biodiversity loss, and climate change (Guo et al., 2022). Other negative consequences for planned development of urbanized rural areas are higher energy intensity, an increase in the frequency of car accidents due to densification of road networks, an increase in material consumption and resultant greenhouse gas emissions.

### 3.3.4. Transferability of governance and planning approaches from one socio-ecological context to the other

The "context" is understood here both from an ecological point of view and in a wider perspective of different socio-economical processes, such as peri-urbanization of bordering/de-bordering and/or constantly shaping landscapes. This gives an opportunity to provide a characterization of a landscape context as emerging from socio-ecological processes. A good example of such landscapes is related to those studied in detail in my research on CBLs and PULs.

My research shows that most of the governance and spatial planning approaches implemented so far for different landscapes are context-specific and solution oriented (# V Geneletti et al., 2017; # VII La Rosa, 2018). Even if an approach proved to be successful in addressing sustainability issues in a specific socio-cultural context, there is no guarantee that it would work in another context, since challenges related to sustainability often differ from one context to the other. Thus, cross-context generalizations related to governance and planning approaches are challenging and need to be described with critical attention. To this end it is important to underscore the fact that direct "importation" of one governance and planning approach, which proved to be successful in one context, to another one is difficult and needs to be always critically assessed if implemented (# V Geneletti et al., 2017). This is the case for spatial planning that focuses on the built-up environment and approaches (ES based planning, for example) that focus more on the natural environment. It is also pertinent for traditional urban planning approaches that address landscape "hardware", meaning its built-up environment. And finally, it is also the case for social-science approaches broadly represented by participatory planning approaches that address landscape "software". Borrowing governance and planning approaches from a different context is a good starting point; however, it needs to be followed up by adjustment to the particular characteristics of the local status. The most important local particular characteristics are related to a specificity of local governance and planning legislation and to different context-specific planning traditions that also need to be respected.

Ideally, structured research comparing usability of governance and planning approaches in different realities is needed as a key step to implementation of aa new approach that has been proved to be usable in a different context (# V Geneletti et al., 2017). Such a review of approaches would allow a reduction of failures or unwanted governance and planning outcomes.

Moreover, importing governance and planning solutions between different contexts can discourage implementation of local, traditional approaches that have proved to be successful in addressing site specific challenges related to protection of local ES, for example, (# IX Spyra et al., 2019) or to the reduction of ES trade-offs (# X Spyra et al., 2020).

Experiences from RENATUR research projects allow us to exemplify the aspect of governance and the transferability of planning approaches (Calò and Spyra, 2022). Specific methodology implemented in this project has assured that governance approaches useful in one context were adjusted to the other with a site-specific action plan. An action plan is a document that describes necessary changes in local policies that are inspired by interregional cooperations that have taken part in the framework of the project. Beside action plans, the project results encompass the collection of good practices. The good practices (defined during RENATUR) were described in the project on-line data base that is available to any internal and external actor. Each good practice described there must prove to be a successful governance story and needs to show an adequate level of transferability. To allow a more objective assessment of the collection of good practices, each good practice was validated by an external policy expert from the founding institution of INTERREG Europe. The collection of good practices serves as an inspiration for other regions to improve their local policies aiming to protect peri-urban open spaces[17].

The significant level of transferability is presented by some of the good practices, which support inter-communal cooperation by, for example, providing information about areas that are suitable for investment and less valuable from an ecological point of view, but could be offered as potential investment sites to foster socio-economic development of a region ("Virtual commercial real estate pool" of Kleve county in Germany). A similar application of this is the good policy practice from Saxony-Anhalt in Germany in which a management system based on a brownfield land registry was put in place. Good policy practices related to implementation of overall policy paradigms show good potential for learning or transfer. For instance, green infrastructure development can, on a general level, be transferred among contexts (e.g. Green Belt of Vitoria-Gasteiz in Spain). Nevertheless, such a transfer relates needs to consider site specific challenges related to, for example, local governance actors' opinions, or local planning legislation. Regarding awareness raising approaches, the distribution of thematic booklets promoting green infrastructure was successful in Budapest (Hungary), although this might be less successful in other, specifically non-European contexts.

Inclusion of support squads formed from university students has considerable potential for transferability among contexts. This was shown by RENATUR good practice implemented in Flemish Belt around Brussels (Belgium) where students provided ideas on how to use ES and green infrastructure concepts to promote the sustainable development of a PUL; this is similar to an approach used in several locations in the Czech-Polish borderland (KOPR and Edu2Work research projects).

Analysis of these good practices has shown that their transferability is relatively high when it comes to aspects of policy paradigms (the ES concept, for example) but is not evident when it comes to more specific planning strategies, solutions, operational methods and tools (for example, the context specific national ecosystem map of Hungary). Moreover, this collection of good practices shows that transferability of specific policy solutions is less challenging between communes located in one region, or in one European Union state.

## 3.4. Use of the ecosystem services concept to enhance sustainable governance and planning in the above contexts

To effectively use the ES concept for sustainable development of landscapes that emerge from a mix of natural and social processes, the ES concept needs to be included in binding governance and planning documents (# IX Spyra et al., 2019). Enhancing sustainable governance and planning of landscapes with the support of the ES concept is related both to the advantages and risks described below.

[17] Source: https://www.interregeurope.eu/renatur/good-practices/ , accessed November 2021.

### 3.4.1. Advantages

There are several advantages of using the ES concept in planning (# IX Spyra et al., 2019). In my research the advantages were analyzed across long/short term temporal scales and regional/local spatial scales. The greatest advantages were facilitation of knowledge sharing among governance actors, the ability to support work on a shared development vision, the contribution of context-specific experiences, an increasing awareness of (hidden) local potentials, and support for local identification of suppliers and demanders of services.

Facilitation of knowledge sharing among governance actors is an important factor in different landscape contexts. As discussed above, several landscape types are characterized by diversity of governance actors operating on different administrative levels. Thus, implementation of the ES concept could support the following: required intercommunal cooperation, coordination of different planning activities, and identification of the needs (demands) of local governance actors. This can be facilitated by establishing a governance platform wherein negotiations between actors could take place and which could contribute to revised and strengthened links between different planning levels (Bondaruk et al., 2015). Such an ES oriented platform could be a form of think-tank whereby various governance actors would have an opportunity to contribute to inclusion of the ES concept in binding planning procedures (Edu2Work research project). Similar results could be achieved in this context through implementation of the ES concept in working on a shared developmental vision. Definitively achieving a developmental vision that is shared among governance actors should be considered as a very important element for strategic planning documents, addressing, for example, aspects of peri-urban open spaces protection (# XI Spyra et al., 2021) or cross-boundary land use management (# I Spyra, 2014).

Increasing awareness of (hidden) local potentials could be useful to perform assessments or to collect context specific knowledge related to parts of a landscape located very close to a border line. For example, my study implemented in the 10 km buffer delimitated from the boundary line between the Czech Republic and Poland showed a need to establish cross boundary sustainable transportation links between cultural ES providing and benefitting areas situated within this buffer (# XII Spyra & Hamerla, 2021). In this specific case implementation of the ES concept also supported identification of service suppliers and demanders. Moreover, hidden local potentials are often related to open spaces that can be marginalized or overlooked in governance and planning practices (# XI Spyra et al., 2021). Better understanding of peri-urban open spaces' socio-ecological potential could lead to, for instance, establishment of a new form of peri-urban agriculture that offers two things: first, an opportunity for local residents to have direct access to fresh food (short food supply chains) and second, the opportunity to work in small allotment gardens to establish valuable social interactions among peri-urban residents (RENATUIR research project).

Contribution of context-specific experiences that can be supported by implementing the ES concept in planning could be particularly useful for transitional landscapes, characterized by large groups of governance actors affiliated with them. This is because of the significance of various context specific governance and planning approaches that need to be implemented in such landscapes. Identification of the needs of local governance actors, and/or considering specificity of local legislation are just two examples here. Moreover, reflecting on local social and historical policy issues and using traditional governance approaches can lead to obtaining acceptance of proposed governance or planning solutions by local actors and thus lead to reducing peri-urban ES trade-offs (# X Spyra et al., 2020).

In general, identified advantages can surely support ES based planning and implementation of green infrastructure concept that are required in different landscape contexts. For example, an ability to reach a shared developmental vision is needed while working on green infrastructure related to spatially extensive projects such as green and agricultural belts (RENATUR research project). It is specifically important when such belts link urban and peri-urban areas and are combined with sustainable transportation infrastructures such as bike lines (Calò and Spyra, 2022).

### 3.4.2. Risks and approaches to limitation thereof

My research shows that lack of ES concept understanding or fragmented understanding of thereof is one of the largest risks related to its implementation in governance or planning practices. There are also some more specific risks related to inclusion of the ES concept in planning (# IX Spyra et al., 2019). Similarly, in reference to the advantages, the risks were also analyzed across long/short term temporal scales and regional/local spatial scales. The most significant risk was related to over-emphasizing specific goods or services. The reason for this could be a stakeholder perception of “my ES”, technical difficulties for ES assessment of valuation, or ex-cathedra decisions taken by powerful governance actors contributing to exclusion of less powerful governance actors.

The specific phenomenon of “my ES” identified here refers to a situation where one or several specific ES are over-emphasized due to the particular interests of some governance actors. Such a situation has similarities with the NIMBY phenomenon already described above and needs to be considered in a very careful manner during governance and planning procedures. There are no easy solutions regarding how to tackle this specific challenge; however, some insights into solving it have emerged from my research and are described below.

Inclusion of the ES concept in governance and planning could be based on several components. These components were described during the RENATUR research project using the example of a specific PUL located in the Hajdu-Bihar region in Hungary[18]. Initially in this process it is important to understand the specific local sustainability challenges that the local decision-makers have to face. It could be done by arranging a long-term cooperation and dialogue in order to, for example, balance a trade-off between protection of nature and economic development. Secondly, it is important to map ES on a regional level as it is broad enough to cover the scope of a landscape (-s). Based on this, a communication strategy to involve local governance actors can be prepared. It can be visualized with clear infographics. Based on these activities, it can be possible to develop a regional or local long-term action plan focusing on the long-term effects of inclusion of the ES concept. An example of such an approach for including the ES concept into a regional spatial development plan was coordinated by the Flemish Land Agency from Belgium (RENATUR research project)[19]. In this case, based on a general communication strategy guide, a series of participatory workshops, which included various governance actors in order to obtain the maximum effect, were carried out. The workshops were focused on combining the ES concept with a vision of regional development. Another strategy, used by the same agency to support inclusion of the ES concept in Biodiversity Action Plan in Holland, was based on development of a communication strategy incorporating clear, self-explanatory and graphically attractive infographics. Such infographics explained the role of ES for inhabitants’ well-being[20].

Another significant group of risks is exclusion of some governance actors related to their limited knowledge or missing scientific background. Here, careful management of the policy-making and planning process, or context specific measures to encourage governance actors to participate in the

[18] Source: https://www.interregeurope.eu/renatur/events/event/4292/interregional-workshop-for-hajdu-bihar-county/ , accessed September 2021.
[19] Source: https://www.interregeurope.eu/renatur/events/event/4292/interregional-workshop-for-hajdu-bihar-county/, accessed September 2021.
[20] Source: http://en.biodiversiteit.nl/bap, accessed September 2021.

policy-making or spatial planning process, can support minimization of this risk (# V Geneletti et al., 2017).

Asymmetries in the provision and demand for ES are another group of risks related to implementation of the ES concept (# VIII Spyra et al., 2019). The first step in addressing such risks needs to be based on assessment of such asymmetries included in governance and spatial planning processes. In this context, steps of inclusion of the ES concept could encompass the following: (1) diagnosis of all landscape asymmetries related to their morphology and binding spatial planning legislature; (2) identification of ES demands and ES deficit areas; (3) bilateral discussion and establishment of joint land-use goals for the entire landscape; (4) inclusion of such goals in binding spatial planning legislation for the whole landscape (# II Spyra, 2014). Implementation of such steps could contribute to establishing ES based planning goals and (generally speaking) ES based planning (# VIII Spyra et al., 2019).

ES delivered by landscapes could generate trade-offs that need to be addressed by governance and planning. This situation is specifically complicated in transitional landscapes like PULs that are constantly influenced by different forces and are arenas of different conflicts (# X Spyra et al., 2020). In this context ES trade-off, analyzed in pairs between corresponding major groups, describes a situation where one ES is gained, while another is lost. Often recognized in my research and widely addressed in literature are the trade-offs between cultural and provisioning or regulating ES. The main reason behind this is increasing usage of PULs for recreational means, e.g. “horsification” of PULs - (Zasada et al., 2013), and observation throughout the European Union and North America of the increase in private houses in PULs. The key steps described in the previous chapter can contribute to reduction of such risks. Nevertheless, in this case awareness of the ES concept by governance actors could again significantly support a pathway from ES trade-offs into synergies.

Overall, addressing all of the risks related to implementation of the ES concept in governance and planning practices could take place within the framework of the ES platform (think-tank), described in the advantages section above, which facilitates negotiations between governance actors affiliated with a landscape.

### 3.4.3. Improving the ES concept understanding among various governance actors

Governance actor’s awareness of the ES concept needs to be seen as a key element in planning of sustainable landscapes and reducing ES trade-offs (# XIII Palacios-Agundez et al., 2022). As stated already in this thesis, any implementation in governance or planning processes for the ES concept must be followed by very detailed explanations of it (# IX Spyra et al., 2019). In the meantime, various ambiguities regarding the ES concept are reported as one of the most significant obstacles to including this concept in any decision-support activities (Hauck et al., 2015).

Landscapes are complex systems, and many types of landscapes are characterized by quick transformations. This particular type refers to landscapes such as CBLs and PULs that are strongly influenced by social processes and, due to them, many ES are lost (# X Spyra et al., 2020). Building awareness about such processes and ES losses or trade-offs related to them should be seen as a basis for implementation of governance and planning approaches (# X Spyra et al., 2020). In the specific context of PULs, raising public awareness regarding a reduction in peri-urban open spaces and the respective negative input into sustainability of our regions and regional citizens well-being could help to address the common PULs trade-off between protection of open spaces – together with related ES – and socio-economic development of a region based on new investments emerging in the extent of such open spaces. Such situations were often identified during implementation of INLAND and RENATUR research projects. Workshops implemented in these projects show that due to low awareness about consequences of sociological processes of ES provision, decision makers in communes often think that open spaces are a kind of easily available “capital” that they can offer to investors to attract them to create new working places in a commune, or to encourage new inhabitants to build their houses and to move their life into a commune. Nevertheless, implementation of RENATUR research projects shows that such an approach is not a rule and there are other communes that are more skeptical towards this “pro-investment” approach and more interested in protecting their ES. Other trade-offs in a peri-urban context emerge between the protection of cultural ES represented by natural and cultural heritage of peri-urbanized rural landscape and the eradication of rural poverty (Guo et al., 2022). In this specific case, understanding of the significance of ES could be an initial step in management processes for such a context-specific trade-off. ES awareness could help to better explain the need for finding synergy between local ES provision and eradication of poverty. For example, the trade-off between protection of ES provided by peri-urban open spaces and economic development of a commune could be addressed with the help of specific incentives for land owners to encourage them to manage peri-urban lands in a more sustainable way and to prevent “open”, meaning not built-up and not sealed, character of such spaces (# XI Spyra et al., 2021).

Awareness of cultural ES is higher than awareness of regulating or supporting services (# XIII Palacios-Agundez et al., 2022), but landscape sustainable development requires that all types of ES are equally acknowledged in governance or planning processes. Awareness rising in reference to the role of ES for landscape sustainability should be based on sound, understandable messages for the general public that are well-presented and evidence-based (# X Spyra et al., 2020). Preparing such messages could be implemented with the help of different modelling approaches based on a constant flow of site-specific data provided by a landscape performance-based monitoring system already introduced in this thesis.

Implementation of my research projects has shown that raising public awareness, understanding of ES – thus engagement of governance actors – must be supported by an effective communication strategy. A communication strategy that is well focused, precise, graphically attractive and based on social media is a very important element encouraging governance actors to take part in different meetings, taking place in participatory planning processes (research projects KOPR, Edu2Work and RENATUR).

In addition to experience arising from research projects, my work has addressed the problem of ES awareness from the perspective of teaching of the ES concept. It is due to the fact that teaching the ES concept needs to be seen as a basic step in improving the understanding of the ES concept by different groups in a society (# XIII Palacios-Agundez et al., 2022).

In academic contexts, the use of outdoor classroom practical teaching activities, active teaching methods or a combination of traditional lectures with active teaching methodologies is a good method for thoroughly explaining the ES concept by stimulating systemic thinking-oriented problem-solving skills and critical thinking skills among students (# XIII Palacios-Agundez et al., 2022). In this way, teaching the ES concept can generate connections between ecological, geological, and social systems to, first of all, support the notion that humans are not units separated from an environment and to, secondly, search for win-win governance solutions.

Nevertheless, teaching of the ES concept needs to be implemented not only at the university level, but also at other educational levels, such as primary and secondary education. My research shows that academics who teach the ES concept are interested in cooperating with non-academic teachers. Such cooperation between different educational levels can be based on sharing experiences, educational materials, or evaluation methods (# XIII Palacios-Agundez et al., 2022).

### 3.4.4. Ecosystem services indicators

To speak about the ES concept in a spatial context and to implement it in governance or planning practices, it is important to precisely measure different types of ES with spatially explicit indicators (# III La Rosa et al., 2016). OECD defines indicator in ecology and planning as a "component or a measure of environmentally relevant phenomena used to depict or evaluate environmental conditions or changes or to set environmental goals" (OECD, 2003).

My research has specifically contributed to indicators for cultural ES in urban contexts (# III La Rosa et al., 2016). Finding effective methods for cultural ES quantitative assessments provides essential insights into governance and planning of landscapes, particularly for landscapes that represent complex contexts where culture, history, location play an important role for cultural heritage and thus for cultural ES provision. In complex urban contexts ES providing areas are very often mixed with areas benefiting (consuming) ES (# III La Rosa et al., 2016). Similar issue can be observed in PULs and some urbanized parts of CBLs. This complicated mixture between provision and consumption of ES could be tackled in governance and planning by addressing specific ES and connecting them to specific objects that provide them (ecosystems for example). In the case of cultural ES such services, mixed with other ES, could even be provided by cultural items such as objects that are outstanding or important for local heritage. To address such a complex situation, ES assessments require a high resolution of data. Nevertheless, aspects of data provision might be problematic in the context of transitional landscapes due to complicated delimitation methods, discussed above, and constant (often dynamic) changes in these landscapes.

Basic ES indicators, implementing land cover area analyses, could be used to assess spatial asymmetries on both sides of a landscape boundary line (# II Spyra, 2014). It offers the opportunity to describe aspects of ES supply and demand that are useful for governance and planning by identifying landscape patches that either have a good ability to provide ES, or to absorb ES, and are located on both sides of a boundary line. Moreover, it offers the possibility to calculate accessibility between ES supply and demand areas. This is a key step towards delimitation of ES connecting areas (# XII Spyra & Hamerla, 2021). In this way, ES indicators can support delimitation of ES providing, benefitting and connecting areas in asymmetric landscapes. Such delimitation is an important step in preparation of any governance or planning document that addresses a landscape (# I Spyra, 2014).

My research has applied a combination of different ES indicators by joining, for example, novel indicators to assess anthropogenized matter, accumulated in a landscape that is characteristic for landscape grey systems (Inostroza et al., 2019), with remote sensing indicators ready to quantify green systems (# VIII Spyra et al., 2019). Such a combination was used to assess asymmetries in urbanized landscapes and ES mismatches. The use of such boundless indicators supports going beyond urban-rural dichotomies and enables quantification of urbanization and peri-urbanization as continuous spatiotemporal processes on the landscape scale. This aspect is also important in peri-urban and cross-boundary landscape contexts and is able to well inform governance and planning there. It leads for example to assessment of ES deficit areas with quantitative methodology based on an ES deficit-factor indicator (# VIII Spyra et al., 2019). Such assessment could become a strong argument for joined efforts to better govern ES on both sides of a boundary line and to reduce trade-offs related to them (# X Spyra et al., 2020).

As already stated, all examples of ES indicator implementation, described above, need to be based on qualitative data. This aspect is particularly significant and could be difficult to address in transitional landscapes, since their constant fluctuations require precise and on-going data collection (# X Spyra et al., 2020). An approach that could be helpful for gathering specific updated data and assessing ES in landscape scale and sharing such assessments with local governance actors is represented by citizen science methods (in the form of participatory ES mapping, for example) (# III La Rosa et al., 2016).

## 3.5. Manuscript contributions into the chapter 3 “Results”

**Table 8** Description of the manuscripts’ contributions into the chapter 3 “Results”

| # | Title of the manuscript | Manuscript contribution |
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| I | The feasibility of implementing cross-border land-use management strategies: a report from three Upper Silesian Euroregions | Findings described in this manuscript, contributed to formulation of six *key steps* described in chapter 3. The list of the manuscript findings and their relation to the *key steps* is presented below:<br>(1) *key step* no. 1: trust is the basic precondition for effective work on land-use strategies in cross-boundary contexts;<br>(2) *key step* no. 2: Polish and Czech governance actors surveyed in this research confirmed effectiveness of multilevel governance approaches in cross-boundary contexts;<br>(3) *key step* no. 3: implementation of land-use management strategies in CBLs should support decentralization of powers from central to regional governments;<br>(4) *key step* no. 6: importance of constant flow of updated and interdisciplinary knowledge about a landscape is usable for its governance and planning;<br>(5) *key step* no. 7: important role of support squads comprised of university students or school pupils in governance and planning of landscapes;<br>(6) *key step* no. 8: more emphasis on collaborative governance and leadership in landscape governance processes;<br>Contributions of this manuscript into the description of the *key steps* allowed also to describe the regional management platform, presented in section 3.2.<br>Moreover, the research showed that NIMBYsm is an important aspect hampering governance and planning of CBLs. In this way it contributes to the descriptions of aspects that hamper usability of governance and planning approaches for landscapes that emerge from a mix of natural and social processes (section 3.3.). |
| II | Ecosystem Services and Border Regions. Case Study from Czech – Polish Borderland | The manuscript described specific asymmetries related to the analyzed example of a CBL. They are indicated by different types, biodiversities and areas of ecosystems identified on both sides of the border and by differences in content of land-use strategies concerning this landscape. In this way it contributed to the description of the *key step* no. 5 “Assessing landscapes asymmetries to inform landscape governance and planning”. This finding of the research also contributed to the description of risks and approaches to limitation thereof described in section 3.4. “Use of ES concept to enhance sustainable governance and planning in the above |

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| | | contexts". Moreover, this finding contributed also to the description of ES indicators presented in section 3.4.4.<br><br>The manuscript underlined the role of university students as a member of a support squad supporting governance of a landscape. In this way it contributed to the description of *key step* no. 7 "Involving support squads in governance and planning processes".<br>The research presented an example of using foresight approaches during the governance process of a landscape, thus it contributed to the description of *key step* no. 8 "Implementing foresight methods". |
| III | Indicators of Cultural Ecosystem Services for urban planning: A review. | The manuscript presents a review of indicators for the assessment of cultural ES. Criteria of spatial features, communicability to planning and relevance of urban context were chosen as particular characteristics for indicators that should be used for urban planning. Findings presented in this manuscript and thoughts developed were the basis for formulation of section 3.4.4 that explains the role of ES indicators in governance and planning of landscapes. |
| IV | Requirements for cross-border spatial planning technologies in the European context. | The study provided general recommendations about cross - border spatial planning technologies. Findings, described in this manuscript, contributed to the formulation of three *key steps* described in chapter 3. The list of the manuscript findings and their relation to the *key steps* is presented below:<br><br>(1) *Key step* no. 1: honesty and trust among governance actors are basic pre-condition to conduct planning in CBLs;<br><br>(2) *Key steps* no. 3 and 6: harmonization of methodological approaches and data for all administrative units are specifically important in cross-boundary planning contexts;<br><br>(3) *Key step* no. 9: using the concept of green infrastructure were comprehensively acknowledged by politician and planners in cross-boundary contexts;<br><br>Contributions of this manuscript into the description of the *key steps* made it also possible to describe the regional management platform, presented in section 3.2.<br><br>The research shows that low willingness of various governance actors to participate in governance or planning processes related to CBLs is a barrier that needs to be overcome. Moreover, it shows that financial resources are a prerequisite for starting intercommunal cooperation in governance and planning. In this way this manuscript contributes to the descriptions of aspects that hamper usability of governance and planning approaches for landscapes that emerge from a mix of natural and social processes (section 3.3.). |

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| V | A review of approaches and challenges for sustainable planning in urban peripheries | The article explored approaches and challenges related to the application of sustainable planning to urban peripheries. The research described in this manuscript used the interpretation key that provided definitions of planning paradigms, planning strategies and solutions, operational methods and tools. These definitions contributed to the classification of the governance and planning approaches, used in chapter 3 to introduce the notion of the *key steps*.<br><br>Findings, described in this manuscript, contributed to formulation of three *key steps* described in chapter 3. The list of the manuscript findings and their relation to the *key steps* is presented below:<br><br>(1) *key step* no. 2: links between different governance and spatial planning levels need to be revised and strengthened in order to introduce new arrangements (cooperation) within regional or metropolitan areas where an urban periphery is located;<br><br>(2) *key step* no. 4: local, context specific legislation frameworks must be taken into consideration while designing governance mixes;<br><br>(3) *key step* no. 6: landscape monitoring system needs to make use of quantitative knowledge, but also qualitative knowledge; implementation of landscape monitoring systems in urban peripheries could support performance-based planning.<br><br>Contributions of this manuscript into the description of the *key steps* made it also possible to describe the regional management platform, presented in section 3.2.<br><br>The manuscript contributed also to the description of the internal limitations of the *key steps.* It contributed to this part by, for example, by giving a warning about the extended time needed to find consensus among governance actors and about complications related to this process. This contribution is also related to showing that implementation of some eco-compatible planning approaches could hamper the existing socio-environmental milieu.<br><br>Moreover, the manuscript highlighted the significance of context specificity of existing planning approaches addressing urban peripheries. This provided a foundation for further considerations described in section 3.3.4 "Transferability from one socio-ecological context to the other".<br><br>The manuscript suggested that management of the policy-making and planning process, or context specific measures can limit exclusion of some governance actors from planning processes. This finding contributed to the section 3.4.2. "Risks and approaches to limit thereof". |
| VI | Special issue on sustainable planning approaches for urban peripheries | The manuscript pointed out that planning decisions must be adopted to the specific existing political, economic and cultural context of the region. This finding contributed to the description of the *key step* no. 4. |

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| | | The manuscript discussed various trade-offs that are the results of implementation of sustainable planning approaches in urban peripheries. This finding contributed to the section 3.3.3 “Conflicts and trade-offs”. |
| VII | Sustainable planning for peri-urban landscapes | The manuscript pointed out that green infrastructure proved to be a cost-effective, sustainable, multipurpose and flexible approach in peri-urban contexts. Such infrastructure increases provision of various ES in close proximity to urban and peri-urban residents. In this way this manuscript contributed to the description of the *key step* no. 9.<br><br>Moreover, the manuscript underscored the fact that landscape planning approaches implemented thus far are context-specific and solution-oriented. Thanks to this finding the manuscript contributed to the section 3.3.4 reflecting on the transferability from one socio-ecological context to the other. |
| VIII | Ecosystem services deficits in cross-boundary landscapes: spatial mismatches between green and grey systems. | The study defined significant spatial asymmetries of a CBL, indicated inter alia by the share of grey and green systems and distribution of ES deficit areas in a landscape. Thanks to these results the manuscript contributed to the description of the *key step* no. 5 and to the description of the risks related to implementation of the ES concept in governance and planning of landscapes (section 3.4.2).<br><br>The manuscript discussed the need for more flexible and process-oriented governance and planning approaches. This finding was used in the description of the *key step* no. 8.<br><br>The research showed that national and administrative boundaries are among the most significant signatures of the human modification of space that could be seen in landscapes. Nevertheless, they are not fully incorporated in many currently used landscape models. Moreover, research showed that implementation of models based on hexagonal cells allows more precise assessments of CBLs and for delimitation of landscape asymmetries. In this way the manuscript contributed to the description of internal limitations of the *key steps*, described in the section 3.3.1.<br><br>The manuscript explained that a CBL from the ecological perspective is a cohesive unit, but from the point of view of governance and spatial planning it is not, since it is divided into smaller spatial units by the national boundary. This contributed to the explanation of the external barriers of the *key steps,* presented in the section 3.3.2.<br><br>The research described ES deficit areas delimitated in the case study CBL. Such areas can be a source of conflicting situations described in the section 3.3.3.<br><br>Findings of this research were possible due to implementation of a combination of different ES indicators. Thanks to this, the manuscript contributed to the ES indicators described in the section 3.4.4. |

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| IX | The ecosystem services concept: a new Esperanto to facilitate participatory planning processes? | The research described in this manuscript showed that trust is a basic pre-condition for using the ES concept as a common language among governance actors who engaged in participatory planning activities related to a landscape. The reflection that emerged from this research contributed to the description of the *key step* no. 1.<br><br>The manuscript explained that implementation of governance and planning approaches requires working with three groups of governance actors: stakeholders (organized groups having a specific interest / a "stake" in an area), experts (objective knowledge holders) and citizens. This contributed to the description of the *key step* no. 2.<br><br>The research identified several positive effects of applying the ES concept in participatory planning, including the facilitation of knowledge sharing and consideration of local experiences, the support towards a shared vision, and the increased awareness among local actors concerning their role as ES suppliers or beneficiaries. These findings contributed to the description of advantages of using the ES concept to enhance sustainable planning of landscapes that emerge from a mix of social and ecological processes, presented in section 3.4.1.<br><br>Among several drawbacks of using the ES concept in participatory planning of landscapes, the research identified the risk of overemphasizing specific ecosystem goods or services during the process. These findings contributed to the description of risks of using the ES concept to enhance sustainable planning of landscapes that emerge from a mix of social and ecological processes, presented in section 3.4.2.<br><br>Moreover, the research findings related to advances and risks contributed to section 3.4.3. in which improvement of the ES concept understanding among governance actors is explained. |
| X | Governance of ecosystem services trade-offs in peri-urban landscapes. | Thoughts, described in this essay, contributed to the formulation of three *key steps* described in the chapter 3. The list of the manuscript thoughts and their relation to the *key steps* is presented below:<br><br>(1) *key step* no. 1: trust is important in governance processes related to PULs and supports reduction of ES trade-offs in such contexts;<br><br>(2) *key step* no. 4: the governance mixes must acknowledge the local ecological, social, historical and political context and need to contribute to reducing specific trade-offs that emerge in the extent of landscapes;<br><br>(3) *key step* no. 6: governance of PULs is related to a constant flow of context specific data, obtained with the help of performance indicators, expressing transitions taking place in a landscape; governance approaches applied to reduce ES trade-offs in PULs must be constantly assessed against their outcomes. |

The essay confirmed the need of establishing a regional management platform that can coordinate various multilevel governance and planning activities related to a landscape. Such a platform is described in section 3.2 of this thesis.

The manuscript pointed out several processes affecting PULs governance. Such processes could be classified as external barriers and/or internal limitations that hamper usability of governance and planning approaches for landscapes that emerge from a mix of natural and social processes (sections 3.3.1 and 3.3.2). For example, the manuscript described:

- a significant role of awareness about landscape transformations among governance actors;

- constant and dynamic physical and sociological transformations of PULs.

The manuscript explained examples of various conflicts and ES trade-offs emerging in transitioning PULs. It also explained basic reasons for such processes that are mainly related to land cover/use changed observed in such contexts. In this way it contributes to the section 3.3.3 of this thesis that reflects on conflicts and trade-offs.

The essay discussed the challenges related to transferability of governance approaches between contexts. In this way it contributed to the section 3.3.4 of this thesis.

Since the manuscript provided specific insights about governance of ES trade-offs in PULs, it contributed to the formulation of several thoughts introduced in the section 3.4 “Use of the ecosystem services concept to enhance sustainable governance and planning in the above contexts”. The contribution was related to the explanation of specific examples on inclusion of ES concept in governance of PULs.

XI Protection of peri-urban open spaces at the level of regional policy-making: Examples from six European regions.

The manuscript introduced the concept of peri-urban open spaces and provided characterization of such spaces. Moreover, it identified and classified policy improvements that are useful to protect peri-urban open spaces. Lastly the research described recommendations for regional policy instruments to improve the protection of peri-urban open spaces.

The manuscript implemented a classification of policy improvements into: policy paradigms, strategies and solutions, operational methods and tools. These contributed to the classification of governance and planning approaches, used in chapter 3 to introduce the notion of the *key steps*.

Findings and thoughts, described in this paper, contributed to the formulation of six *key steps* described in chapter 3. The list of the manuscript findings and their relation to the *key steps* is presented below:

(1) *key step* no. 1: trust must be established among representatives of regional policy-makers, who have been working together to define policy and planning approaches to protect peri-urban open spaces,

(2) *key step* no. 2: cooperation should be related to implementation of multi-level and adaptive approaches implemented in non-hierarchical, horizontal and polycentric directions; there is a high potential to improve regulatory policy instruments that should be the foundation of multilevel governance and planning cooperation;

(3) *key step* no. 4: policy-making related to peri-urban open spaces must acknowledge local ecological, social, historical and political context; boundaries between urban and rural areas located in a landscape need to be considered as fluid/flexible and not strictly related to administrative boundaries between cities and villages.

Such contributions to the formulation of the *key steps* indicated in this manuscript the need for coordination among various regional policies and gave the foundation for the description of regional management platform in the section 3.2 of this thesis.

The manuscript pointed out low flexibility of policy-making processes, time demanding procedures, low effectiveness of regulatory policy instruments addressing peri-urban open spaces. This contributed to the description of internal limitations on the *key steps* described in section 3.3.1.

The paper explained limited awareness of PULs transformations among governance actor and the vulnerability of governance approaches vis-à-vis pressure of investors. In this manner, the manuscript contributed to the description of external barriers (obstacles) of the *key steps* described in section 3.3.2.

The paper showed that peri-urban open spaces have a hidden potential to deliver various services, including ES. This contributed to the description of the advantages of using the ES concept in planning and governance of landscapes described in section 3.4.1.

Moreover, the manuscript provided arguments for why protection of peri-urban open spaces is important for provision of ES. Such a case could be used to increase understanding of the ES concept among various governance actors, described in section 3.4.3.

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| XII | Bicycle Accessibility to Cultural Ecosystem Services in a Cross-Boundary Landscape. | The manuscript presented results of accessibility studies implemented in a case study CBL. Research approach implemented in this study contributed to planning in the framework of multilevel cooperation described in the *key step* no. 2 by providing a method to visualize ecological and socio-economic problems of a landscape.<br><br>The manuscript described asymmetries of a CBL, assessed with the help of accessibility studies. In this manner, it contributed to the description of the *key step* no. 5.<br><br>The research showed that a CBL is not a cohesive unit from the point of view of landscape governance and planning. This thought contributed to |

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| | | the description of external barriers introduced in section 3.3.2 of this thesis.<br>The study described an example of specific conflict between the needs for nature protection and the needs of local inhabitants to have better accessibility to cultural ES. This contributed to the section 3.3.3 “Conflicts and trade-offs”.<br>The manuscript described a need to establish cross boundary sustainable transportation links between cultural ES providing and benefitting areas situated within a CBL. Such links could increase the well-being of local inhabitants. This contributed to the description of the advantages of using ES concept in governance and planning of landscapes (section 3.4.1).<br>The research showed that spatially explicit ES indicators have a potential to delimitate ES connecting areas in CBLs. This was used as an argument in section 3.4.4 reflecting on ES indicators. |
| XIII | Teaching the ecosystem service concept: experience from academia. | The research described in this paper delved deeper into how the ES concept is taught and which teaching strategies are currently being used by ES research academics.<br>The manuscript underlined that teaching the ES concept, mainly with the help of active teaching methodologies, needs to be a basic step in improving the understanding of the ES concept by different groups in a society. This paper discussed the notion that governance actor’s awareness of the ES concept should be seen as a key element in the planning of sustainable landscapes. It also explained that awareness of cultural ES is higher than awareness of regulating or supporting services. These thoughts have provided the foundation for section 3.4.3 explaining the improvement of the understanding of the ES concept among various governance actors. |

# 4. Discussion

## 4.1. Towards "good governance" of landscapes

There are several general aspects about the *key steps towards improved governance and planning for sustainable development of landscapes that emerge from a mix of natural and social processes* (further named as *key steps*) worth being acknowledged. First, the *key steps* lead towards so-called "good governance" of landscapes. Literature characterization of good governance covers aspects introduced in the *key steps* and presented in the Results section of this thesis. Even if the good governance term is quite general and might sound a bit like a simplification, it is also straightforward and easy for the general public to understand, thus useful for awareness raising processes and highlighting the importance of governance decisions for future generations of landscape users. Such understanding was used by Kofi Annan who said that "good governance is perhaps the single most important factor in eradicating poverty and promoting development"[21]. According to the Institute on Governance the five general principles for good governance, based on the United Nations Development Program description, are: (1) legitimacy and vote, meaning that the activities are implemented in wider participation and are consensus oriented; (2) direction, meaning that a long term strategic vision is described; (3) performance, meaning that needs of different actors are acknowledged; (4) accountability, meaning that decision-makers are accountable to the public and their activities are transparent and (5) fairness, meaning all actors including particularly inhabitants have opportunities to improve well-being (Graham et al., 2003).

There are different examples of governance practices described in the literature as "good". In the context of peri-urban farmland, good governance requires vertical and horizontal coordination between different actors which leads to better arrangements between them (Paül & McKenzie, 2013). It also needs to be implemented in the framework of participatory processes, based on excellent public information (Romero, 2015) and where restrictive approaches like zoning are used only when necessary. According to good governance in forest landscape, the synchronous functioning of different components of a politically accepted governance process is very important (Fischer et al., 2021).

## 4.2. Influence that is made by borders and boundary lines over a landscape.

Another aspect important for the *key steps* is related to influence that is made by borders and boundary lines over a landscape. This is because many landscape types cannot be reducible to administrative boundaries (# VII La Rosa et al., 2018; # X Spyra et al., 2020). As shown in my research, even if boundary is not the core concept issue introduced in a landscape notion, it would be difficult to conceptualize some specific landscapes without addressing it. Moreover, borders influence governance and planning practices of many landscapes in a significant way. For example, in the CBL context, governance and planning must involve at least two countries that represent independent planning systems; however, they are frequently not linked with effective interaction patterns. Such systems grow over different planning traditions and self-reinforcing interactions (Jacobs, 2014).

In my research, border-related challenges were exemplified by both CBLs and PULs. In CBLs a boundary/border is a central element of such conceptualizations of landscapes. In the case of PULs, boundary planning and governance challenges are less evident. Nevertheless, several administrative boundaries are located inside a PUL, and the location of PULs could be described as "cross-boundary", since PULs are often located at the edge of one city or several cities (# VII La Rosa et al., 2018). Such boundaries could be classified on various administrative levels. In my research I have analyzed an example of PUL that is located between Poland and Czech Republic in Upper Silesia Region (Inostroza

[21] Source: Kofi Annan, www.unu/p&g/wgs/, accessed August 2021.

et al., 2019). Analysis of this landscape morphology, implemented with the help of a novel spatially explicit indicator Technomass, shows spatial asymmetries between Polish and Czech parts of this example of PUL. As shown by results from my research, such asymmetries are characteristic for CBLs. A specific situation is when a PUL contains boundaries between regions, like in the case of the PUL between Halle and Leipzig in Germany that spans across two federal states (German *Ländern*) Saxony and Saxony-Anhalt (Haase et al., 2012). More common in peri-urban contexts are boundaries between provinces, communes, or cities. The literature related to PULs does not sufficiently underscore the significance of an internal boundary. Moreover, boundary as an element plays a different role in PUL conceptualization than in CBL conceptualization.

My research implemented in the extent of PULs confirmed that addressing a presence of boundaries in a planning process is important when it comes to policymaking and planning of PULs (INLAND and RENATUR research projects). Boundary surely creates different governance and spatial planning challenges in the context of a CBL that stretches over two or more national states; this is different in the context of a PUL that is located in one country where it is known as a "mono-national construct". Nevertheless, there are some similarities between these two cases. They are related, for example, to aspects of "cooperation over the boundaries", or as named by RENATUR partners, weak and ineffective "intercommunal cooperation" leading, for example, to intensive competition for development funds between municipalities or communes belonging to one PUL (Table 5). A good example that is related to this is hazard management.

## 4.3. Delimitation of landscapes as a governance and planning challenge

Delimitation of landscapes that emerge from a mix of natural and social processes is an essential issue when it comes to governance and planning practices. Mainly due to their transitional and dynamic character previously described here, these types of landscapes are not easy to delimitate.

Quantitative methods for CBLs delimitation are still missing. My studies concerning CBLs show that very often these types of landscapes are described from a sociological or even historical perspective (Spyra, 2013e). In my research concerning CBLs I have used different methods of delimitating these landscapes. On the regional scale I was working with the extent of Euroregions that are institutions facilitating cross-boundary cooperation (# I Spyra, 2014) and Czech and Polish NUTS 4 to 5 regions located close to the national boundary line inside Pradziad Euroregion (# II Spyra, 2014). A different method to delimitate CBL was used in the study covering the larger territory of the Upper Silesia cross-border region, where we decided to analyze CBL in a 10-kilometre buffer delimitated from a national Polish-Czech boundary line (# XII Spyra & Hamerla, 2021). In urban scale I was working with the extent of Cieszyn / Cesky Tesin municipalities that are located directly on a boundary line between Poland and Czech Republic (# VIII Spyra et al., 2019). Nevertheless, in the context of CBLs a basic question remains open: What does influence over a landscape of a boundary influence mean? What kind of indicators would be necessary to grasp it? And how far inside a landscape does the influence of a national boundary reach? (Figure 9). Thus, spatial representations of a contemporary CBL outer boundary on a map are still problematic. Further works related to CBLs need to focus on aspects of multidisciplinary data collection to characterize CBL and spatially explicit indicators (or set of indicators) to delimitate its boundary. This could give a very good foundation to provide more precise governance and planning recommendations for CBLs.

In the course of my research, it was not necessary to perform a detailed delimitation of PULs. Nevertheless, a basic delimitation of peri-urban open spaces was implemented with CORINE land cover data. This was done for practical reasons as CORINE is the only harmonized data on a European level that covers the whole extent of the case study regions analyzed in my study (# XI Spyra et al., 2021).

The next step of more detailed delimitation of peri-urban open spaces that I plan to implement will be done with Copernicus Urban Areas data[22].

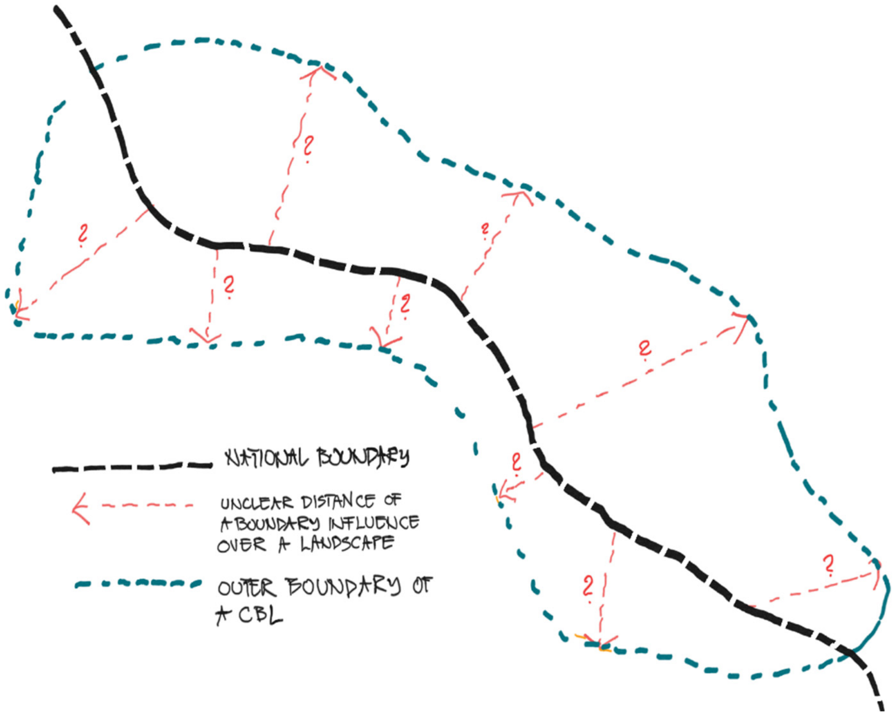


**Figure 9** Delimitation problems of cross-boundary landscapes. Source: own elaboration.

Even if current literature provides methodologies to delimitate PULs (Kumar & Narain, 2020) a cross-boundary character of PULs is complicated by a lack of common guides on how to delimitate PULs at the regional, national or European levels (Cattivelli, 2020). Significantly different methodologies used by different regional and municipalities to delimitate PULs render comparative studies of them difficult (Mortoja et al., 2020). This complicates collection of spatially explicit data related to PULs (# V Geneletti et al., 2017).

## 4.4. Specific aspects addressed in the *key steps*

### 4.4.1. Trust

"Without the trust, all will collapse" – suggest Stein and Harper in their essay on power, trust and planning (Stein & Harper, 2003, p.137). Many of the *key steps* emerging from my research are based on the trust that is or still should be established over time among governance actors.

As explained by Klijn et al., (2010) "trusting another actor means that one is willing to assume an open and vulnerable position" and in the context of governance, this means an ability to take into consideration all actors perspectives concerning a problem (Klijn et al., 2010). Trust has been correlated since ancient time with governance activities (Braithwaite & Levi, 1998). It can either help different governance actors to cooperate, or, conversely, can damage any network of cooperation. As shown in the research results, trust is seen as a main component of success of any governance activity and, specifically, it needs to be established between more "passive" actors and more "active" ones.

"Laying the groundwork" *nemawashi* factor (Thackara, 2006) is the basis for all kinds of cooperation not only related to planning or governance. Thus, a move towards consensus, also in governance and

[22] https://land.copernicus.eu/local/urban-atlas, accessed September 2021.

planning processes, requires trust. My research relates not to the concept of trust as such that has a place in the governance or planning practices, but to the process of trust establishing thus the process of establishing "vocabularies of trust" (Stein & Harper, 2003). The trust is a vast aspect, difficult to define and to measure (Talvitie, 2012). The measurement of trust is a contested field with different mostly qualitative methods being implemented. Thus, it is not easy to assess effectiveness of methods implemented to establish trust between governance actors. Nevertheless, my research shows that it is a basic pre-condition for participatory governance or planning processes and emerges as such at different stages of those processes and makes it more inclusive. My results relate to a combination of social truth (trust in people) and political truth (actor A trusts actor B to implement activity X) (Kumagai & Iorio, 2020). The aspect of trust emerged regarding several issues in my research related to performing participatory governance or planning processes. The trust aspect was most visible in the studies related to CBLs and emerged specifically during direct talks with local governance actors (# I Spyra 2014).

The aspect of establishing trust is also related to fostering a sense of community which could be consolidated by a leader (i.e., a person or an institution) (Talvitie, 2012). This aspect is particularly relevant for urban and neighborhood scales of landscape planning and governance.

### 4.4.2. Multi-level and inter-communal cooperation in governance and planning

As shown in the results section, governance and planning of landscapes that emerge from a mix of social and ecological processes is fragmented between a big number of independent local administrative units and other stakeholders. Such arrangements are characteristic specifically for CBLs and PULs that have been studied in detail. Thus, multi-level, multi-sectoral, multi-actor governance arrangements need to be implemented in the extent of such landscapes. But all of the "multi arrangements" need to be well coordinated across different levels and implementation of diverse policies and plans must be fine-tuned (Knickel et al., 2021). In cross-boundary landscape contexts, such fine-tuning could assume the form of cross-boundary planning documents (# I Spyra, 2014). Coordination of such arrangements needs to be related to identification at which level the decisive actors are situated, what is their sphere of influence and how the different decisions are linked (Leck & Simon, 2018). In this way a role of social-network analyses, implemented as one of the first stages of governance and planning processes concerning landscapes, is continuously rising in importance. Moreover, as shown in the results, different approaches to participatory planning and governance must be constantly implemented.

If the multi-level arrangements are incoherent, they foster a risk of municipal governance failure determined by, for example, increasing peri-urban land grabbing (Feola et al., 2019). Weak inter-municipal collaboration is a significant drawback for implementing transformative adaptation in PULs (Leck & Simon, 2018). On the other hand, carefully planned multi-level governance arrangements support the shift towards new and better modes of governance suited for transformative landscapes (Leck & Simon, 2018) and foster rural-urban partnerships aiming to establish a stable and flexible structure for inter communal cooperation (Knieling et al., 2017).

### 4.4.3. Cross-boundary planning documents

For the sake of clarity, it is important to mention that cross-boundary and cross-border terms are still mixed in the literature. Nevertheless, a general trend in the literature is that cross-border is more often related to planning or governance over a national border line, while cross-boundary relates to similar activities, albeit implemented in the extent of two or more administrative units located in a single country. As explained in the introduction section, for the sake of clarity, this thesis has used the term of cross-boundary, but I acknowledge the differences that emerge between boundaries and borders. Basically speaking, cross-border cooperation related to planning or governance is a more complex issue due to differences in national planning systems and the more evident NIMBY syndrome. Such activities are also much more vulnerable to changes in national political settings and often miss overall coordination from a level higher than just regional planning. Depending on a specificity of governance settings, often cross-boundary planning or governance on the regional, or metropolitan scale needs coordination and support from a central government (Yang, 2005).

My research didn't explore deep specific planning systems of neighboring countries. Nevertheless, such explorations, even in the context of the European Union that implements cohesion policies, shows a long way forward to a better harmonization of cross-border planning standards, objectives and values (Tölle, 2013).

Implementation of cross-border planning or governance requires support of complex, multi-stakeholder structures equipped with a constant flow of financial resources. Moreover, such activities need to be built on a long-term development strategy concerning a CBL, prepared in a framework of a multi-level cooperation and agreed upon by various governance actors (Medeiros, 2014).

The aspects of cross-boundary planning documents examined in my research are limited to the European context and more specifically to Czech and Polish CBLs. My research covers aspects of such a document's necessity and elements of their preparatory processes with general input into the document's required contents. Further literature studies explain several detailed issues that need to be covered by cross-boundary planning and governance. Examples of such issues cover biodiversity protection in conservation policies related specifically to migratory species (Kark et al., 2015), forest landscape restoration projects (Kelly & Kusel, 2015), or aspects of habitats isolation fostered by cross-boundary peri-urbanization processes (Ng et al., 2011).

#### 4.4.4. Governance mixes

The term governance mix appears in the literature, but mainly in relation to socio-economic issues. For example it relates to multi-level governance practices in the European Union where combinations (mixes) of both within and beyond state governance approaches exist (Börzel, 2010). From the perspective of landscape studies, governance mix is described as a combination of project execution, financial incentives, organizational incentives and awareness raising activities (Bussola et al., 2021).

The concept of governance mixes that emerged from my research is to some extent similar to an environmental policy-mix concept that aims to better conserve biodiversity and protect ES provision (Ring & Schröter-Schlaack, 2011). The difference between these two terms relates to the presence of planning approaches in a governance mix, while such approaches are absent in a policy mix. The term "policy mix" is widely described in the literature and its origins are related to economic policy literature from the 1960s (Flanagan et al., 2011). A policy mix can address landscape development issues by mixing climate policies, environmental policies or innovation policies. It is described as an approach combining several policy instruments, policy support tools and methodologies to achieve a particular developmental goal. A policy mix also combines processes (interactions) emerging between its components.

Threats related to possible implementation of governance mixes related, for example, to lack of ambiguous terminology used to explain it (Rogge & Reichardt, 2013), or to undermining existing policy and planning coherence (Uyarra et al., 2016). Other possible threats are similar to those related to a policy cycle implementation and are, for example, misalignments between policy making and policy implementation stages (Rogge & Reichardt, 2013).

The literature has not addressed explicitly the concept of planning mixes that should be considered as a part of a governance mix. Nevertheless, it is possible to visualize that a landscape planning challenge can be addressed by a mix of planning documents operating on different scales such as regional (e.g.

regional land use plan), urban (e.g. local zoning plan), architectural (e.g. detailed design of built landscape elements). It is a standard procedure in hierarchically organized spatial planning.

#### 4.4.5. Landscape asymmetries

The issue of landscape asymmetries is analyzed from both social and economic perspectives (Jędruch et al., 2020) and is typical particularly for CBLs. Nevertheless, research that directly relates to landscape asymmetries indicated by landscape configuration (metrics of connectivity and proximity) and composition (proportions of different land cover types) is still limited. Studies that directly address landscape asymmetries concern, for example, soil forming processes (Rusanov, 2005), river basin asymmetry in central Spain (Garrote et al., 2008), or valley-river landscapes in Ukraine (Лаврик et al., 2019). Analysis of soil organic matter content in a landscape shows that landscape asymmetry needs to be carefully managed as its loss might cause a collapse of ago-ecosystem resilience (Van Apeldoorn et al., 2011). Poorly governed asymmetries in areas with access to ES result in ES inequality that has significant influences over a landscape driven by the markets such as overuse of natural capital, ecosystem degradation and biodiversity loss (Laterra et al., 2019).

Different landscape colonization history has an impact on the level of a landscape's asymmetries. In the case of ecoregions, the highest asymmetries were detected in productive landscapes, and smaller asymmetries were detected in less-productive ones (Piquer-Rodríguez et al., 2021). Since national governance practices can promote or minimize asymmetries over time, landscape asymmetries reflect different stages of socio-economic development of a landscape.

All types of governance landscape asymmetries can hamper equitable development of landscapes on various scales. For example, in a neo-liberal economy, a private sector is often better than a public one equipped with knowledge and has better meta-governance perspective (Falleth et al., 2010). Such power relation asymmetries have consequences for the shape and functioning of landscapes, specifically in urban scale. Moreover, governance landscape asymmetries can contribute to unequal development of tourist infrastructure on both sides of a boundary line (Jędruch et al., 2020).

#### 4.4.6. Socio-ecological monitoring systems

Monitoring systems should be able to collect information about site specific conditions, perceptions and attitudes (Hirschnitz-Garbers & Stoll-Kleemann, 2011). Monitoring of landscapes are essential for adaptive governance and planning practices (Stem et al., 2005). It aims to increase knowledge about a landscape and to reduce uncertainty of governance and planning decisions. By monitoring effects of governance and planning activities over a landscape, it enables constant learning for governance actors. It is important that such monitoring takes place before a governance or planning action is applied to a landscape and after its application (Waylen et al., 2019). A monitoring phase must be followed by an evaluation phase that concerns governance and planning documents or activities affecting a landscape. This process is similar to a policy-cycle where a policy after a monitoring phase is assessed, (re-)designed and re-implemented[23].

Effective landscape monitoring that is able to support planning and governance decisions needs to go beyond simple observation and data collection activities, but should focus on continuous human actions and their inter-linkages with landscape transitions (Lotze-Campen et al., 2008). Functioning of such landscape monitoring systems could be supported by implementation of citizen science approaches that have proved to be useful also in contexts of peri-urban environmental monitoring and management (Pérez-Belmont et al., 2019). Usability of such performance-based monitoring systems

[23] https://ipbes.net/policy-design-evaluation-review, accessed March 2022.

was shown in other transitioning contexts related, for example, to shrinking towns (Caselli, Ventura, & Zazzi, 2019).

Data availability on the level of a specific landscape is displayed as the main threat to any landscape monitoring system (Calvache et al., 2021; Lotze-Campen et al., 2008; Norden et al., 2021). Other threats are low data survey response rates, a lack of spatially explicit indicators addressing specific landscape issues (# III La Rosa et al., 2016), a wrongly selected set of monitoring indicators, or integration into a landscape monitoring system of data related to various spatio-temporal scales (Calvache et al., 2021). Moreover, landscape monitoring too often focuses specifically on biophysical indicators while neglecting social and economic aspects of landscape functioning, as they are perceived as more difficult to measure (Waylen & Blackstock, 2017). Monitoring systems that focus too much on general state understanding and trends rather than observing effects of planning interventions on environmental and social spheres can in fact not support but hinder adaptive landscape governance or planning (Waylen et al., 2019).

### 4.4.7. Foresight methods

My research concerned only a part of the large set of foresight tools. It focused on: scientific workshops where policy improvements for protection of peri-urban open spaces were discussed (# XI Spyra et al., 2021), land use policy workshops aiming to identify changes in regional policy documents (research project RENATUR), and several university students' workshops (research projects School without borders, KOPR, Edu2Work; # 2 Spyra 2014). In the last group of workshops, university students were acting as support squads for the planning process. Moreover, students can benefit from taking part in simulated planning workshops by practicing scenario planning (Franco et al., 2013). Cooperation with university students is also useful to assess selected participatory planning approaches to understand their usefulness for engaging governance actors in the conceptual phase of planning (McEvoy et al., 2018).

Organization and implementation of planning workshops and other participatory planning events need to be based on well-established social networks, where individual voices could be better heard and acknowledged and where a consensus over governance and planning priorities could be relatively easily reached (Cachia et al., 2007).

The complete set of foresight methods usable for landscape planning and governance is bigger than the approaches used in my research and encompasses qualitative (e.g. expert panel discussions), semi-qualitative (e.g. Delphi method) and quantitative methods (e.g. GIS based scenario planning). It is important to acknowledge that a thoughtful, evidence based, and non-intuitive selection of foresight methods is a very important factor for the overall success of governance and planning (Popper, 2008). In addition, there are other risks related to foresight methods implementation such as misinterpretation of the results, low participation in forecasting events, or resistance to administrative levels to incorporate foresight results in binding planning documents. Moreover, units working with foresight activities related to landscape planning face structural, institutional and organizational challenges (Wilner & Roy, 2020).

Foresight methods that consider possible, probable and desirable futures are tools that have implementation potential for decision-making processes concerning various landscapes (Cook et al., 2014). Advantages of implementation of foresight methods in landscape planning and governance are related to identification of forthcoming landscape related problems and opportunities. In this way it is possible to prepare a proper planning or governance response to problems or, on the other hand, readiness for benefit maximization from expected opportunities (Sutherland & Woodroof, 2009). In this way it is possible to reduce the number of foreseeable surprises (so called "black swans") in landscape governance and planning processes and to mitigate risks of such events (Jore et al., 2018). Moreover, implementation of foresight methods allows one make governance and planning decisions based on broader qualitative and quantitative sets of evidence.

Such advantages of foresight strategic thinking are specifically important for the transitioning of dynamic landscapes that have been analyzed in my research, whose future state is difficult to foresee, but still needs to be planned in a sustainable way.

### 4.4.8. Green infrastructure

The concept of green infrastructure is included in the *key steps*, as it was addressed in several parts of my research. Even if the concept from theoretical perspective is not new and has received a lot of attention among scientific community (Ying et al., 2021), the workshops implemented during my research show that it is still not always acknowledged by a wider group of planners or policy-makers, who often prefer to refer to it in more general terms of non-systemic and single spot oriented greenery planning.

An example of green infrastructure implemented on a regional scale and discussed in the RENATUR project are green buffer zones designated in several countries around cities to prevent urban sprawl, protect urban areas from negative influence from industry, or to save land for agricultural uses (Kennedy et al., 2016). There are specific limitations to this approach. For example, the green belt established close to Sydney in Australia to protect rural areas against peri-urban expansion finally failed to do so as peri-urban growth was finally allowed in its extent (Argent et al., 2010). Another example is related to local governance actors' opinions about directions of sustainable landscape development. In this case, analyses of local actors' opinions related to protection of open spaces located in peri-urban green buffer zone showed that responsible authorities have positive inclinations towards continuous urbanization, while experts and local NGOs lean towards protection of open spaces (Al Mamun & Kim, 2020).

Also, on an urban scale, implementation of urban green infrastructure can support solving several important challenges such as air pollution, noise, climate change impacts, heat waves, floods and public health concerns (Zulian et al., 2021). Among other specific examples, green infrastructure can also contribute to environmental microbiota that has a significant role for public health and urban ecosystem functionality (Watkins et al., 2020).

Thus, as suggested in my results and in other researches (Ramyar et al., 2021), green infrastructure should be put in the center of landscape planning and governance processes concerning landscapes that emerge from a mix of social and natural processes.

## 4.5. Regional management platform: towards soft planning of landscapes?

Described in the results, the regional management platform, aiming to coordinate the *key steps*, could benefit from experience of other similar initiatives. Most of the landscape management platforms implemented so far focus on activities related to data collection and elaboration, focusing for example on management of groundwater in sedimentary media in urban areas (Loretta et al., 2014). Examples of specific approaches used in landscape management platforms are based on detection of environmental human health impacts (Casazza et al., 2019), Cellular Automata models to simulate urban expansion and its influence over ES (Yang et al., 2011), or urban ecological risk assessment to provide implementation strategies of urban ecological risk for governance actors (Hua et al., 2017).

What is novel in the proposed regional management platform is that is aims to join qualitative methods like workshops, advising, shared vision building with quantitative ones based on socio-ecological data collection and elaboration. This would allow facilitation of ground governance and planning decisions concerning landscapes on both quantitative and qualitative arguments. The proposed regional management platform can support governance and planning across administrative boundaries, thus in the extent of landscapes such as PULs and CBLs that are characterized by fuzzy outer boundaries. In this way it can contribute to soft planning that refers to coordination, negotiation, cooperation, learning and strategic development (Purkarthofer & Granqvist, 2021). Soft planning approaches showed so far their usefulness in emerging supra-regional CBLs covering more than two countries (Cappellano et al., 2021). To this end, the platform is ready to be implemented in the framework of "soft planning scales" that relate to city regions, functional areas, cross-boundary and macro regions (Purkarthofer, 2018; Purkarthofer & Granqvist, 2021) that are often described in literature as "soft spaces". In this way it can contribute to an on-going discussion in the European Union to make territorial cooperation in functional areas (examples of "soft spaces") a mandatory element of every regional and national funding program (Nadin et al., 2018).

Examples of such soft spaces can be landscapes studied in my research. A specific example of a soft space in the European context, also studied in my research, is the Euroregion. It is an administrative construct, delimitated in soft planning scales that cover large parts of a CBL. Euroregions are one of the manifestations of the cross–border cooperation in Europe (Lepik, 2009; Perkmann, 2003). Projects implemented by the Euroregions help to foster bottom–up partnerships, the feeling of shared responsibility among citizens and stimulate the decentralization processes thus fostering soft cross-border cooperation. Nevertheless, a significant weakness of such administrative units is that they must be constantly supported with European Union financial resources related mostly to cohesion funds (# I Spyra, 2014).

On the other hand, there is a continuous critique vis-à-vis soft planning, as it can promote economic centered development approaches (Purkarthofer et al., 2021), neoliberal planning approaches (Olesen, 2012), or can limit wider citizen participation in planning, resulting in poor legitimacy and democratic representation (Allmendinger et al., 2014).

## 4.6. Further methods for the ES concept to support landscape governance and planning processes

The advantages and risks of using the ES concept were analyzed in my research in the specific context of participatory planning (# IX Spyra et al., 2019). Such a context is an important one to be analyzed, as governance and planning practices often include opinions of various governance actors, or directly involve them in the entire policy or planning process (Fürst et al., 2014). Thus, it is possible to assume that the results from this part of my research can have broader implementation in governance and planning processes relating to various landscapes types.

ES are addressed across different types of boundaries, e.g. aquatic -terrestrial boundaries (Stewart et al., 2017). Nevertheless, still not much is said about use of the ES concept in governance and spatial planning of CBLs (# XII Spyra & Hamerla, 2021) and the ES concept could still provide a better framework for governance and planning in cross-(administrative) boundary contexts. ES flow from areas where they are being produced to other areas where they are consumed (Constanza, 2008). Thus, ES are "distributed" over existing administrative boundaries and they do not stop on human-made, artificial barriers such as administrative or national boundaries. ES "flow over" them, and it could happen that ES provided by areas located on one side of the boundary can be consumed on the other side of it (# VIII Spyra et al., 2019). It concerns for example regulating ES such as climate regulation, disease regulation, water regulation or water purification. It is possible to imagine that such ES are produced on one side of a boundary and consumed on the other. Such situations are common but are not always directly considered in governance and spatial planning practices. Thus, this could become a strong argument for joined efforts to better govern ES on both sides of a boundary and to reduce trade-offs related to them.

One of the critical elements for the ES concept to become usable in governance and planning of landscapes is identification of ES providing and benefitting areas (Syrbe & Walz, 2012), and delimitation of ES connecting areas. The implementation of ES indicators provides a very useful framework for such areas (#3 La Rosa et. al., 2015). This is a very useful governance approach in different transitioning landscapes (# XII Spyra et al., 2021). For example, spatially-explicit ES provision assessments can provide information such as potential ES mismatches, hotspots, and optimized allocation of land for specific uses (Bennett et al., 2015). Moreover, in cross-boundary contexts delimitation and assessment of providing and benefitting ES areas can also inform governance and planning (# XII Spyra & Hamerla, 2021). Such approaches in CBLs could be used to delimitate areas that are at risk of being “overused” by local people or tourists, thus where natural and cultural heritage of local ecosystems could be degraded. This could be implemented with usage of a factor of ES providing areas (U) calculated with the following equation:

$$\mathrm{U} = \frac{\mathrm{A_n}}{\mathrm{N_{SBA}}\mathrm{I}}$$

Where $\mathrm{A_n}$ means ES providing area; $\mathrm{N_{SBA}}$ means amount of linkages between ES providing area “n” and various ES benefitting areas; and I means the number of inhabitants living in ES benefitting areas connected to the ES providing area “n”.

Nevertheless, it should be noted that the described indicator needs to be enriched with other indicators or data related to ES benefitting areas to show how many people living in ES benefitting areas would be willing to visit the ES providing area “n” and with which means of transportation. Also, it would be important to discuss the question: What are the context specific thresholds related to "overusing" ES providing areas?

Management of ES often takes place at higher administrative levels (Pleasant et al., 2014). Even if such levels (e.g. regional) play an important role for governance and planning of landscapes, it is also important to measure ES at the very local level to better inform local decision makers about provision and demand for those services. For example, this could involve smaller communes located in PULs that could be in the “shadow” of bigger cities for which the peri-urbanization driving forces are related. Such peri-urban communes are often marginalized in higher administrative level planning processes, and the impact of peri-urbanization on ES provided by them remains unclear. As showed in the results, often local policy-makers would like to see their communes as “investment friendly”, meaning that they would like to enable different open spaces belonging to their communes for investments like housing, transportation infrastructure, leisure objects or commercial objects. Such investments very often contribute to diminishing ES provided by whole PULs. Minimizing such losses could be supported by measurement of ES in those contexts. Such indicator-based measurements can be the basis for further modelling approaches to visualize how possible losses and gains in ES provision influence the well-being of local inhabitants and the stability of local ecosystems (Koo et al., 2020).

It is crucial in the context of landscape governance and planning, that the ES concept becomes an integral part of governance and planning processes. Inclusion of the ES concept in such processes is specifically challenging for governance actors who are not related to academia. The literature discusses several approaches to handling such a situation. The first one is implementation of a step-by-step approach (Levrel et al., 2017) in which governance or the planning process starts from building awareness among governance actors about the significance of the ES concept. Governance actors need to be aware what the notion of the ES concept is, why provision of ES is significant for inhabitant’s well-being and why ES diminishment could hamper this well-being. This process should be performed in the framework of participatory methods, and all significant governance actors need to be included in it. In this way the ES concept can be "owned" by them; this is a first step towards reducing the tendency to think exclusively about someone's specific ES ("my ES" explained in the results). However, this can be hampered by a self-centered orientation of governance actors that can foster negative valuation of ES (Obeng & Aguilar, 2018). After ES awareness is built among governance actors, the participatory discussion on how to include this concept in existing policy or spatial planning goals, or even on how to restructure those goals to better reflect aspects related to the ES concept can take place (Plant & Ryan, 2013).

General awareness related to regulating ES is lower than the awareness of cultural ES which are better understood by governance actors (Zhang et al., 2016); thus, educational programs need to focus on increasing positive attitudes towards "non-market" ES (Obeng & Aguilar, 2018). The same authors write that landscape composition and site-specific social conditions play a significant role in building awareness about the ES concept. What makes the situation more complicated is that among some specific groups of governance actors (e.g. farmers in China) awareness levels related to the ES concept does not correspond to their demands for such services (Xun et al., 2017). Thus building ES awareness needs to be based on detailed, sound, empirical data that is "translated" into information that is understandable for the general public (Richards et al., 2017). Moreover, valuations of ES on different scales and addressing messages emerging from such exercises to policy-makers, specifically, can increase awareness of this concept (Costanza et al., 2014).

Awareness of the ES concept can support the general public in better understanding the need for effective biodiversity management (Buijs et al., 2008) and in acknowledging that human-nature relations are crucial for the sustainable future of our planet (Musacchio, 2018). This can contribute to a cognitive paradigm shift away from the dominant and flawed neoliberal/neoclassical economic view towards a more holistic, regenerative, life-cycle and social well-being-based worldview. This will serve as a healthy step towards ecological wisdom in governance and planning of different landscapes (Xiang, 2014).

Awareness of the ES concept needs to be supported by effective teaching of it (# XIII Palacios-Agundez et al., 2022). Even if scientific literature does not say much about how and what is being taught related to the ES concept, it at least underlines the significant role of it (Ruppert & Duncan, 2017). Kurt & Heink (2015) stated that teaching and understanding the ES concept help to visualize that variety of "life on earth" is of existential value to human beings (Jax & Heink, 2015). For example, teaching the ES concept can contribute to better understanding and appreciation of ES provided by overlooked and under-protected ecosystems such as temporary rivers (Leigh et al., 2019). Obviously, teaching the ES concept needs to specifically address those groups of governance actors that have low awareness of it (Xun et al., 2017) and who, according to the research from Obeng & Aguilar (2018), are often non-urban inhabitants (Obeng & Aguilar, 2018).

Both the processes of teaching the ES concept and further implementation of it in governance and planning practices need to critically reflect on several weak aspects of it. For instance, according to its critics, the ES concept underscores too much an anthropocentric way of looking at Nature (McCauley, 2006) expressed by an economic production metaphor used to explain ES (Fairhead et al., 2012). This is represented, for instance, by criticized payments for the ES approach (Kaiser et al., 2021). Such an anthropocentric approach can lead to the assumption that ecosystems are only important for people if these ecosystems are able to provide them with (monetarized) services (Bekessy et al., 2018).

Some results of my work contribute to addressing the criticisms of the ES concept. These results have shown that informing about ES and using this concept in governance and planning must relate not only to a cost-benefit analysis that is just one element of the policy making process, but also addressing this concept at every stage of the governance and planning process (# X Spyra et al., 2020). Awareness raising processes related to the ES concept that have been present in my work (Edu2Work, INLAND and RENATUR projects), reduce the risk of replacement of altruistic motivations of governance actors by external, often monetarily rewarded behaviors. Such processes are one of the criticisms of the ES concept (Bekessy et al., 2018).

# 5. Conclusions and outlook

My research described in this synthesis document started from my fascination with CBLs, as types of landscapes strongly influenced by historical and political issues. From this fascination I investigated quantitative research about CBLs, aiming to understand their morphology, the influence of a national boundary line over such landscapes and to see how findings related to these aspects could be useful for governance and planning of CBLs. This interest in landscape boundaries lead me to research related to PULs. As explained in this synthesis document the notion of PUL is also influenced by aspects related to boundaries. Nevertheless, such aspects in peri-urban contexts are not related only to one strong national boundary, but rather to a set of administrative boundaries that often divide larger PUL into smaller administrative parts like municipalities, districts, etc., making governance and planning of such landscapes quite challenging.

Landscapes analyzed in my research, exemplified mostly by CBLs and PULs, emerge from a mix of natural and social processes. Such processes are open, meaning it is difficult describe when they can start and when they can finish, and that they have no specific phases. These landscapes analyzed by me are difficult to delimitate, characterized by various spatial and legislative asymmetries and are observed in soft planning scales. Obviously, this makes governance and planning for these landscapes difficult, requiring implementation of diverse approaches, governance mixes and confrontation with diverse challenges. Those challenges can be addressed by the *key steps* described in this thesis that contribute to soft planning of landscapes based on coordination, negotiation, cooperation, constant learning and strategic visioning. Specifically, the *key steps* are based on establishing trust among governance actors, planning in the framework of a multilevel cooperation supported by socio-ecological monitoring systems, and on various foresight methods encompassing planning and policy workshops implemented with various groups of governance actors. Important aspects for governance and planning of landscapes that are emerging from a mix of natural and social processes are context specific governance mixes. They are a thoughtful and complex mix of various top-down and bottom-up governance and planning approaches, which are introduced at different administrative levels resulting in different formal and informal outcomes, and which are discussed and implemented by a wide range of governance actors.

My research shows that all the *key steps* as well as other existing governance and planning approaches are vulnerable towards several internal limitations such as low flexibility, slow reactions for dynamic transitions of various landscapes, or specific limitations of patch-corridor-matrix models. On the other hand, governance and planning of landscapes is hampered by external barriers such as low awareness of governance actors about ecological processes, consequences and transformations taking place in the extent of landscapes, NIMBY syndrome, and difficult to address pressure from investors threating the sustainability of landscapes. Moreover, most of the approaches need to be constantly supported with financial resources and can lead to various conflicts and trade-offs that are unwanted and hard to foresee during a planning stage.

A common element in my research considering landscapes has been the ES concept. The thesis explains how to make use of the ES concept in order to enhance sustainable governance and planning in landscapes that emerge from a mix of natural and social processes. My research shows that the ES concept has potential to be used as an Esperanto style language in governance and planning in order to find consensus among various actors important for sustainable development. Nevertheless, using the ES concept in such a way has, on the one hand, specific advantages such as facilitation of knowledge sharing among governance actors, an ability to support work on a shared development vision, contributions to context-specific experiences, increasing awareness of local potential, and support in local identification of supplier and demander of services. On the other hand, some risks have been indicated related mostly to the lack of ES concept understanding, or the “my ES” phenomenon. My research shows that skillful governance and planning need to not only make use of the ES concept advantages and become able to address risks related to it, but also to allow better addressing of ES trade-offs emerging in different landscapes. Such trade-offs are specifically significant in dynamically transitioning landscapes, where ES providing and benefiting areas are mixed. Here, the governance and planning approaches need to be adaptive and integrative at multiple levels, while engaging diverse actors to balance ES trade-offs that have mixed urban and rural character.

Moreover, my research stressed the important role of ES indicators for landscape planning processes; specifically in urbanized landscapes that are characterized by high demand for ES and concentration of often underexplored ES. Use of spatially explicit indicators, preferably not proxies, impacts in a significant way the potential for sustainable decision-making concerning landscapes that emerge from a mix of natural and social processes.

In my research I have also pointed out the importance of improving ES understanding among various governance actors. The most important method to achieve this aim should be teaching of the ES concept which implements best educational practices based mainly on active teaching such as project-based learning, problem-based learning and inquiry-based learning. This part of the research concludes that a comprehensive, practical and meaningful method of ES concept teaching can support ecological wisdom and literacy, thereby also supporting the sustainable development of landscapes that emerge from a mix of social and ecological processes.

## 5.1. Further research directions

### 5.1.1. Neglected open spaces

Peculiarities of transitioning landscapes such as decentralization processes, leap-frog development, intensive development of transportation infrastructures, previous industrial activity and also demographical changes (# X Spyra et al., 2020) leave some spaces degraded and poorly accessible to inhabitants, but still important from the point of view of ES provision (Bakr & Gawad, 2021) or social benefits (Kim, 2016). An example of such spaces could be open spaces, or more specifically different types of neglected open spaces that can be abandoned, unused, or used below their potential to provide ES. These neglected open spaces could be abandoned or socially inefficient green spaces, brown-fields, former military areas, deteriorated waterfronts, oversized streets, non-developed built areas (Abd El Gawad et al., 2019). They can also be different types of badly accessible, marginalized spaces, often located close to a national boundary line, or even attracting illicit activities (Bakr & Gawad, 2021). The notion of “neglected urban space” is often used in equivalent ways in literature with terms like: brown-field, which on the other hand has country specific definitions and is indicated in various ways (Bielinskas et al., 2015; Oliver et al., 2005), vacant lands (Kim, 2016), or lost urban spaces (Sameeh et al., 2018). Terms similar to neglected open spaces have been discussed by the science since the days of the Industrial Revolution. Different authors have been using different names like broader vacuums (Jane Jacobs, 1993), or lost areas (Hospers, 2010).

The emerging process of the neglected open space is expressed in the literature in different ways. Most of the literature concerning urban landscapes and the aspect of “neglection” are related to qualitative research methods. Some of these works are based on Lefebvre’s concept of social “production of urban space” (Lefebvre, 1970), or on “place making approaches” which are equivalent in particular for post-industrial cities (Leary-Owhin, 2016). Thus, in this context the neglection process of urban (or any other) space is not related to ecological flows, but to social behaviors of urban space users.

The decision as to whether or not a space is "neglected" is up to its users. Urban space is not an empty container (Lefebvre, 1970), but is maintained by people (users), who give it meaning. Similarly, humans give meaning to any other kind of landscape and arbitrarily decide whether it has an investment potential, is neglected, "forgotten", or fully appreciated and acknowledged. It is important to acknowledge here that the human perspective of landscapes is simply different from the species perspective (Lindenmayer, 2009); nevertheless, this manner of thinking has brought some confusions and uncertainties (Haila, 2002). Using anthropocentric perspective of landscapes, neglected parts of a landscape could be full of untapped potential. I have been studying such neglected areas in CBLs during several workshops with students, in which a group of students became a planning "support squad" formed to brainstorm possible ideas on how to identify such investment potential and how to make use of them when planning CBL development (# II Spyra, 2014).

Neglected open spaces offer possibilities for either investing in grey infrastructures, or strengthening existing green infrastructures to provide more different kinds of ES (research project RENATUR). Balancing this situation remains a challenge specifically in transitioning landscapes and needs to be tackled by well-prepared governance mixes, as skillful planning of such areas is in the best economic interest of each region or municipality. The open question to be studied by further research would be how to explore such untapped potential by, for example, investing in new infrastructure to increase cultural ES provided by neglected areas. Or would it be better to simply leave neglected open spaces to Nature, so that they do not become degraded by different human activities? Answering such a question must be context specific and needs to acknowledge a wider assessment of a landscape.

Often those neglected open spaces are located close to ES deficit areas, which are characterized by higher ES demand than ES provision[24]. Thus, quantitative assessment of ES provision offered by neglected open spaces should be based on implementing a set of spatially explicit indicators such as the ES deficit factor (# VIII Spyra et al., 2019). The indicators could be calculated separately for each cell forming a grid covering an extent of analyzed landscape. This methodology has been initially tested in the extent of a landscape located in the city of Ostrava (Czech Republic). Detection and assessment of the ES provision level offered by neglected open spaces could contribute to their more effective governance and planning by informing governance actors how increased ES provision could contribute to their well-being. It could also be implemented to maintain a balance between built-up areas and ecologically active areas in PULs, and to strengthen the green infrastructure system parallel to on-going peri-urban densification processes (Spyra et. al, 2018a).

### 5.1.2. Quantification of governance mixes tailored for peri-urban landscapes

Policies usually come in specific mixes, since a landscape challenge (e.g. need of green innovation) is influenced to a different extent by several policies. What is interesting from the perspective of my research is that such mixes are very rarely intentionally constructed and managed; rather, they emerge over time from institutional, political and cultural decisions affecting landscapes (Flanagan et al., 2011). I have been exploring the question of whether it would be possible to intentionally design a governance mix that joins both policies and planning approaches, and implement it to steer sustainable development of a landscape that emerges from a mix of cultural and ecological processes.

Described in the results the *key step* "implementation of context specific governance mixes" is now a theoretical idea that has emerged from my various studies related to landscape governance and planning. To better frame this concept, together with colleagues from Humboldt University (Germany)

[24] Source: Application for Horizon 2020, call SC5–13–2018-2019: "Strengthening international cooperation on sustainable urbanisation: nature-based solutions for restoration and rehabilitation of urban ecosystems". The application was coordinated by me.

and Polytechnique Milano (Italy), I developed a survey aiming to better understand what kind of policy instruments are available for addressing the sustainability challenges of PULs, how they have been implemented, and with what results. We asked respondents to answer the survey using their experiences from a policy instrument that they know of, which has been designed for or implemented in the extent of a PUL. This study will be based on the analysis of fifty case studies of PULs, collected in the survey and located in different parts of the World and on outcomes from a scientific session planned for the International Association of Landscape Ecology Europe conference in July 2022 in Warsaw.

### 5.1.3. Interactions and conflicts in peri-urban landscapes

Implementation of my research project showed that conflicts are characteristic for transitioning landscapes. For example, the issue of conflicts in peri-urban settings is one of the major challenges to be addressed by governance and planning of PULs. Sometimes such peri-urban conflicts can even go beyond a standard (meaning typical for the planning profession) planning issue and become a major problem characterized by violent events (Lombard, 2016). My further development of research on conflicts in PULs is based on a structured review of English peer-review literature. The overall aim of this study is to define and characterize different conflicts that emerge in different PULs and describe governance and planning approaches that have been implemented so far to tackle them. A starting point for this review is a classification of peri-urban land use conflicts defined in a case study located in Switzerland (Von Der Dunk et al., 2011).

Specifically, I study human-wildlife conflicts to provide governance recommendations on how to tackle them in the extent of the PULs. This research is developed with the cooperation of the Global Land Programme that supported my team in organization of international scientific workshops to discuss what the characteristics of human-wildlife interactions in PULs are, what the characteristics of PULs as arenas of such interactions are, and on characteristics of policy making to tackle human-wildlife interactions in PULs.

This topic of human-wildlife conflicts is important enough to be addressed specifically in the extent of landscapes that emerge from a mix of social and natural processes, since they are often characterized by diminishing wild areas and an increase in anthropogenized ones. Thus, conflicts in such landscapes are triggered by competition between humans and wildlife involving the same space and food resources (König et al., 2021). Results of this study will show how governance and planning of landscapes could contribute to diminishing human-wildlife conflicts and pave the way towards coexistence between both parties.

### 5.1.4 Analysis of ecosystem service trade-offs in peri-urban landscapes in 20 regional case studies

ES trade-offs occur in the situation in which one service increases and fosters the reduction of the other service. ES trade-offs are a significant issue, fostering the sustainability of transitional PULs. It is due to the dynamic process of peri-urbanization, which endangers peri-urban natural ecosystems and their services. It is also related to rising demand for ES in PULs.

Policy making and planning related to ES trade-offs in PULs need to support the balancing of opposing services, thereby fostering ES synergies among ES. Nevertheless, ES trade-offs in PULs are not on the top of policy and planning agendas. Knowledge related to policy making and planning for ES trade-offs in PULs remain hidden in country and regional case study specific niches.

Aims of this on-going study are threefold. Firstly, it aims to identify and characterize ES trade-off drivers in the case study PULs. Secondly, it aims to identify existing obstacles/shortcomings, concerning how ES trade-offs in PULs are addressed by policy instruments and spatial planning documents in the case of PULs. Thirdly, it aims to analyze governance and planning improvements to better address ES trade-offs in PULs.

To fulfil these aims a semi-qualitative survey was designed which has been distributed to researchers and policy makers from different regions world-wide. In total, twenty-four case study PULs located in different parts of the World were analyzed. Multi-criteria statistical analyses and descriptive statistics were implemented to analyze the survey results.

The results will describe how policy and planning instruments at the regional level are tackling the issue of ES trade-offs in PULs. Based on the results, I plan to draft recommendations for policy and planning on the regional level to better tackle ES trade-offs in PULs.

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Zasada, I, Loibl, W., Berges, R., Steinnocher, K., Koestl, M., Piorr, A., & Werner, A. (2013). Rural-urban regions: a spatial approach to define urban-rural relationships in Europe. In K. Nilsson K., Pauleit, S., Bell S.,, Aalbers C., & Nielsen T. (Eds.), *Peri-urban futures: scenarios ad models for land use change in Europe* (pp. 45–68). Berlin, Heidelberg: Springer.

Zasada, Ingo, Berges, R., Hilgendorf, J., & Piorr, A. (2013). Horsekeeping and the peri-urban development in the Berlin Metropolitan Region. *Journal of Land Use Science*, *8*(2), 199–214.

Zhang, W., Kato, E., Bhandary, P., Nkonya, E., Ibrahim, H. I., Agbonlahor, M., … Cox, C. (2016). Awareness and perceptions of ecosystem services in relation to land use types: Evidence from rural communities in Nigeria. *Ecosystem Services*, *22*, *Part A*, 150–160.

Zhao, P. (2013). Too complex to be managed? New trends in peri-urbanisation and its planning in Beijing. *Cities*, *30*(1), 68–76.

Žlender, V. (2021). Characterisation of peri-urban landscape based on the views and attitudes of different actors. *Land Use Policy*, *101*, 105181.

Zulian, G., Raynal, J., Hauser, R., & Maes, J. (2021). Urban Green Infrastructure: Opportunities and Challenges at the European Scale. In Arcidiacono A. & Ronchi S. (Eds.), *Ecosystem Services and Green Infrastructure* (pp. 17–28).

Лаврик, О. Д., Максютов, А. О., & Цимбалюк, В. В. (2019). Asymmetry and symmetry of valley-river of landscape and technical systems. *Visnyk of V. N. Karazin Kharkiv National University, Series "Geology. Geography. Ecology&quot*, *49*, 125–136.

# Curriculim vitae

**General information**

**Spyra, Marcin Dr.**,

- Post-doc Senior Scientists, Department of Sustainable Landscape Development, Martin Luther University Halle-Wittenberg;
- Associate Professor at Department of Architecture and Urbanism, Opole University of Technology, Poland – currently on the leave.

Phone:

Mobile:

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https://orcid.org/0000-0002-0551-9915

**Education**

- 10/1995 – 11/ 2000: Faculty of Architecture, Silesian University of Technology, Poland;
- 02/2000 – 04/2001: Faculty of Architecture, Chalmers University of Technology, Gothenburg, Sweeden;
- 10/2003 – 06/2004: Course for academic teachers, Silesian University of Technology, Gliwice, Poland;
- 01/2009 – 09/2009: Management Training Programme for Young Professionals, FIDIC International Federation of Consulting Engineers, final seminar in London, UK.

**Scientific degrees**

- 06/2022: start of the cumulative habilitation procedure at Institute of Geosciences and Geology, Martin-Luther-University Halle-Wittenberg, Germany;
- 2007: Doctoral degree (Dr. Ing. Arch.) in Architecture and Urbanism, Silesian University of Technology, Poland – PhD with distinction;
- 2000: Diploma in Architecture and Urbanism, Silesian University of Technology (Poland), acknowledged by Chalmers University of Technology (Sweeden).

**Academic positions**

- 03/2017 – present: Post-doc senior scientists, Department of Sustainable Landscape Development, Martin Luther University Halle-Wittenberg, Germany;
- 03/2022 – present: Acosiate Professor, Department of Architecture and Urbanism, Opole University of Technology, Poland (curently on the leave);
- 10/2009 – 03/2022: Asistant Professor, Department of Architecture and Urbanism, Opole University of Technology, Poland;
- 10/2006 – 10/2013: Lecturer, University of Technology, Katowice, Poland;
- 10/2010 – 03/2011: Lecturer, FH - Bielska Wyższa Szkoła im. Józefa Tyszkiewicza, Bielsko-Biala, Poland;

- 12/2002 – 10/2007: Research associate (PhD candidate), Faculty of Architecture, Silesian University of Technology, Gliwice, Poland.

**Other job committments**

- 05/2000 – 08/2000: Assistant Architect, Dag Tvilde Sivilarkitekt MNAL, Oslo, Norway;
- 10/2000 – 05/2004: Assistant Architect, Pracownia Architektoniczna „Czora & Czora" sp. z o.o., Katowice, Poland;
- 01/2002 – 02/2003: Foreman, Przedsiębiorstwo Remontowo – Budowlane „Piaskowski i Spółka" Sp. z o.o., Dąbrowa Górnicza, Poland;
- 07/2003 – 07/2004: Foreman, Przedsiębiorstwo Konserwacji Zabytków „Conres" Sp. z o.o, Katowice, Poland;
- 08/2007 – 12/2016: Architect, Planner and Owner, Project Studio "Marcin Spyra – Architect", Katowice – Ustron, Poland;

**Publications** (14.07.2022): WoS h-index – 8; Scopus h-index – 9; Google scholar i10-index – 11.

Full list of publications attachd in the separate document.

- Papers in ISI-listed peer reviewed journals: 13;
- Papers in other journals + proceedings: 21;
- Books and book contributions: 6;
- Popular publications: 10.

**Language skills**

- Polish (mother tongue);
- English (fluent – C2);
- German (very good – B2);
- Russian (basic – A1).

**Awards / Miscellaneous**

- 2004: Team award of the 1st degree for achievements in the field of teaching - Rector of Silesian University of Technology (Poland);
- 2008: Award of the Polish Minister of Infrastructure for doctoral thesis "Parks science - technology. Evolution and context of the contemporary urban environment ";
- 2008: The first honorable mention in competition for the urban master plan: "Development vision for Sychiv district in Lviv, Ukraine" (in cooperation with "Czora & Czora" architectural office);
- 2010: The European Federation of Engineering Consultancy Associations Award. Young Professionals competition of 2010;
- 2011: The research grant for a young scientist Faculty of Civil Engineering, Opole University of Technology, Poland;
- 2011: Individual award for outstanding achievements in the field of teaching and organizational initiatives, University of Technology in Katowice;
- 2011 - 2014: Scholarship for an outstanding young scientist awarded by Polish Minister of Science and Higher Education.

**Memberships and activities in scientific networks and bodies**

- 11/2004 – 11/2016: member, Silesian Chamber of Architects, Katowice, Poland; http://slaska.iarp.pl/
- 2007 – 2010: member, Stowarzyszenie Inżynierów Doradców i Rzeczoznawców SIDiR (Corporation with FIDIC); https://sidir.pl/o-nas/ https://fidic.org/
- 2009 – 2012: member, Polish Business and Innovation Centers Association in Poland; https://www.sooipp.org.pl/en
- 05/2012 – present: member, European LandUse Institute (ELI); https://www.eli-web.com/
- 09/2013 - present: coordinator of the European Nodal Office, Global Land Project (GLP); https://glp.earth/
- 10/2014 – 10/2018: member and vice-president of Polish Society of Town Planners (TUP), branch in Opole, Poland; https://www.tup.org.pl/
- 09/2014 – 09/2019: member, Regional Studies Association (RSA); https://www.regionalstudies.org/
- 10/2017 – present: managing of the working group "Urban and peri-urban governance", International Association of Landscape Ecology (IALE) https://www.landscape-ecology.org/

**Activities in scientific conferences**

- 2011: **Architektura v perspektive,** Ostrava, Ostrava, Czech Republic;
- 2012: **Architektura v perspektive,** Ostrava, Ostrava, Czech Republic;
- 2012: **RegioResources21 Regions in Transition**, Dresden, Germany;
- 2013: **RegioResources 21 Regions in Transition** "A cross-disciplinary dialogue on future perspectives for a sustainable development of regional resources, Catania", Italy,
  - ➔ member of the scientific and organizing committee;
- 2014: **8th international scientific Conference TeMA** „Innovations in regional and urban Planning" Naples, Italy;
- 2014: **RegioResources21 Regions in Transition** "Restoring Environment, Landscapes and Services", Katowice, Poland,
  - ➔ member of the scientific and organizing committee;
  - ➔ key note titled "Planning in the age of technotopes and metropoles";
- 2015: **Dresden Nexus Conference: Global Change – SDGs - Nexus Approach**,
  - ➔ co-convener of the scientific session "Urban ecosystem services and biological diversity";
- 2015: **IUFRO Landscape Ecology Conference** "Sustaining ecosystem services in forest landscapes", Tartu, Estonia,
  - ➔ co-converner of the scientific session „Ensuring ecosystem services provision in spatial planning",
  - ➔ co-converner of the scientific session "Sustainable approaches for new urban peripheries";
- 2015: **IALE-D Annual Conference** "Ecosystem Services to ensure Sustainable Rural Development and Sustainable Use of Natural Resources", Bonn (Germany),
- 2016: **"The Ecosystem Services of Urban Rivers"**, Kŕtiny, Czech Republic;
- 2016: **EcoSummit**, Elsevier, Montpellier, France,
  - ➔ organizer of scientific workshop titled "Generating practical outputs from ecosystem services studies- an interdisciplinary exchange";
- 2016: **RegioResources21 Regions in Transition** "A cross-disciplinary dialogue on sustainable development of regional resources", Lugo, Spain,
  - ➔ member of the scientific and organizing committee;

- 2017: **Association of Eurpean Schools of Planning (AESOP)** congress "Spaces of Dialog for Places of Dignity", Lisbon, Portugal;
- 2017: **International Association of Landscape Ecology IALE European Landscape Ecology Congress** "From pattern and process to people and action", Ghent, Belgium,
  - ➔ session key note "The ecosystem services concept – a new Esperanto to facilitate participatory planning processes?"
- 2017: **IUFRO – Landscape Ecology Conference**, Halle (Saale), Germany,
  - ➔ member of the organizing committee, host of the scientific sessions;
- 2018: "**Landscape 2018 - Frontiers of Agricultural Landscape Research**", Berlin, Germany,
  - ➔ co-organizer of the workshop "Metropolitan agri-food-systems and peri-urban agricultural landscapes";
- 2018: **RegioResources21 Regions in Transition** "Global megatrends and the Landscape", Smolenice, Slovakia,
  - ➔ member of the scientific and organizing committee;
- 2018: **Ecosystem Services Partnership Europe Congress**, San Sebastian, Spain,
  - ➔ host of the session titled: "Governing the trade-offs of peri-urban ecosystem services"
  - ➔ co-host of the session titled: "Bottlenecks and opportunities for applying ecosystem services in spatial planning";
- 2018: **POL-EKO SYSTEM International Fair of the Environmental Protection**, Poznań, Poland,
  - ➔ host of the stakeholder workshop titled: "Innovative environmental governance for sustainable peri-urban landscapes";
- 2019: **4th Open Science Meeting of the Global Land Programme**
  - ➔ host of the scientific session / immersive workshop titled: "Governance of natural heritage in peri-urban open spaces";
- 2019: **International Association of Landscape Ecology, IALE World Conference**, Milan, Italy,
  - ➔ co-host of the scientific session "Towards visionary peri-urban landscapes? Environmental governance mixes for sustainable peri-urbanization";
- 2019: **Ecosystem Services Partnership**, **World Conference**, Hanover, Germany,
  - ➔ host of the scientific session "Governance approaches for ecosystem services in urban and peri-urban open spaces";
  - ➔ co-host of the scientific session "Effective teaching strategies for making the ES concept relevant to society";
- 2022: **International Association of Landscape Ecology IALE** "Making the future, learning from the past", Warsaw, Poland,
  - ➔ host of scientific session "Governance mixes for sustainable peri-urbanization: how can landscape ecology contribute?"
  - ➔ co-host of scientific session "How to develop a "successful" environmental governance for the protection of biodiversity?";

**Review activities**

- CASES: Change and Adaptation in Socio-Ecological Systems - 2;
- Conservation Biology - 3;
- Conservation Science and Practice - 2;
- Ecological Indicators - 3;
- Ecological Processes - 1;
- Environmental Management - 3;
- European Planning Studies - 3;
- LAND - 5;
- Land Use Policy - 9;

- Landscape and Urban Planning - 8;
- Journal of Land Use Science - 4;
- Moravian Geographical Reports - 1;
- People and Nature - 2;
- Planning Practice and Research - 1;
- SEPR: Socio-Ecological Practice Research - 2;
- Urban Ecosystems - 4;
- Urban Forestry and Urban Greening – 1;
- Urban Governance – 1.

**Editorial works**

- 2013: Editor of the monography titled “Cross-border Landscape of Euroregion Pradziad”, Oficyna Wydawnicza Politechniki Opolskiej, Opole;
- 2014 - 2015: guest co-editor of the special issue of Ecological Indicators journal (IF 4.958). Title of the special issue: “Developing and Applying Ecosystem Services Indicators in Decision-Support at Various Scales”;
- 2015 - 2016: guest co-editor of the special issue of Landscape and Urban Planning journal (IF 6.142) Title of the special issue: “Sustainable Planning Approaches for New Urban Peripheries”;
- 2017 - 2021: member of the editorial board of the journal CASES Change and Adaptation in Socio-Ecological Systems;
- 2020 - 2021: guest editor of the special issue of Sustainability journal (IF 2,592). Title of the special issue “Governance Mixes for Sustainable Peri-Urbanization";
- From 2020: guest editor of the special issue of LAND journal (IF 3,905) titled “Ecosystem Services and Biodiversity of Peri-Urban Landscapes”;
- From 2022: editor of collection in LAND journal (IF 3,905) titled “Integrated Management, Planning, and Policy for Sustainable Landscape Development in Europe”.

**Experience in submitted / coordinated research project applications**

- 2014, 2016, 2019: Horizon 2020;
- 2015: NCN - National Science Center, Poland;
- 2015, 2016: Erasmus + Jean Monnet Modules;
- 2018: INTERREG Europe;
- 2018, 2022: INTERREG Central Europe;
- 2018,2021: BMBF - Federal Ministry of Education and Research, Germany;
- 2021: NCBiR- National Centre of Research and Development, Poland
- 2021-2022: ANR - French National Research Agency and DFG - German Research Foundation.

# List of publications

## Five most significant publications

| Bibliometric information | Journal 5-year IF |
|---|---|
| Geneletti D., La Rosa D., **Spyra M.**, Cortinovos C., (2017) A review of approaches and challenges for sustainable planning in urban peripheries. *Landscape and Urban Planning*, 165, 231-243; | 6.852 |
| **Spyra M.**, Inostroza L. Hamerla A., Bondaruk J. (2018) Ecosystem services deficits in cross-boundary landscapes: spatial mismatches between green and grey systems, *Urban Ecosystems*, 22, 37-47; | 3.032 |
| **Spyra M.**, Kleemann J., Cetin N.I, Vázquez Navarrete C.J., Albert C., Palacios-Agundez I., Ametzaga-Arregi I., La Rosa D., Rozas D., Esmail B.A, Picchi P., Geneletti D., König H., Koo H.M, Kopperoinen L., and Fürst C. (2019) The ecosystem services concept – a new Esperanto to facilitate participatory planning processes? *Landscape Ecology*, 34, 1715–1735; | 3.843 |
| **Spyra M.**, Zasada I., La Rosa D., Sylla M., Shkaruba A. (2020) Governance for ecosystem services trade-offs in peri-urban landscapes, *Land* Use *Policy* vol: 95 pp: 104617; | 5.525 |
| **Spyra M.**, Kleemann, J., Calo N., Schürmann, A. (2021) Protection of peri-urban open spaces at the level of regional policymaking: examples from six European regions, *Land Use Policy* vol: 107 pp: 105480. | 5.525 |

## Publications indexed by Web of Science

| No. | Bibliometric information | Journal 5-year IF |
|---|---|---|
| 1* | **Spyra M**. (2014) The feasibility of implementing cross-border land-use management strategies: a report from three Upper Silesian Euroregions, *iForest,* 7, 396 – 402; | 2.082 |
| 2* | La Rosa, D., **Spyra, M.**, & Inostroza, L. (2015). Indicators of Cultural Ecosystem Services for urban planning: A review. *Ecological Indicators,* 61, 74-89; | 5.172 |
| 3 | Hauck J., Albert C., Fürst C., Geneletti D., La Rosa D., Lorz C. and **Spyra M**. (2015). Developing and applying ecosystem service indicators indecision-support at various scales. *Ecological Indicators* Vol. 61, 1-5; | 5.172 |
| 4* | Geneletti D., La Rosa D., **Spyra M.**, Cortinovos C., (2017) A review of approaches and challenges for sustainable planning in urban peripheries. *Landscape and Urban Planning*; 165, 231-243; | 6.852 |
| 5* | La Rosa, D., Geneletti, D., **Spyra, M.***,* & Albert, C. (2017). Special issue on sustainable planning approaches for urban peripheries. *Landscape and Urban Planning*, 165, 172-176; | 6.852 |
| 6* | **Spyra M.**, Inostroza L. Hamerla A., Bondaruk J. (2018) Ecosystem services deficits in cross-boundary landscapes: spatial mismatches between green and grey systems, *Urban Ecosystems*, 22, 37-47; | 3.032 |
| 7 | Inostroza, L., Hamstead, Z., **Spyra, M.**, and Qhreshi, S. (2019). Beyond urban–rural dichotomies: Measuring urbanisation degrees in central | 5.172 |

* Publication used to form the basis for the habilitation thesis

| | | |
|---|---|---|
| | European landscapes using the technomass as an explicit indicator. *Ecological Indicators,* 96, 466-476; | |
| 8* | **Spyra M**., Kleemann J., Cetin N.I, Vázquez Navarrete C.J., Albert C., Palacios-Agundez I., Ametzaga-Arregi I., La Rosa D., Rozas D., Esmail B.A, Picchi P., Geneletti D., König H., Koo H.M, Kopperoinen L., and Fürst C. (2019) The ecosystem services concept – a new Esperanto to facilitate participatory planning processes? *Landscape Ecology*, 34, 1715–1735; | 3.843 |
| 9* | **Spyra M.**, Zasada I., La Rosa D., Sylla M., Shkaruba A. (2020) Governance for ecosystem services trade-offs in peri-urban landscapes, *Land* Use *Policy* vol: 95 pp: 104617; | 5.525 |
| 10 | König, H. J., Ceaușu, S., Reed, M., Kendall, H., Hemminger, K., Reinke, H., Osterman-Miyashita, E.F., Wenz, E., Eufemia, L., Hermanns, T., Klose, M., **Spyra, M**., Kuemmerle, T. and Ford, A. T. (2021). Integrated framework for stakeholder participation in identifying and addressing human-wildlife conflicts. *Conservation Science and Practice*, (February), 1–18; | 3.233 |
| 11* | **Spyra M**., Kleemann, J., Calo N., Schürmann, A. and Fürst, Ch. (2021) Protection of peri-urban open spaces at the level of regional policymaking: examples from six European regions, Land Use Policy, vol: 107 pp: 105480; | 5.525 |
| 12* | Palacios-Agundez I., Rodríguez-Loinaz G., Hagemann N., Sylla M. **and Spyra M**. (2022) Teaching the ecosystem service concept: current experiences and the way forward, Ecology and Society; | 5.275 |
| 13 | Guo Q., He Z., Li D. **and Spyra M**. (2022) Analysis of spatial patterns and socioeconomic activities of urbanized rural areas in Fujian Province, China. Land. | 3.398 |

## Book chapters

| No. | Bibliometric information |
|---|---|
| 14 | **Spyra M.** (2011) Wytyczne lokalizacyjne współczesnego parku technologicznego [in:] Matusiak K.B. „Strategiczne obszary rozwoju parków technologicznych”, Polska Agencja Rozwoju Przedsiębiorczości, Warszawa; |
| 15 | **Spyra M.** (2011) Wybrane aspekty kształtowania obiektów parków technologicznych w kontekście nowych potrzeb ich użytkowników [in:] Matusiak K.B. „Strategiczne obszary rozwoju parków technologicznych”, Polska Agencja Rozwoju Przedsiębiorczości, Warszawa 2011; |
| 16 | **Spyra M.** (2013) Economic Development Opportunities for the Pradziad Euroregion Borderland [in:] Spyra M. “Cross-border Landscape of Euroregion Pradziad”, Oficyna Wydawnicza Politechniki Opolskiej, Opole; |
| 17 | **Spyra M.** (2013) Zrównoważony rozwój Euroregionu Silesia. Synteza pracy podczas warsztatów projektowych[in:] Kiszka J. „Blue Notes” VSB-TU Ostrava |
| 18 | **Spyra M.** (2013) Eksperymentowanie z metodami planowania strategicznego na obszarze Euroregionu Silesia[in:] Kiszka J. „Blue Notes” VSB-TU Ostrava; |
| 19 | La Rosa D., Geneletti D., **Spyra M**., Albert C., Fürst C., (2018) Sustainable Planning for Peri-urban Landscapes In: Perera A., Peterson U., Pastur G., Iverson L. (eds) Ecosystem Services from Forest Landscapes. Springer, Cham, pp 89-126; |

* Publication used to form the basis for the habilitation thesis

## Other scientific publications

| No. | Bibliometric information |
|---|---|
| 20 | **Spyra M.** (2004) Przemiany oraz sukces dzielnicy Grünerløkka w Oslo. *Czasopismo Techniczne*. 9th International Conference of Institute of Urbanism, Faculty of Architecture, Cracow University of Technology; |
| 21 | **Spyra M.** (2004) The development chances for shrinking cities. Case studies from Dąbrowa Górnicza and Cottbus. *Architektura ir gyvenamosios aplinkos kokybe* – International Scientific Conference "Architecture and Quality of Living Environment", Kaunas University of Technology, Lithuania; |
| 22 | **Spyra M.** (2006) Zespoły badawczo – przemysłowe. Analiza wybranych przykładów Europejskich. *Zeszyty Naukowe Politechniki Śląskiej*, 2nd International Conference of PhD Students from faculties of architecture "Science in Everyday Live"; |
| 23 | **Spyra M.** (2006) Park naukowo – technologiczny jako przykład współtworzenia przestrzeni miejskiej przez kapitał międzynarodowy – 17th International Scientific Conference „Outcomes of cities rebuilding with EU structural Fonds"; |
| 24 | **Spyra M.** (2008) Silesian Technopolis. *Urbanistyka* Vol 2; |
| 25 | **Spyra M.** (2008) Czy możliwe jest wytworzenie policentrycznego środowiska innowacyjnego na Śląsku? *SOOIP Stowarzyszenie Organizatorów Ośrodków Innowacji i Przedsiębiorczości w Polsce Annual* 2008; |
| 26 | Czora G. and **Spyra M.** (2009) Park of Light – creation of the new iamge of cities [in:] Sulimowska – Ociepka A. „Attractiveness of the city. Urban Landscape Renewal" The Deapartment of Architecture at The Silesian University of Technology, Gliwice 2009; |
| 27 | **Spyra M.** (2009) Miasto jako optymalne środowisko parku technologicznego *Zeszyty Naukowe Uniwersytetu Szczecińskiego*. *Ekonomiczne problemy usług*, Szczecin 2009; |
| 28 | **Spyra M.** (2010) Water in the process of transformation of urban space. Case study: Świdnica and Sieradz [in:] Januchta – Szostak A. "Sensitive approach to water in urban environment", Wydawnictwo Politechniki Poznańskiej, Poznań |
| 29 | **Spyra M.** (2010) The role of public space in city's environment [in:] Perinkova M., Spackova E. "Architecture in Perspective", Stavebni Fakulta Vysoka Skola Banska – Technicka Univerzita Ostrava; |
| 30 | **Spyra M.** (2011) Trwanie i przemijanie architektury miasta w kontekście metodologii projektowych. *Czasopismo Techniczne* 4-A/2011/1 volume 14 year 108; |
| 31 | **Spyra M.** (2012) Creation of new places in urbanized space, illustrated with the example of the city of Opole [in:] Juzwa N., Sulimowska – Ociepka A. „The Urban Landscape Renewal. City – People Friendly Places Ideas – Projects – Realisations", Gliwice 2012; |
| 32 | Obracaj P. and **Spyra M.** (2012) Studenckie warsztaty projektowe jako element planowania regionalnego. *Inżynieria i Budownictwo* 8/2012, s.451 – 452, |
| 33 | **Spyra M.** (2012) Durability and fleetingness of architecture at the example of cross – border town Cieszyn [in:] Špačková E. "Transformations in twentieth-century architecture", Ostrava; |
| 34 | **Spyra M.,** Oględcki J. (2013) Opportunities and threats to the development of medium-sized towns in the Upper Silesia region exemplified by Bogumin and Jastrzębie Zdrój [in:] Juzwa N., Sulimowska – Ociepka A. „Middle – sized cities of tommorow", Gliwice, Łódź 2013; |
| 35* | **Spyra M.** (2014) Ecosystem Services and Border Regions. Case Study from Czech – Polish Borderland, *TeMA Journal of Land Use, Mobility and Environment*, Special issue, 06/ 2014; |
| 36 | **Spyra M.** (2015) Small Cities as an Element of Cross-border Landscape Exemplified in the Pradziad Euroregion. *Space&Form* 23/2, pp. 259-264; |
| 37 | Bondaruk J., Pilch A., Kruczek M. & **Spyra M**. (2015) Metody planowania rozwoju przestrzennego obszaru transgranicznego na przykładzie projektu Edu2Work [in:] Ptaček P., Opravil Z., Roubinek P. Uwarunkowania zrównoważonego rozwoju polsko-czeskiego |

obszaru transgranicznego: studium przypadku pogranicza Euroregionu Pradziad. *Geographia Moravica*, Univerzita Palackého v Olomouci, pp. 85 – 105;

38 Obracaj P., **Spyra M**., Opałka P. (2015) Czynności realizowane dla studentów uczelni w czesko-polskim pograniczu, [in:] Ptaček P., Opravil Z., Roubinek P. Uwarunkowania zrównoważonego rozwoju polsko-czeskiego obszaru transgranicznego: studium przypadku pogranicza Euroregionu Pradziad. *Geographia Moravica*, Univerzita Palackého v Olomouci, s.105 – 115;

39* Frank S., **Spyra M.,** Fürst C. (2017) Requirements for cross-border spatial planning technologies in the European context CASES Change and Adaptation in Socio-Ecological Systems (3): p. 39–4;

40* **Spyra, M**., and Hamerla, A. (2021). Bicycle Accessibility to Cultural Ecosystem Services in a Cross-Boundary Landscape. In D. La Rosa & R. Privitera (Eds.), Lecture Notes in Civil Engineering Innovation in Urban and Regional Planning (Vol. 1, pp. 91–99).

41 Calò N. and **Spyra M.,** (in-press) Implementing green infrastructures concept to protect peri-urban open spaces. Example from Gorenjska region, Slovenia. BMBF Skripten

## Popular publications

| No. | Bibliometric information |
|---|---|
| 42 | **Spyra M.** (2004). Co zrobić z kurczącym się miastem? Architektura – Murator. 06/ 2004; |
| 43 | **Spyra M.** (2004). Oswoić przemysł. Architektura – Murator. 11/ 2004; |
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| 53 | **Spyra M**., Cortinovis Ch., Ronchi S., (in prep, target journal Land Use Policy) Governance mixes for sustainable peri-urban landscapes; |
| 54 | **Spyra M**., Aubrechtova T., Krpec P. (in prep, target journal Urban Ecosystems) Neglected urban spaces for better provision of urban ecosystem services; |

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55 Rozas-Vásquez D., **Spyra M.,** Jorquera F., Molina S. and Caló N. (under minor revision journal Land) Ecosystem services supply from peri-urban landscapes and their contribution to the sustainable development goals: a global perspective;

56 Adamska M., **Spyra M**. (in prep) On an evolution from divided cities to twin cities. Comparative study of Český Těšín/Cieszyn and Görlitz/Zgorzelec.

# Affidavit

The habilitation thesis has been written independently and without outside help. No sources or aids than those indicated have been used, and passages taken verbatim or in terms of content from other works have been identified as such.

Halle (Saale)

Dr. Marcin Spyra

# Appendix

# I

Spyra, M. (2014). The feasibility of implementing cross-border land-use management strategies: a report from three Upper Silesian Euroregions. IForest, 7, 396–402
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Guest Editors: Daniele La Rosa, Carsten Lorz, Hannes Jochen König, Christine Fürst

# The feasibility of implementing cross-border land-use management strategies: a report from three Upper Silesian Euroregions

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*Communicated by: Raffaele Lafortezza*

**This paper presents several comments concerning land-use management strategies for three Czech-Polish Euroregions: Pradziad, Silesia and Cieszyn Silesia. These Euroregions comprise part of the Upper Silesia cross-border region. The study was conducted interviewing management representatives of each Euroregion on a set of questions concerning land-use strategies in the cross-border Czech-Polish Euroregions. The first section of the questionnaire concerned the need for such strategies, and the impediments to their implementation and their content. The second section described possible methods for implementing Euroregion land-use strategies after their preparation. It is argued that Euroregion land-use management strategies should reflect such aspects as the further development of the Euroregion as a cross-border institution and should include selected issues regarding economic development and the natural environment. The lack of enthusiasm among Euroregion members, the limitations of the 2014-2020 European Union budget and difficulties in achieving a single Czech-Polish development vision are the main obstacles in the implementation of the mentioned land-use strategies. Moreover, the importance of adequate Czech-Polish borderland planning tools and the role of citizens in Euroregion development are emphasised. The utility of a Euroregion scale for regional and national land-use management is discussed, using the example of the Upper Silesia cross-border region. The connection of the study results with regional land-use norms is explored, incorporating current strategic documents concerning the Czech-Polish borderland and existing legislation from both sides of the border. Some conclusions concerning appropriate cross-border landscapes land-use planning tools are outlined.**

**Keywords: Czech-Polish Borderland, Upper Silesia, Euroregion, Cross-border Land-use Management Strategy**

## Introduction

The Association of European Border Regions (AEBR) defines "Euroregion" as an organisational unit that allows and stimulates the cooperation of local governments and other public and private bodies on both sides of the border (AEBR 2000). As Perkmann & Spicer (2007) noted, Euroregions are "organising templates for coordinating policies among contiguous local or regional authorities across national borders" (p. 12). Euroregions are dynamic constructs in which different processes are taking place, such as setting development goals, searching for new financing possibilities and expanding membership structures (Perkmann 2003).

In the context of this study, the land-use management strategy should be understood as a joint document regarding the Czech-Polish borderland in the Euroregion area. It was assumed that the structure of such a document should start with an evaluation (diagnosis) of the Euroregion's potential (location, land cover, infrastructure, demography, education, economy, analysis of existing strategic documents), followed by an analytical/strategic discussion (development scenarios, development and strategic goals, development priorities and implementation tools). Cross-border land-use management strategies are important, in that they should help to coordinate the development of the cross-border region (CBR), make transnational cooperation much smoother, and thus have a positive impact on cross-border ecosystems. On the other hand, land-use goals, interests concerning the CBRs (and Euroregions) and legislatures of the Czech Republic and Poland differ in many ways (Ministerstwo Budownictwa Rzeczypospolitej Polskiej 2006). Moreover, the administrative divisions are different on each side of the border. The cross-border land-use management strategy should strengthen the cross-border cooperation and coordinate the development of a particular CBR (Euroregion). The strategy should be one of the most important documents used in the implementation of the European Union Multiannual Financial Framework for the years 2014-2020, by facilitating the efficient use of the investment. However, little research has been carried out on the need for land-use management strategies and methods concerning such cross-border strategies in central Europe in general, and the Czech Republic/Poland in particular.

The method in this study is based on interviews conducted at the top level of management of the three studied Czech-Polish Euroregions: Pradziad, Silesia and Cieszyn Silesia. The objective of this study is to analyse the possibilities for implementing new Czech-Polish land-use management strategies in the analysed Euroregions. Additionally, this study is intended to deliver an overview of the method for developing land-use management strategies, which could be useful for each of those Euroregions.

The purposes of the study include:

- Increasing knowledge about the need for and content of cross-border land-use management strategies in relation to the three Upper Silesian Euroregions.
- Proposing a method suitable for preparing future cross-border land-use strategy documents that separately cover the three Upper Silesian Euroregions.

## Cross-border land-use management strategies

### *The study area*

The study area includes three Euroregions located inside the Upper Silesia CBR: Pradziad, Silesia and Cieszyn Silesia (from west to east). Such Euroregion members are

**Tab. 1** - Area, population and population density in the Pradziad, Silesia and Cieszyn Silesia Euroregions as of December 2006. Source: "*Euroregiony na granicach Polski*" Statistical Office of Wroclaw, Poland.

| Euroregion | Subregion | Area [km²] | Inhabitants | Population density [persons per km²] |
|---|---|---|---|---|
| Pradziad | CZ | 1 878 | 131 583 | 70.07 |
| | PL | 4 186 | 628 238 | 150.08 |
| | Total | 6 064 | 759 821 | 125.3 |
| Silesia | CZ | 1 116 | 224 919 | 201.54 |
| | PL | 1 453 | 288 163 | 198.32 |
| | Total | 2 569 | 513 082 | 199.72 |
| Cieszyn Silesia | CZ | 763 | 351606 | 460.82 |
| | PL | 967 | 305129 | 315.54 |
| | Total | 1730 | 656735 | 379.62 |
| Overall | CZ | 3 757 | 708 108 | 188.48 |
| | PL | 6 606 | 1 221 530 | 184.91 |
| | Total | 10 363 | 1 929 638 | 186.2 |

Czech and Polish communities and districts. The three Euroregions differ in population, area, land use and economy, among other aspects (see Tab. 1).

The Upper Silesia CBR, defined by its historical borders based on the study by Kordecki & Smolorz (2011), currently covers most of the area of the Polish Slaskie and Opolskie Voivodeships and the Czech Moravskoslezský region at the level of NUTTS 2 (Fig. 1). Upper Silesia is located in central Europe at the axis of the Moravian Gate, which is formed by the depression between the Carpathian Mountains and the Sudetes (Fig. 1). Culturally and politically, the CBR was shaped by German, Czech, Slovak, Jewish and Polish influences.

### *Previous experiences*

Paasi (2010) raises the question of whether a "region" actually exists or is merely an idea. He stresses that a region should also be seen as an end product of a research process. Such issues seem to be important also in the context of defining CBRs and delimiting their areas. Elaborating land-use management strategies should be understood as an important element of such a research process, helping to clarify the specificity of the CBR and the strength of the idea behind it.

Beginning in the late 1980s, Czech-Polish cross-border cooperation began to grow as a result of bottom-up initiatives. The 1980s also saw an intensification of the discussion of land-use issues concerning the Czech-Polish cross-border area (Kotkowska 2012). The first document concerning these issues, "Coordination document for Czech-Polish borderland", was prepared in 1991. The document was updated several times, with the currently binding version "Study of the spatial development of the Polish-Czech borderland" ("*Studium zagospodarowania przestrzennego pogranicza polsko-czeskiego*"), being announced in 2006. Several issues such as environmental protection, infrastructure development, tourism and the labor market were discussed between the neighboring countries (Ministerstwo Budownictwa Rzeczypospolitej Polskiej 2006).

As requested in the above-mentioned document, a Euroregion land-use management strategy can help identify local common ideas and priorities for land-use planning at the Czech-Polish borderland that would be applicable to the whole Upper Silesia. This strategy will help fulfill the goal of central European land-use planning, namely to facilitate the decentralization process - the shifting of power from central governments to the local level (Beunen & Opdam 2011). Moreover, the strategies discussed therein can be helpful in achieving the strategic goals of Czech-Polish borderland development, including the enhancement of the external and internal cohesion of the Polish-Czech borderland and the protection and restore of natural and cultural resources. Such goals could be achieved by adopting a proper land-use policy based on an in-depth knowledge about each Euroregion acquired during the preparation of the local land-use strategies. In addition, these efforts would be promoted by: (i) coordinating different land-

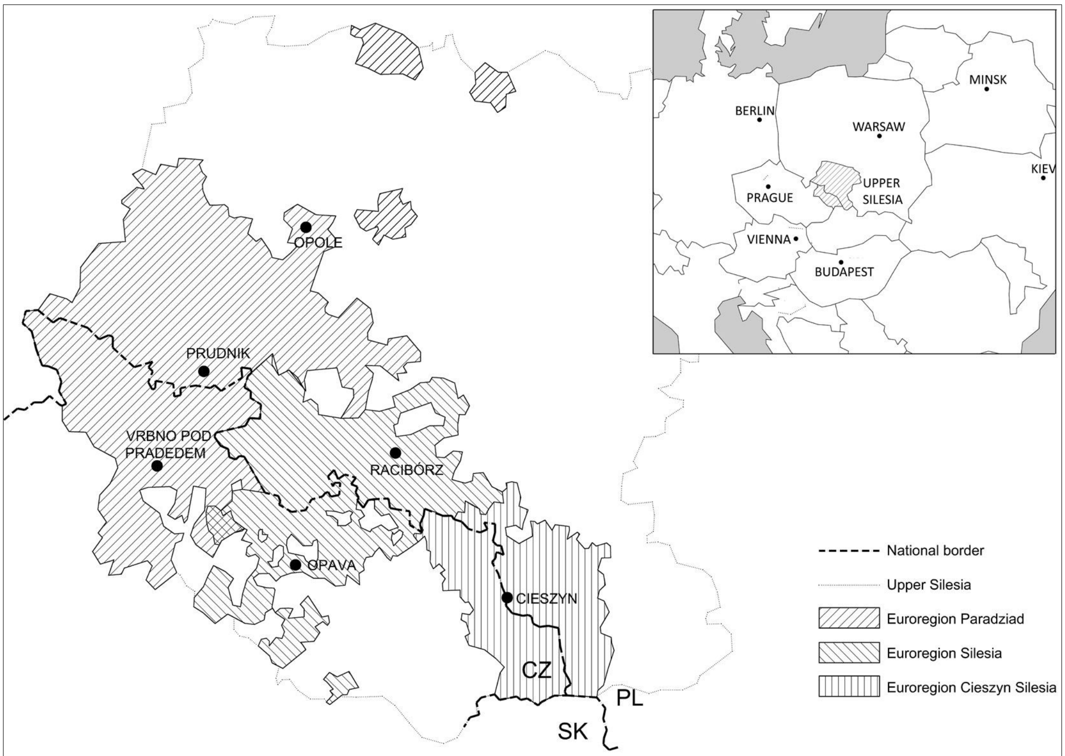


**Fig. 1** - Location of Pradziad, Silesia and Cieszyn Silesia Euroregions inside the Upper Silesia CBR.

**Tab. 2** - The project matrix (PM).

| Module | Objective | Actions | Outcomes |
|---|---|---|---|
| M1 | Collecting interdisciplinary knowledge about the Euroregion cross-border landscape, which will be used as a basis for the project actions undertaken in later modules. | (1) Research into the Euroregion's cross-border landscape, with a focus on climate, microclimate, geology, natural topography, water resources, soil, fauna and flora, current land use, infrastructure, demographic aspects, economy history and culture.<br>(2) Consultations with public administration units and the Euroregion, preceded by an analysis of existing strategic documents.<br>(3) Public consultation (*e.g.*, the Delphi method).<br>(4) Workshop for high-school students.<br>(5) Workshop for Polish and Czech students. | Diagnosis of the Euroregion. User-friendly and modifiable/updatable interdisciplinary set of knowledge on the Euroregion (its cross-border landscape). |
| M2 | (1) Drawing up the 2020 Euroregion development vision.<br>(2) Four versions of the 2020 Euroregion development scenarios based on the outcomes of MODULE 1. | (1) Drawing up guidelines for the planning tools to be developed in MODULE 3.<br>(2) Public consultation on the development scenarios.<br>(3) Workshop for Polish and Czech students aimed at commenting and developing the development scenarios.<br>(4) Final version of the development scenarios. | Guidelines for the planning tools to be developed in MODULE 3. |
| M3 | Setting priorities and strategic goals for the Euroregion. Based on outcomes of MODULE 2, developing planning tools, namely, a set of methods and actions to be used to stimulate further development of the Euroregion and further land-use planning. | (1) Formulating descriptive part of the strategy (priorities, strategic goals, action lines, planning tools).<br>(2) Organisation of a series of consultation workshops for representatives of the public and private sector.<br>(3) Organisation of implementation workshops for the Euroregion.<br>(4) Publications promoting project results.<br>(5) Establishment of an Expert Council to monitor the development of the cross-border region (similar to a think-tank). | Euroregion land-use strategy, including a set of actions described in detail (a toolbox), intended to stimulate further development of the Euroregion. |

use planning initiatives on both sides of the border; (ii) formulating common Czech-Polish strategic goals for the Euroregion; and (iii) ensuring the continuity of Czech and Polish strategic planning operations.

### *Data collection*

The study was carried out between November 2012 and February 2013 through interviews to five Euroregions management representatives (presidents and directors of the Czech and Polish parts of each Euroregion). Euroregion executives were chosen to access the viewpoints of people responsible for the Euroregion's development.

Data were collected by a questionnaire composed of two sections (one and two). In section one, general issues about the Euroregion's current and future cross-border land-use planning initiatives were included, with the aim of:

- investigating the need of a cross-border land-use management strategy in the Upper Silesian Euroregions;
- assessing the main impediments to implementing these cross-border land-use management strategies; and
- analyzing the types of issues related to Euroregion planned development that should be addressed in cross-border land-use management strategies.

In section one, seven general open-ended and closed questions concerning the land-use strategies in the Czech-Polish Euroregions were formulated:

- 1A. What are the most important impediments to the Euroregion's development?
- 1B. If the Euroregion has a common Czech-Polish land-use strategy, which issues related to planned development were addressed in the strategy?
- 1C. If the Euroregion does not have a common Czech-Polish land-use strategy, which issues related to planned development should be addressed in such a document?
- 1D. What are the main threats to implementing land-use strategies for cross-border regions?
- 1E. Does the Euroregion have a common Czech-Polish land-use strategy (yes, no)?
- 1F. Are land-use strategies for cross-border regions necessary (definitely yes, yes, no, definitely no)?
- 1G. Do land-use strategies for cross-border regions have a chance of being implemented (definitely yes, yes, no, definitely no)?

In the section two of the questionnaire, the proposed land-use strategic planning method based on the project matrix (PM) was evaluated (Tab. 2). The PM represents a planning scheme and is used as a theoretical basis to discuss and address the general challenges for implementing cross-border land-use management. The main aim of the PM is to structure the preparation of a land-use management strategy in a stepwise manner. The PM consists of three modules, M1, M2 and M3, described in detail in Tab. 2. The data concerning the Euroregion landscape collected in module M1 are sorted according to the method proposed by Steiner (2008), in which the main inventory elements are regional climate, earth, terrain, water, soil, microclimate, vegetation, wildlife and existing land use and land users. Moreover, information about the area's history, culture, economy and demography is included. Module M2 is based on the development of expert land-use scenarios for the Euroregions. Lastly, module M3 implements the results of the previous modules and formulates the strategic priorities and goals.

The purpose of this section was to:

- develop an outlook of the method to facilitate the future preparation of land-use management strategies for the three Upper Silesian Euroregions; and

- identify general challenges for land-use management in the studied area.

The section two of the questionnaire consisted of 11 open-ended and closed questions:

- 2A. How would you rate the utility of actions described in the proposed PM (insufficient, sufficient, good, very good)?
- 2B. How would you rate the logic of the modules (M1, M2, M3) proposed in the PM (insufficient, sufficient, good, very good)?
- 2C. How would you rate the idea of using a foresight method to analyze the development potential of the Euroregion (insufficient, sufficient, good, very good)?
- 2D. How would you rate the potential help given by middle-school pupils in collecting interdisciplinary data about the Euroregion and different stories about the Euroregion ("storytelling": insufficient, sufficient, good, very good)?
- 2E. How would you rate the possible help given by university students of the Opolskie, Slaskie and Moravsko-Slezkie "voivodeships" (administrative division) in collecting interdisciplinary knowledge about the Euroregion (storytelling about the Euroregion) and in creating development scenarios (insufficient, sufficient, good, very good)?
- 2F. How would you rate the citizens' involvement in the Euroregion development (insufficient, sufficient, good, very good)?
- 2G. How would you rate the existing brand of the Euroregion (insufficient, sufficient, good, very good)?
- 2H. How would you rate the role of creative class members in the development of towns, cities and regions (entirely irrelevant, unimportant, important, very important)?
- 2I. How would you rate the need for citizen involvement in the Euroregion's development (entirely irrelevant, unimportant, important, very important)?
- 2J. What are the necessary actions that should be implemented to increase citizens' involvement in the Euroregion's development?
- 2K. Which general aspects should be used to address the scenarios prepared in module 2?

### *Interpretation of the results*

The answers to the questions from both sections of the questionnaire are presented in Tab. 3.

Results from section one clearly demonstrate that now is an appropriate time to examine the possibilities of implementing cross-border land-use strategies in the Euroregions analyzed. Only the Cieszyn Silesia Euroregion representative indicated that his/her institution has implemented cross-border strategic documents, namely "BORDER CROSSING - Model study of border crossings in the year 2005" and "INTERTURISM - Joint strategy for tourism development in the Silesian Beskid and Moravian-Silesian Beskid areas" (question 1E). At the time of the study the Polish association forming the Pradziad Euroregion was preparing a document entitled: "Strategy for Polish-Czech cooperation in the Pradziad Euroregion area in the years 2014-2020". The representatives acknowledged that cross-border land-use management strategies are very necessary (question 1F), and all interviewees indicated that implementing such documents should be possible (question 1G).

According to the results, issues that the cross-border land-use strategies should address can be classified into three general categories:

1. Further development of the Euroregion as a cross-border institution. The following issues were identified: strengthening cross-border cooperation between Euroregion stakeholders; identifying the issues affecting stakeholders' development and searching for ways to solve them; seeking financing sources (question 1C).
2. Economic development. The important aspects highlighted were: cross-border transport infrastructure; cross-border institutional cooperation (for instance, in the framework of cross-border clusters); the labor market; tourism and education (question 1B and 1C).
3. The natural environment. The aspects deemed to be important in this area were: environmental hazards; environmental protection and preservation; liquidation of the consequences of natural disasters; inhabitants' quality of live (question 1B and 1C).

Three main obstacles to the implementation of a cross-border land-use management strategy were identified (questions 1A and 1D):

1. A lack of enthusiasm for or serious engagement with cross-border land-use planning among the Euroregion partners. This fact, combined with a fear of the European Union's procedures, a lack of new institutional members in the Euroregions, and the resignation of existing members, should be identified as the foremost threat to cross-border land-use planning. It indicates a need for the improvement of the Euroregion's brand and the building of trust among its members.
2. The uncertainty of the European Union's financial programming and budget for the years 2014-2020 was indicated as an impediment to cross-border land-use planning six times. This fact clearly indicates that both the process of land-use planning and further integration inside the Euroregions must be supported by proper financing.
3. It is difficult to achieve a common vision of land-use planning on both sides of the border. The representative of the Polish association in the Pradziad Euroregion indicated that it is difficult even to summon the will to work on such a document. The Polish association in Cieszyn Silesia Euroregion also stressed the importance of "proper cooperation with the Czech partner".

In section two the logic behind the proposed PM is appreciated, giving rise to the possibility of further elaboration and practical implementation of this theoretical planning scheme (questions 2A and 2B). Further considerations from the PM emphasize the following issues.

#### Constant development of adequate land-use strategic management tools for the Czech-Polish borderland

Results showed a marked potential for this area (question 2C). Moreover, the importance of involving different stakeholders in the early stage of the planning process was stressed by the interviewed Euroregion representatives (questions 2D & 2E). Such involvement can be implemented by planning and providing workshops for stakeholders. Cooperating with the public administration during the planning process is considered a priority, while the involvement of middle-school pupils and university students is commonly less considered. Representatives of middle-school pupils and university students could be considered a "support squad" in the planning process, providing a different perspective (different stories) about the spatial problems of the Euroregions. These support squads should be engaged in the planned workshops: (i) by gathering data and compiling fundamental information and knowledge about the Euroregion's problems (PM, module M1); (ii) by critical reviewing and visualizing the land-use scenarios prepared (PM, module M2 - question 2K).

#### Engagement of Czech and Polish citizens in the Euroregion's development

From the perspective of the Euroregion management, citizens could be more involved in the Euroregion development (question 2F). Three out of five interviewed managers rate this factor as important, and the other two as very important (question 2I). Moreover, all interviewees recognize the important role of the creative class in the regional development (question 2H). The answers to question 2J suggest several possible approaches to this purpose, all based on frequent discussions among Czech and Polish stakeholders. A possibility is to improve the Euroregion's branding, which would encourage citizens to participate in Euroregion development in general and land-use in particular. The respondents' answers suggest that it is important to continuously develop and improve such a brand (question 2G). Again,

**Tab. 3** - Summary of all answers given in both sections of the study interviews.

| Section | Pradziad PL | Pradziad CZ | Silesia PL | Silesia CZ | Cieszyn Silesia CZ / PL |
|---|---|---|---|---|---|
| 1A | - | (1) The lack of a clear target for bilateral co-operation | (1) The lack of funds for continuing Euroregion activity<br>(2) Determination of "priority themes" for European Union programme period 2014-2020 in the framework of the European Territorial Cooperation, which does not correspond to real Euroregion needs<br>(3) Different opinions between Polish and Czech partners about development goals | (1) No proper engagement of Euroregion members in its activities<br>(2) Fear of European Union procedures<br>(3) Lack of new members in Euroregions and resignation of existing ones<br>(4) Financial problems (*e.g.*, low membership fees, microproject administration)<br>(5) Little interest in new Czech-Polish cooperation programme for the years 2014-2020<br>(6) Increasing disproportion between the Czech and Polish sides of the Euroregion - better cooperation promotion on the Polish side | (1) Availability of funds from the European Union |
| 1B | - | - | - | - | (1) Exchange of information and experiences concerning regional development, labor market<br>(2) Cooperation in the following fields: spatial planning, prevention and liquidation of consequences of natural disasters, rescue services, economy and trade, schools and young people, tourism and further improvement of cross-border traffic<br>(3) Solving common problems in the following fields: transport, communication, citizens' security, ecology and environment protection<br>(4) Cultural exchange and concern for common cultural heritage |
| 1C | (1) Transport infrastructure<br>(2) Tourism<br>(3) Environmental hazards and environmental protection<br>(4) Education<br>(5) Labor market<br>(6) Social security<br>(7) Health care<br>(8) Institutional cooperation<br>(9) Economy | (1) Continuing cross-border cooperation of municipalities and other stakeholders<br>(2) Building lasting friendships<br>(3) Defining new development goals | (1) Institutional development of the Euroregion<br>(2) Development of the Euroregion as a strong association, grouping its member communities and helping to solve their problems<br>(3) Socio-economic development<br>(4) Increasing competitiveness<br>(5) Inhabitants' quality of life | (1) Development of the Euroregion as an institution able to raise its own funds for its activities<br>(2) Continuous search for new financing sources<br>(3) Involvement in projects and activities that are interesting and acceptable to all Euroregion members<br>(4) Widening cooperation in the framework of the Euroregion beyond its management down to each member | - |
| 1D | Lack of the Czech partners' willingness to cooperate | "No strategy is currently implemented" | Similar to answers for question 1A and<br>(1) No funds available for implementing the strategy<br>(2) Organisational changes inside the Euroregion | Same answers as for question 1A | Fluent cooperation between Polish and Czech partners comprising the Euroregion |
| 1E | No | No | No | No | Yes |
| 1F | Definitely yes | Definitely yes | Definitely yes | Definitely yes | Yes |
| 1G | Yes | Yes | Definitely yes | Yes | Yes |
| 2A | Very good | Very good | Sufficient | Good | Good |
| 2B | Very good | Good | Good | Sufficient | Good |
| 2C | - | Very good | Good | Good | Good |
| 2D | Very good | Very good | Sufficient | Very good | Good |
| 2E | Very good | Sufficient | Good | Very good | Very good |
| 2F | Insufficient | Very good | Sufficient | Sufficient | Sufficient |
| 2G | Sufficient | Very good | Good | Good | Good |

**Tab. 3** (continued) - Summary of all answers given in both sections of the study interviews.

| Section | Pradziad PL | Pradziad CZ | Silesia PL | Silesia CZ | Cieszyn Silesia CZ / PL |
|---|---|---|---|---|---|
| 2H | Very important | Important | - | Important | Important |
| 2I | Important | Very important | Important | Very important | Important |
| 2J | (1) Education in Polish and Czech schools (2) Informational meetings in different communities | (1) Frequent and well-prepared information about bilateral cooperation and its impact on quality of life (2) Public discussion of examples of other similar "good practices" | Public debate | (1) Raising awareness of the Euroregion (further cross-border cooperation, development of areas close to the border, communication between people from both sides of the border) (2) Public discussion of examples of other similar "good practices" from other Czech, Polish and European Euroregions | (1) Awareness of the regional potential (2) Deepening of citizens' knowledge about the Euroregion |
| 2K | (1) Infrastructure (2) Tourism (3) Education (4) Labor market (5) Health care | No answer | (1) Development of the Euroregion as a strong association, grouping its member communities (2) Development of the Euroregion as an institution (3) Transport infrastructure (4) Tourism, culture, sport (5) Supporting entrepreneurship (6) Development of human resources Euroregion management | (1) Development of the Euroregion as an institution (2) Transport infrastructure (3) Culture (4) Sport Economy/business (5) Human resources (6) Euroregion management Specifying certain actions and projects in selected strategic divisions | (1) Natural environment (2) Waste management (3) Health care (4) Public security and emergency management (5) Economic development of the Euroregion area |

planning workshops are also a promising tool for increasing citizen participation.

## Conclusions

### *Planning the CBR future*

There are few important needs for land-use management in Upper Silesia CBR at the Euroregion scale. A document on the cross-border land-use management strategy does not exist in either Polish or Czech planning legislation. However, the conclusions from the Euroregion land-use management strategy should be included in national planning procedures. First, these conclusions can serve as valuable framework for land-use management at the regional level on both sides of the border and as a basis for the regular updating of national documents, being prepared with the help of local citizens and public sector representatives. Second, selected issues elaborated in the Euroregion land-use management strategy should be included in detailed land-use plans concerning Czech and Polish communities or parts thereof. During the preparation of the Euroregion land-use management strategy, Czech and Polish communities should have the chance to express their opinions about each other's land-use plans. The process described above should be supported by the hierarchical nature of land-use planning that is well-established in the legislation, where planning at the community level takes into account the frameworks described in regional-level documents (Jedraszko 2005). Obviously, the differences in the land-use management/ planning legislation on each side of the border does not facilitate this implementation, but the proposed transnational and transparent process for preparing a Euroregion land-use management strategy (including adequate tools) can help overcome these difficulties.

The involvement of the Czech and Polish communities in the preparation of the requested land-use management strategy, identified as a critical issue, may help these public bodies to consider land-use management and planning form a wider, cross-border perspective, discouraging the unproductive "not in my backyard" line of thought. The involvement of Czech and Polish communities in cross-border land-use strategic management is significant in that these institutions are taking a substantial responsibility for the details of land-use planning in their areas.

Following are the issues identified in this study that can be linked to national/regional land-use norms/instruments.

#### Increasing Polish and Czech stakeholders' collaboration in the land-use planning process

The European Landscape Convention emphasizes the role of participation in landscape strategic planning, the need to raise awareness of the landscape and the role of training and education (Council of Europe 2000). Representatives of the public sector should obviously be involved in the planning process at the earliest stage (Whittington 1996). Different methods of transdisciplinary and participative land-use strategic planning have recently been discussed (*e.g.*, Cantiani 2012, Cumming & Norwood 2012, Sevenant & Antrop 2010) and criticized (*e.g.*, Stenseke 2009). Moreover, this study suggests the involvement of middle-school pupils and university students in the process *via* planning workshops. Those can serve as "support squads" for the overall process and can help in the identification of the planning problems, approaching from a different perspective (Spyra 2013).

#### Use of foresight for land-use strategic planning at the borderland

It is proposed to extend the foresight to the so-called "foresight 2.0", in which more emphasis is placed on leadership rather than on management over the whole planning process. The process itself is also more flexible and focuses not only on problem-solving but also goal-creation (Nelson 2010, Stevenson 2006). The literature has indicated a significant growth in interest in scenario planning (Varum & Melo 2010). Scenario planning approaches based on qualitative imaginary and storytelling should be introduced as a possible instrument of cross-border land-use planning (MacKay & McKiernan 2010, Ratcliffe & Krawczyk 2011). Storytelling, which has been growing in importance over the last two decades, is an interesting and feasible approach (*e.g.*, van Hulst 2012). The planner's role is to listen carefully to people's stories and, using proper tools and methods, systematize the knowledge therein and use it as a basis for the decision-making process.

### *Future directions and research needs*

As discussed by Lepik (2009), Euroregions need to constantly define new development goals, cooperate with new types of members (*e.g.*, NGOs, universities) and, above all, be aware of their financial resources. Better stakeholder involvement in land-use management could stimulate progress towards these goals. The Euroregion land-use management strategy can be used to overcome the impediments to Euroregion development mentioned in the interviews (Tab. 3). Specifically, it can be used to: (i) define clear targets for bilateral cooperation; (ii) prepare the Euroregion for the new European Union programme period (2014-2020); (iii) encourage the entrance of new members (*e.g.*, districts and communities as well as NGOs and universities) into the Euroregion; and (iv) provide a more prominent role in national policies and participation in regional and national decision-making regarding land-use by serving as a reference for the Euroregion lobbying policy at the central governmental level on both sides of the border. In this way, the Euroregion land-use management strategy can help strengthen cross-border cooperation within all the Upper Silesia CBR in particular and other CBRs in general. All these issues should be considered as directions for future research.

Thackara (2006, p.43) writes that "dialogue and encounter are inescapable basis of trust in our relationships". He describes the creation of trust through time as the *nemawashi* ("laying the groundwork") factor. Trust must also be built between Czech and Polish stakeholders working on the cross-border land-use management strategy and planning the future of the CBR. Adequate land-use management tools and engagement of Czech and Polish citizens in the Euroregion's development, argued in this paper, should be an element of the *nemawashi* factor. This factor could be the motto for further research concerning cross-border land-use management in CBRs.

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# II

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# ECOSYSTEM SERVICES AND BORDER REGIONS

## CASE STUDY FROM CZECH – POLISH BORDERLAND

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**ABSTRACT**

Land-use management and planning of cross-border regions is a complex problem. Different legislatures, development visions and interests on both sides of the border make it even more complicated. Introducing ecosystem services concept into land-use planning and management at cross-border regions is a challenge. However not much is said about this issue in literature.

This paper aims to present result of the study concerning to ecosystem services concept in the context of cross-border part of Pradziad Euroregion. The studyed area is situated within Czech – Polish borderland. First part of the research concerns to land-cover analyze of the region. The second one to Czech and Polish land-use strategies, which are binding at NUTS 4 and 5 level in the studyed area.

Resoults of the research indicates asymmetry of the cross-border landscape of the analyzed region. The asymmetry is indicated by different types, biodiversities and areas of ecosystems identified on both sides of the border. It is also identified by differences in land-use strategies concerning to the region.

It is discussed to what extend ecosystem services concept can be implemented in planning legislature of the cross-border region.

**KEYWORDS**

Ecosystem services, Land-use management and planning, Czech-Polish borderland, Assymetries of cross-border landscape

# 1 INTRODUCTION

## 1.1 ECOSYSTEM SERVICES IN THE BORDERLANDS

As noted by MEA (2005), Ecosystem services (ES) are the different benefits people receive from ecosystems. ES include: supporting services, provisioning services, regulating services and cultural services (MEA 2005). ES concept has been growing into importance since last years. That fact is indicated by selected internationally published studies (e.g. Fisher *et al.* 2009, Tuan *et al.* 2012). Several attempts have been made to introduce ES into land-use planning and management (Scolozzi *et al.* 2012, Steiner 2014). Also the aspects of economic valuation of ES were explored as an element of policy and decision making (Laurans *et al.* 2013). Furthermore it is crucial to make the ES concept more actionable for local communities. Actionable science as defined by Palmer (2012) has the potential to inform land-use decisions, to influence policies and strategies, which affect the environment. This can be the way to pustule by Xiang (2014) "ecological wisdom for urban sustainability".

Different national legislatures, land-use planning and management regimes, implemented policies, economic potentials, historical and political issues makes the problem of cross-border land use planning and management difficult to solve. Moreover not much have been said about ES in the context of land-use planning and management of European cross-border regions. While studying such case, firstly the diagnosis concerning to land-cover of the region needs to be made. Secondly national planning documents at local administrative level has to be analyzed in the context of ES implementation. Such approach can help to make the ES concept actionable for land-use planning and management. Outlined research method was used to analyze described in this paper case study.

## 1.2 THE CASE STUDY

The paper analyze the case study of the part of Euroregion Pradziad. The Euroregion is located between Poland and Czech Republic. The studied part of the Euroregion Pradziad covers an area of two Polish districts: Nysa and Prudnik and Czech district Jesenik and commune Krnov, Bruntál and Rýmařov (Fig. 1).


Fig. 1 Location of the studied region

The districts and communes are located beside the border line between Poland and Czech Republic and cover borderland part of Pradziad Euroregion. The mentioned Polish districts covers area of the NUTS 4[1]. The Czech district Jesenik (communes with expanded competence) covers an area of NUTS 4 and commune Krnov, Bruntál and Rýmařov of NUTS 5. Eurostat statistics for NUTS 3 level characterizes Polish districts as "intermediate rural, remote regions" and Czech as "intermediate rural regions, close to the city"[2]

In Poland at NUTS 4 level district governor is responsible for preparing land-use studies, strategies and analyzes. Detailed land-use plans are prepared at NUTS 5 level. In Czech Republic at NUTS 5 level communes and NUTS 4 "communes with expanded competence" are responsible for land-use strategies, other general land-use analytical documents and detailed land-use plans.

# 2 RESEARCH METHOD

## 2.1 FIRST STEP OF THE RESEARCH

Firstly, the diagnosis concerning to ES potential at the analyzed part of the Euroregion was performed. The diagnosis was partially prepared during the student workshop, which was held in the frame of the project titled "Edu2Work Cooperation between schools and public institutions located at Czech – Polish borderland in the frame of education increases chances at labor market". The project is conducted by Palacký University from Olomouc, Czech Republic, Central Mining Institute from Katowice, Poland with help of experts from Opole University of Technology. The five day long student workshop was held in April 2014 in Vidnava, the small town located in district Jesenik, next to the Polish border. The author lead one workshop group consisting of two students from Olomouc (Michael Cestr, Dan Horalík) and two from Opole (Dorota Michna, Michał Bartecki).

For the diagnosis following data was used: (i) Corine Land Cover (CLC) and other land-cover data available from European Environmental Agency, (ii) statistic data available from Czech Statistical Office and Polish Central Statistical Office, (iii) photographs prepared by workshop team members.

Workshop team members prepared the analyze of the region land cover. The area of the analyze covers Polish districts of Prudnik and Nysa and Czech district of Jesenik and "communes with expanded competence", Krnov, Bruntál and Rýmařov. The analyze was prepared with use of Quantum GIS 2.2 software.

## 2.2 SECOND STEP OF THE RESEARCH

Secondly, the performed analyze concerns to the land-use strategies. Districts of Nysa, Prudnik, Jesenik and Krnov commune were chosen to give a general overview of the ES implementation potential in the part of Polish – Czech borderland. The aim behind this selection was to perform the analyze on the administrative level, which is large enough to cover significant part of the land. On the other hand, land-use strategies for the selected districts and commune describe in a clear way development aims and problems of the studied area. Moreover districts of Nysa, Prudnik, Jesenik and Krnov commune have comparable land-use strategies. Namely following four documents were analyzed:

- District Jesenik: Land-use strategy for Jesenik district titled "Rozbor udržitelného rozvoje území pro správní obvod ORP Jeseník".

1 NUTS - Nomenclature of territorial units for statistics is a hierarchical system for dividing up the European Union.

2 Source: http://epp.eurostat.ec.europa.eu/cache/GISCO/mapjobs2009/0501EN.pdf.

- Commune Krnov: Land-use strategy for Krnov commune titled „Územně analytické podklady pro správní obvod městského úřadu Krnov".
- District Prudnik: Land-use strategy for Prudnik district titled "Strategia Rozwoju Powiatu Prudnickiego".
- District Nysa: Land-use strategy for Nysa district titled „Strategia Rozwoju Wspólnoty Międzygminno – Powiatowej Ziemi Nyskiej na lata 2004 – 2015".

Inside the content of each document, potentials for implementing ES concept were searched. Czech documents were analyzed according to identified land-use problems, while Polish documents according to land-use goals. The criteria for the selection was that certain problem or goal has to revere to ES concept. Based at the outcomes of the second step of the research, some conclusions for further land-use planning and management in the context of ES concept were drown.

## 3 RESULTS

### 3.1 FIRST STEP OF THE RESEARCH

During the first part of the study seven land-cover groups were identified. All groups reflect to Corine Land Cover (CLC) classification. Codes of that classification are given in brackets. Below list of identified land-cover groups is systematized from the ecosystems characterized by relatively little biodiversity (shades of red) into the ones characterized by high biodiversity (yellow, blue and shades of green) (Tab. 1, Tab 2):

- Urban fabric: continuous urban fabric (111) and discontinuous urban fabric (112).
- Industrial, commercial and transport units: industrial or commercial units (121), roads and rail networks and associated land (122), mineral extraction sites (131), construction sites (133).
- Agricultural areas: non-irrigated arable land (211), fruit trees and berry plantations (222), pastures (231), complex cultivation patterns (242), land principally occupied by agriculture, with significant areas of natural vegetation (243).
- Artificial, non-agricultural vegetated areas: green urban areas (141) and sport and leisure facilities (142).
- Water bodies: water bodies (512).
- Forest and semi natural areas: broad-leaved forests (311), coniferous forests (312), mixed forests (313), natural grasslands (321), moors and heathland (322), transnational woodland-shrub (324).
- Wetlands: inland marshes (411), peat bogs (412).

Moreover Nature 2000 and protected areas were identified, thanks to data available from European Environment Agency (Tab. 1, Tab 2). It was assumed that the higher biodiversity of certain ecosystem, the better potential to supply different ES.

Results of the first part of the study indicates **asymmetry of the cross-border landscape** of the analyzed region. The asymmetry is characterized by different types and areas of ecosystems identified on both sides of the border, their different biodiversity and different percent of each land-cover group on both sides of the border. Moreover identified on both sides of the border ecosystems have different potential to supply and absorb ES. The asymmetry is also indicated by following issues concerning to demographic data and land-cover (Fig. 2, Tab. 1, Tab 2):

- Higher amount of inhabitants on the Polish side of the region.
- Much higher density of urban fabric at the Polish side of the region.
- Much higher density of agricultural areas, dominated by non-irrigated arable land, on the Polish side of the region.
- Much higher density of forest and semi natural areas on the Czech side of the region.

- Much higher density of wetlands on the Polish side of the region.
- Much higher density of Nature 2000 and protected areas on the Czech side of the region.

| CLC GROUP | CLC CODE | AREA [HA] | GROUP AREA [HA] | PERCENTAGE OF THE REGION [%] | AMOUNT OF INHABITANTS |
|---|---|---|---|---|---|
| Urban fabric | 111 | 0,00 | | | |
| | 112 | 6 953,07 | 6 953,07 | 3,09 | |
| Industrial, commercial and transport units | 121 | 849,78 | | | |
| | 122 | 0,00 | | | |
| | 131 | 208,75 | | | |
| | 133 | 53,64 | 1 112,17 | 0,49 | |
| Agricultural areas | 211 | 41 339,61 | | | |
| | 222 | 0,00 | | | |
| | 231 | 35 729,61 | | | |
| | 242 | 131,95 | | | |
| | 243 | 26 325,20 | 103 526,37 | 46,07 | |
| Artificial, non-agricultural vegetated areas | 141 | 0,00 | | | |
| | 142 | 215,80 | 215,80 | 0,10 | |
| Water bodies | 512 | 869,76 | 869,76 | 0,39 | |
| Forest and semi natural areas | 311 | 4 951,87 | | | |
| | 312 | 66 700,30 | | | |
| | 313 | 28 390,54 | | | |
| | 321 | 301,15 | | | |
| | 322 | 104,15 | | | |
| | 324 | 11 540,49 | 111 988,50 | 49,83 | |
| Wetlands | 411 | 0,00 | | | |
| | 412 | 54,54 | 54,54 | 0,02 | |
| Nature 2000 | | 60 429,31 | 60 429,31 | 26,89 | |
| Protected areas | | 54 788,87 | 54 788,87 | 24,38 | |
| Analyzed region | | 224 720,20 | 224 720,20 | 100,00 | 136 062 |

Tab. 1 Land-cover and inhabitants amount of the Czech part of the analyzed region

Figure 2 compile each identified group of natural ecosystems (yellow, blue and shades of green) with high ability to supply ES (high biodiversity) with identified gropes of antropogenized ecosystems (shades of red) with high demand for ES (low biodiversity).

This analyzes indicates higher potential to supply ES on the Czech side of the region and higher demand for ES on the Polish side of the region (Burkhard *et al.* 2012). This fact is also confirmed by higher amount of inhabitants on the Polish side of the region (Tabb. 1,2).

Moreover, indicated in yellow, blue and shades of green land-cover groups (ecosystems) can be described as "service providing areas" (SPAs), while land-cover groups indicated in grey as "service benefiting areas" (SBAs). Following Fisher *et al.* (2009) and Syrbe & Walz (2012) SPAs as should be understood as "spatial units that are source of landscape services". While the same authors describe SBAs as spatial units, which can be characterized by "demand" for services and are complement to SBAs. Polish part of the region has higher amount of SBAs, Czech part of SBAs. That strenghts the cross-border landscape assymetry. In cases when SPAs and SBAs are not contiguous Syrbe & Walz (2012) defines service connecting areas (SCAs), which link providing and benefiting areas[3].

| CLC GROUP | CLC CODE | AREA [HA] | GROUP AREA [HA] | PERCENTAGE OF THE REGION [%] | |
|---|---|---|---|---|---|
| Urban fabric | 111 | 64,82 | | | |
| | 112 | 10 119,44 | 10 119,44 | 5,68 | |
| Industrial, commercial and transport units | 121 | 581,92 | | | |
| | 122 | 26,34 | | | |
| | 131 | 211,15 | | | |
| | 133 | 0,00 | 819,41 | 0,46 | |
| Agricultural areas | 211 | 121 841,69 | | | |
| | 222 | 28,34 | | | |
| | 231 | 8 220,09 | | | |
| | 242 | 4 524,43 | | | |
| | 243 | 5 974,75 | 140 589,30 | 78,93 | |
| Artificial, non-agricultural vegetated areas | 141 | 304,93 | | | |
| | 142 | 397,14 | 702,07 | 0,39 | |
| Water bodies | 512 | 2 424,18 | 2 424,18 | 1,36 | |
| Forest and semi natural areas | 311 | 7 538,44 | | | |
| | 312 | 6 881,95 | | | |
| | 313 | 6 298,71 | | | |
| | 321 | 542,19 | | | |
| | 322 | 25,07 | | | |
| | 324 | 1 367,42 | 22 653,78 | 12,72 | |
| Wetlands | 411 | 820,25 | | | |
| | 412 | 0,00 | 820,25 | 0,46 | |
| Nature 2000 | | 9 910,99 | 9 910,99 | 5,56 | |
| Protected areas | 14 069,97 | 14 069,97 | 7,90 | | |
| Analyzed region | 178 193,25 | 178 128,43 | 100,00 | | 198 842 |

Tab. 2 Land-cover and inhabitants amount of the Polish part of the analyzed region

### 3.2 SECOND STEP OF THE RESEARCH

Land-use strategy for **Jesenik district** describes 10 thematic areas: geological environment and geology, water regime, environmental hygiene, nature and landscape protection, agricultural land and land designated for forestry, public transport and technical infrastructure, socio-demographic conditions, housing, recreation, economic conditions (Ekotoxa 2010). All those thematic areas are obligatory for land-use strategies in Czech Republic prepared for NUTS 4 and 5 regions. Four thematic areas were selected to search for connections with ES concept: (i) environmental hygiene (ii) nature and landscape conservation, (iii) agricultural land and land designated for forestry, (iv) recreation. For selected thematic area several, described in the analyzed document, problems were selected. The selection was made according to potential of implement ES concept (R – regulating services, P – provisioning services, C – cultural services; Tab. 3).

[3] Service connecting area (SCA) can include river valley, ecological corridor, hollows, etc.

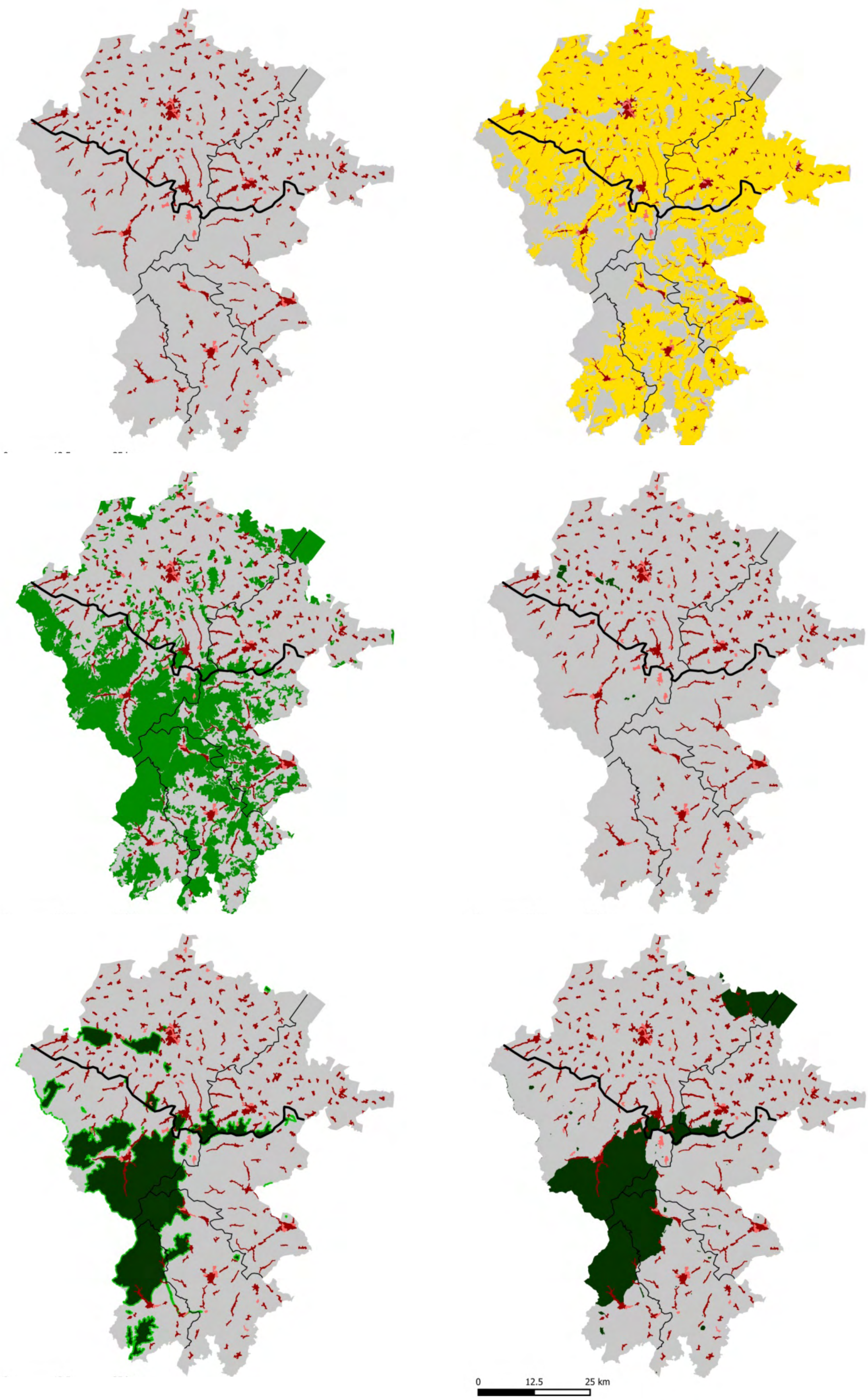


Fig. 2  Land-cover of the analyzed region

| THEMATIC ANALYZE | IDENTIFIED PROBLEMS | ES |
|---|---|---|
| Environmental hygiene | – Ensure sufficient area to increase forest coverage and purposeful planting of greenery ( | – P,R |
| Nature and landscape conservation | – Expansion of buildings in the open countryside and fragmentation of the landscape | – R |
| | – Clashes with ecological corridors | – R |
| | – The creation of conditions for the preservation and expansion of scattered vegetation in the landscape | – P,R |
| | – The creation of erosion control measures | – P,R |
| Agricultural land and land designated for forestry | – Forest protection | – P,R |
| | – Exploit the possibilities of forestation of unused agricultural land | – P,R |
| Recreation | – Unused potential of good natural and cultural assumptions of local landscape | – C |
| | – No need to worry about exceeding the limits of ecological sustainability in the context of tourism development | – C |

Tab. 3 Potential of implementing ES concept in Jesenik district

In land-use strategy prepared for **Krnov commune**, for each obligatory thematic area, SWOT analyze was prepared (Haluza, 2008). After SWOT analyzes main land-use problems areas were identified and described in four following categories: (i) problems in the field of communes spatial development, urban problem, total 56 problems (ii) transport problems, total 12 problems (iii) ecological problems, total 61 problems (iv) water regime problems, total 6 problems. The document is more detailed than the one concerning to Jesenik district, however issues concerning to ES are packed mostly into one problem area namely "ecological problems" (Tab. 4).

| ECOLOGICAL PROBLEMS REVERE TO FOLLOWING ISSUES | ES |
|---|---|
| – Change of local ecological corridors into dysfunctional | – P,R |
| – Continuity of local ecological corridors | – P,R |
| – Minimum width of local ecological corridors | – P,R |
| – Disabled functionality of local biocenters | – P,R |
| – Size and connections of local biocenters | – P,R |

Tab. 4 Potential of implementing ES concept in Krnov commune

Land-use strategy for **Prudnik district** defines eight strategic goals: (i) economic, cross-border cooperation, (ii) arrangement of natural environment - technical infrastructure and system solutions, (iii) tourism - the use of historical, cultural and environmental aspects, (iv) education adapted to the labor market and lifelong learning, (v) activation of food processing and shaping of agricultural restructuring, (vi) improving the quality of life and ensuring the stability and prospects for the local community, (vii) preservation of spatial order and sustainable development, (viii) better efficiency of development planning (Klepacz 2000). From the above listed, strategic goals number two, three, five and seven were selected for further analyze concerning to ES concept (Tab 5).

| STRATEGIC GOAL | DETAILED STRATEGIC GOAL | ES |
|---|---|---|
| Arrangement of natural environment - technical infrastructure and system solutions | – Natural environment inventory of Pradziad Euroregion | – P,R,C |
| | – Improvement of communication infrastructure solutions with attention to natural environment impact | – R |
| | – Adjusting the riverbeds and increase flood safety | – R |
| | – Increase flood safety and protection of water potential by building retention reservoirs | – R |
| | – Protection of meadows melioration and planting crops in mid-field open spaces | – R |
| | – Improving the quality of soil | – R |
| Tourism - the use of historical, cultural and environmental aspects | – Using the landscape potential to build bike routes and touristic paths | – C |
| | – The development of agritourism | – C |
| Activation of food processing and shaping of agricultural restructuring | – Adoption of a comprehensive program concerning to processing of agricultural products | – P |
| Preservation of spatial order and sustainable development | – Economic activation along Osobłoga river | – P,R,C |

Tab. 5 Potential of implementing ES concept in Prudnik district

Land-use strategy for **Nysa district** defines seven strategic goals and eight operational goals: economy, agriculture and rural areas, infrastructure and communication, social infrastructure, culture, natural environment protection, tourism, cross-border and interregional cooperation (Rada Powiatu w Nysie, 2004). In three operational goals detailed proposals concerning to ES were identified (Tab 6).

| OPERATIONAL GOAL | INCLUDED PROPOSALS | ES |
|---|---|---|
| Economy | – Sustainable development of the sub region | – P,R |
| | – Enhancing development of agriculture | – P |
| Natural environment protection | – Increasing the area and protecting forests | – P,R |
| Tourism | – Building infrastructure like: paths, bike and water routes | – C |
| | – Promoting eco-tourism and agro-tourism | – C |
| | – Using the existing nature potential for tourism development | – C |

Tab. 6 Potential of implementing ES concept in Nysa district

## 4 DISCUSSION

“Task Force” group consisting of representatives of following institutions: Czech and Polish Euroregions, the Czech – Polish cooperation managing institutions, national coordinators and other Czech and Polish stakeholders, has selected several Czech – Polish investment priorities. Among those priorities issues concerning to: (i) “protecting, promoting, developing of national cultural and natural heritage” and (ii) ”protecting and restoring biodiversity, soil protection and promoting ecosystem services including NATURA 2000 and green infrastructure” were included (Opolska Fundacja Inicjatyw Międzynarodowych 2013). That fact indicated rising understanding of ES concept and need for more detailed incorporating it into national land-use planning / management regimes.

Two reasons indicates “asymmetries” of the Czech and Polish land-use strategies prepared at NUTS 4 and 5 level. Firstly, land-use strategies are not obligatory documents for Polish districts (NUTS 4). However many of Polish districts decide to prepare such documents. Polish land-use planning system assumes that general land-use decisions are taken firstly at national level and then at voivodeship level. Detailed decisions are described at commune (city) level (NUTS 5). While in Czech land-use planning system it is obligatory to prepare land-use strategies at the level of NUTS 4 / 5. That is the basic reason why Czech documents are more detailed than Polish ones. Secondly, Czech and Polish documents have different structure (Ministerstwo Budownictwa Rzeczypospolitej Polskiej *et al.* 2006). Czech land-use strategies revere obligatory to following thematic analyzes: geological environment and geology, water regime, environmental hygiene, nature and landscape protection, agricultural land and land designated for forestry, public transport and technical infrastructure, socio-demographic conditions, housing, recreation and economic conditions. That makes the structure of Czech documents clearer that structure of Polish documents. It also allows Czech document to be more precise that Polish ones. More detailed Czech land-use strategies, obligatory at NUTTS level 4 / 5, are better tools for incorporating ES concept into land-use management and planning. This fact, together with bigger demand for ES on the Polish side, creates the risk of uneven use of ES in the analyzed region. This indicates the need for better implementing ES idea into Polish land-use management and planning systems at NUTTS 4 level.

Asymmetries of Czech and Polish land-use strategies makes ES idea difficult to implement in cross-border land-use planning and management. However, implementation of most of the selected in this study development problems and development / operational goals influence ecosystems in way they are able to provide different services (Tab. 3, 4, 5, 6). Some of the identified land-use problems and goals concerning to fragmentation of the landscape, forestation and forest protection partially overlap on both sides of the border. In general identified land-use problems / goals revere mostly to provisioning (P) and regulating services (R). Analyzed data is not enough detailed to assess precisely which of those two ES categories are represented more often. Nevertheless, it is more clear where cultural ES (C) are influenced (Tab. 3, 4, 5, 6). That fact show high importance of cultural ES for the analyzed region and for the construction process of the cross-border region (Paasi 2010).

How l-u planning and management documents concerning to different borderland regions can revere to ES concept? This should be implemented in few steps. Firstly by diagnose what kind of asymmetries characterizes certain borderland. Diagnosis should concern to land-cover of the borderland area and land-use legislature. Secondly by identifying where and what kind of ES demands occur in particular area and who has those demands (Ernstson 2013). Thirdly by arranging bilateral discussion about land-use goals (existing and planned) concerning to both countries (Spyra 2014). This discussion should lead to defining bilateral land-use goals taking into account ES. Monetary values of certain ecosystems should be used as arguments during this process. Those bilateral goals should be included in national land-use documents, preferably at NUTS 4/5 level. Other possibility is that agreed land-use goals concerning to ES could be described in bilateral document, sort of cross-border land-use strategy.

Future research needs, concerning to the studied thematic area, refers to several issues. Firstly more detailed diagnosis concerning to land-cover / use should be performed. Calculations could be based on more precise data available at the basis of INSPIRE regulations[4]. Then more detailed outcomes of the diagnosis would allow to analyze detailed land-use plans of selected communes (NUTS 5), located beside the border.

[4] INSPIRE - Infrastructure for Spatial Information in the European Community.

With the help of such results, service connecting areas (SCAs) can be defined and thus, reducing the risk of uneven use of ES in the analyzed region, can be obtained. SCAs should be clearly described in Polish and Czech detailed land-use plans at NUTS 5 level.

## 5 CONCLUSIONS

Continous efforts are needed to better introduce ES concept into land-use stretegies concerning to borderlands. Each cross border landscape and cross-border region can be characterized by certain asymmetry on both sides of the border. The assymetry has to be included as important factor influencing land-use planning and management of the cross-border region. In the discussed case study assymetry of the landscape are indicated by land-cover and demographic issues. Dynamic of spatial supply and demand of ES in connection with SPAs and SBAs of ES co defines asymmetry of the cross-border landscape (Burkhard et al, 2012, Syrbe & Walz, 2012). That issue should be the basis for further consideration of ES potential in land-use planning and management of the studied region. Land-use strategies should describe possible tools for minimizing negative impacts of cross-border landscape asymmetry. Necessary to describe in land-use documents actions should concern to:

- Disproportion of SPAs and SBAs in the analyzed region
- Lack of clearly defined cross-border service connecting areas SCAs (Syrbe and Walz 2012)
- Identifying what kind of ES demands are characteristic for the analyzed region (Ernstson 2013)

Moreover assymetry of the functional region is indicated by differences in land-use legislation. Land-use strategies covering whole cross-border area are needed.

To make the ES concept actionable for the corss-border region and to use it as a part of cross-border region "construction process" it must be open (and understandable) to different stakeholders on both sides of the border. It can not be left only to researchers and politicians (Jax *et al.* 2013).

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## IMAGES SOURCES

Fig. 1: author Spyra M.; Fig. 2:: authors Bartecki M., Cestr M., Horalík D., Michna D., Spyra M.

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# III

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Review

# Indicators of Cultural Ecosystem Services for urban planning: A review

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ABSTRACT

The concept of Ecosystem Services has gained traction on the scientific agenda and has found its way into research on urban environments. Cities and towns, like any other ecosystem, provide specific services to their inhabitants and communities and they are benefited by surrounding ecosystems as well. Among the different categories, typical Ecosystem Services categories such as food production and erosion control usually have a lesser importance within urban contexts. However, the very diverse range of land uses and ecosystems in urban contexts provide specific Cultural Ecosystem Services including recreational, cultural and educational values.

However, to date only limited attention has been given to the provision of Cultural Ecosystem Services (CES), especially considering the relevant benefits that communities and urban planning processes can derive from them. In this document we review existing approaches for the assessment of CES in urban contexts and provide a critical overview of how indicators are used to assess and measure CES. We first conduct a literature review on the indicators used for CES in urban contexts then the paper addresses some specific issues with reference to both operability and benefits of the use of CES indicators for urban planning and management.

Our results show that existing CES indicators have limited usability for urban planning and management. Moreover a lack of appropriate data use is a significant obstacle for proper CES assessment. This impacts the potential for sustainable decision-making concerning CES in urban contexts. These issues, together with fact that most identified indicators are proxy ones, identify an urgent need to develop proper assessment indicators for CES.



**Contents**



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## 1. Introduction

The concept of Ecosystem Services (ES) has gained traction on the scientific agenda and has found its way into research on urban environments. Cities and towns, like any other complex ecosystem, provide specific services to their inhabitants and communities (Bolund and Hunhammar, 1999; Gómez-baggethun and Barton, 2013; Haase et al., 2014) and they are benefited by surrounding ecosystems as well. In urban contexts, a diverse range of land uses and ecosystems provide different services including air filtration (gas regulation), micro-climate regulation, noise reduction (disturbance regulation), rainwater drainage (water regulation), sewage treatment (waste treatment), and recreational, cultural and educational values. Other services such as food production and erosion control usually have a lesser importance within urban boundaries, but may become relevant when looking at more extended contexts (i.e. metropolitan or regional areas), especially under the eventual pressures that climate change might exert on urbanised areas.

To date limited attention has been given to Cultural Ecosystem Service (CES) among different categories of ES, especially considering the relevant benefits that communities and urban planning processes can derive from them (Hernández-Morcillo et al., 2013; Tengberg et al., 2012). Widely accepted and used definitions of CES are provided by MEA (2005) or TEEB (2011) and define CES as non-material and/or socio-ecological benefits people obtain from a contact with ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences. CES are directly experienced and appreciated by people through ecosystems, thus, unlike other services, CES cannot be replaced if degraded (MEA, 2005; Plieninger et al., 2013).

In a recent review, Milcu et al. (2013) highlighted five clusters of research regarding CES, dealing with general conceptualisations, case studies coming from different disciplines, social and participatory approaches, descriptive reviews and economic assessments. Even if CES can act to bridge gaps between different research areas (Milcu et al., 2013; Hernández-Morcillo et al., 2013) studies on CES still do not have an effect on decision-making processes and especially on planning (Gómez-baggethun and Barton, 2013; Steiner, 2014).

Assessing the benefits of cultural services is a complex and sometimes even controversial issue, as CES need multidisciplinary outcomes from several disciplines such as ecology, economics and social sciences (Milcu et al., 2013). The diversity of approaches to CES can indicate a wide interest on the topic and dynamism in the applied research but, at the same time, might also be related to a lack of solid common terminology and understanding.

There are several features of CES that make their assessment different to assessment of other ES. Firstly, the general dependence of CES to an individual's value systems makes their assessments less quantitative than other services (i.e. provisioning services) that can be quantified independently from the presence of humans (Nahuelhual et al., 2014). Another important issue is the difficult use of spatial geographical units for CES assessment (Abson and Termansen, 2011; Burkhard et al., 2012). The use of spatial units is often absent, is rather general (Norton et al., 2012; Klain and Chan, 2012) or is characterised by continental/country mapping exercises (Maes et al., 2012; Paracchini et al., 2014). Furthermore, when it comes to measurements and operationalisation of CES through specific indicators, there is also lack of conceptual clarity. An explicitly spatial-based assessment of CES thus presents many challenges and studies have mainly focused on mapping benefits rather than on CES provision itself (Milcu et al., 2013). All these issues can be a good starting point to improve current assessments of CES towards their inclusion in urban planning.

The economic concept of cultural capital has recently taken shape for assessing cultural services (Throsby, 2001; Cheng, 2006; Bucci and Segre, 2011). This is an effort to recognise the distinctive features of certain cultural goods as capital assets and thus to capture the ways in which cultural assets contribute to the production of further cultural goods and services, job creation and wellbeing of local communities (Licciardi and Amirtahmasebi, 2012). This economic assessment of CES has found robust theoretical development in urban economics, where the use of hedonic models has developed strongly during recent decades, with a tremendous number of applications and calculations, many of them suitable in principle for their use in the assessment of CES (e.g. Colombo et al., 2014; Sander and Haight, 2012).

However, due to the problems inherent in monetary evaluations and to avoid reductionism, many authors have adopted non-economic approaches such as the relationship between a specific cultural service and its user, including personal culture, experiences and preferences (Klain and Chan, 2012; Gee and Burkhard, 2010; Kumar and Kumar, 2008). Examples of these approaches include mapping of personal preferences (Klain and Chan, 2012; Sherrouse et al., 2014; Sherrouse and Semmens, 2014), photo-based (Sherren et al., 2010) or survey based methods (Plieninger et al., 2013; Bieling and Plieninger, 2013; Bieling et al., 2014).

As noted by Bossel (1999) "indicators represent valuable information" and are also an expression of different values. Even if some ambiguity and plural meanings are still present in the term "indicators" (Heink and Kowarik, 2010), their use in ES research has recently increased (Müller and Burkhard, 2012; Hernández-Morcillo et al., 2013). As suggested by Heink and Kowarik (2010), an all-encompassing definition of indicators in environmental science can be: "An indicator in ecology and environmental planning is a component or a measure of environmentally relevant phenomena used to depict or evaluate environmental conditions or changes or to set environmental goals" as put forward by the OECD (2003).

For CES, a recent study by Feld et al. (2009) showed that even taking into consideration all indicators used for other ES assessments, only 6% referred to CES categories. Similar results can be obtained from the Ecosystem Service Indicators Database, created by the World Resource Institute, where no indicators are reported both for the "cultural" ecosystem service type and "urban" ecosystems (ESID, 2012).

In urban systems, research about CES is even more poorly developed and its real applicability in planning is still a promise (Haase et al., 2014). This is due to two main reasons. First, mismatches between areas providing services and areas benefiting from services should be highlighted in the context of urbanised territories. ES flow from production sites to sites where they are consumed (Costanza, 2008) and this makes CES assessments and evaluation difficult (Maes et al., 2012). Moreover, in urban systems the concentration of beneficiaries of ES is usually high and might result in frequent and difficult to interpret overlaps between the spatial extent of research and the spatial scale of its applications.

**Table 1**
Keywords for the search in the academic databases.

| Searched terms |
|---|
| Q1: "ecosystem services" and "indicators" |
| Q2: "cultural ecosystem services" |
| Q3: "cultural ecosystem services" and "indicators" |
| Q4: "**cultural ecosystem services" and "indicators" and "urban"** |

However the situation changes when we refer to particular CES, such as those provided by monuments, architecture and other cultural items that are naturally concentrated in cities, and thus currently addressed in standard urban planning. Thus, the second of our reasons is that urban ecosystems are characterised by high complexity, requiring careful selection of research methods, approaches and indicators. Complexity in urban systems is indicated by many different aspects, such as the large number of different land-cover types and their high degree of spatial mixing. This makes CES assessment based on land-use information particularly challenging and it requires data with an appropriately high resolution that is not always available.

Finding a proper way to assess and measure CES can provide essential insights for urban planning, especially for specific urban contexts where culture, history, location and other related features play a central role for social identity, local heritage and cohesion.

In this document we review existing indicators for the assessment of Cultural Ecosystem Services in urban contexts and provide a critical overview of how indicators can be used for urban planning purposes. We first conduct a literature review on the indicators used for CES in urban contexts and then address some specific issues with reference to both operability and benefits of the use of CES indicators for urban planning and management. The central research questions read as follows:

- What kind of indicators are currently used for CES in urban contexts?
- Which particular issues aspects are discussed in current research concerning CES?
- What are the conceptual shortcomings concerning current CES assessments?
- Which are the most suitable measurement methods and calculation units for CES indicators in urban areas?
- How and at which extent the results of CES indicators can inform urban planning and management of urban systems?
- Are there some indicators more relevant and effective for urban planning?

The paper is structured as follow. In Section 2 we present results of the queries made in academic databases about the ongoing research on CES topics. Section 3 shows the results of the queries, highlighting some key issues about the use of CES in urban systems. In Section 4 we discuss the main findings of the review, addressing the above listed research questions and especially focusing on the use of CES for planning in urban contexts. Section 5 summarises the main conclusions of the work.

## 2. Method

Scopus (http://scopus.com) and all ISI Web of Knowledge (WoK) databases (https://webofknowledge.com) were used to perform a search for peer-reviewed papers or book chapters on Cultural Ecosystem Services in urban contexts. In order to understand the amount of ongoing research, different terms and combinations have been used, as shown in Table 1. The results obtained from the two databases were selected and merged to define a unique set of papers.

We decided to merge results from Scopus and WoK queries Q2 and Q3 in order to have a broader set of examples of CES that could have been evaluated. We then verified the relevance of these records by checking article titles, keywords and abstracts, ending up with a set of articles that specifically dealt with indicators for CES. We then analysed these papers to understand whether these studies contained examples of the use of indicators for CES.

As previously stated, the aim of the review was to obtain a refined list of CES indicators suitable for being used in urban planning. To assess the papers we used a system of double evaluation based on two sets of criteria.

In the first evaluation we first provide a general characterisation of the selected papers with relative indicators according to the following descriptive attributes:

- *Categories of CES evaluated*: categories of specific CES addressed by the paper (Aesthetic values, Sense of place, Recreation/amenity, Ecoturism, Inspirational values, Spiritual–religious value, Heritage, Educational values) are listed. We assigned a numeric code to every paper and to every CES category addressed;
- *Indicator(s)*: indicator(s) used in the paper. We assigned a reference code as a combination of the paper's number and the indicator's number;
- *Assessment method*: what kind of method was performed in the paper to evaluate the CES;
- *Measurement unit and calculation resolution*: the diverse kind of units (i.e. $, Hectares, etc.) and the minimum spatial unit used for the calculation of indicators;
- *Data and information used*: base spatial data or other information used in the assessment and calculations;
- *Geographical location*: the specific location and extension of the study area;
- *Spatial indicator(s)*: presence or not of spatially explicit indicators.

Each paper was reviewed according to the above-mentioned attributes. From the initial set, we selected those papers whose indicators might be used in urban contexts for planning purposes. Papers were considered pertinent if they used indicators that were spatially explicit.

Such papers were then used for the second further evaluation aimed at understanding the possible use of the indicators to inform planning processes in urban contexts. This second evaluation was based on an inclusive combination of two criteria: "**communicability**" and "**relevance of the urban context**" within the case studies presented in the papers.

"**Communicability**" was understood as the ability to transfer the results from indicators to policymaking. The following sub-criteria were used: (i) use of clear, theoretical framework for CES assessment, (ii) presence of the spatially explicit results of the study area (i.e. maps, tables, charts, etc.), (iii) reproducibility of the assessment method. Indicators used in the papers were considered to be communicable if all of the above sub-criteria were present.

We checked the "**relevance of the urban context**" for the use of indicators by evaluating the predominance of the urban context within the study area. We evaluated the relevance of the urban context using a qualitative scale of three grades A–C: (A) null or low relevance – in this case the study did not contain urban areas or they were insignificant such as the case of Grand County Colorado which has a population of only 11,000 inhabitants (Brown et al., 2012); (B) medium relevance: urban areas were more prevalent but not predominant, like in the case of Flanders in Belgium which is an area with significant levels of urbanisation but also has vast rural areas (Broekx et al., 2013); (C) high relevance: urban areas were predominant within the study area, like in the case of specific case study of cities like Tamar river estuary (Davis and Kidd, 2012) or the four cities in Florida (Escobedo et al., 2014).

**Table 2**
Combination of values of criteria of "communicability" and "relevance to urban context".

| Communicability | Relevance of urban contexts | Possibility of use in urban planning |
|---|---|---|
| Y | A | It can be used with **major** adjustments |
| Y | B | It can be used with **minor** adjustments |
| Y | C | It can be used **as it is** |
| N | A | It can be used with **major** adjustments |
| N | B | It can be used with **major** adjustments |
| N | C | It can be used with **minor** adjustments |

The combinations of the two criteria provided a qualitative evaluation of the possible use of the indicators for planning purposes in urban contexts. Those indicators fulfilling "communicability" sub-criteria and implemented in an area that has high relevance of urban context (C) were considered usable. Indicators fulfilling "communicability" sub-criteria, but implemented in an area that has a medium relevance of urban contexts (B) and indicators not fulfilling "communicability" sub-criteria and implemented in an area that has high relevance of urban contexts (C) are considered to be used with some minor adjustments (i.e. re-scaling, spatialising indicators or use of the same data in a more urban context). In all other possibilities, indicators might be used but with major adjustment (i.e. modification in calculation methods and/or type of data used). All these combination are summarised in Table 2.

Results from the literature review were analysed with VOSviewer, a freeware for creating, visualising, and exploring bibliometric maps of science (http://www.vosviewer.com/). The program uses a text mining and clustering functions to analyse co-occurrence of particular terms or data from citations (van Eck and Waltman, 2010). The software integrates a visualisation environment able to produce maps of analysed terms' occurrence. In our case we use as input to run the software the title, keywords and abstracts of papers obtained from queries Q2 and Q3.

Fig. 1 shows a graphical representation of the adopted approach for the review.

**Table 3**
Results from queries to SCOPUS and ISI Web of Knowledge (periods: all time).

| Searched terms | Occurrences | |
|---|---|---|
| | Scopus | ISI WoK |
| Q1: "ecosystem services" and "indicators" | 716 | 798 |
| Q2: "cultural ecosystem services" | 60 | 42 |
| Q3: "cultural ecosystem services" and "indicators" | 11 | 8 |
| Q4: **"cultural ecosystem services" and "indicators" and "urban"** | **1** | **0** |

## 3. Results

The results obtained from the SCOPUS and ISI WoK database in terms of resulted number of papers are reported in Table 3.

The combination of terms used in the search query highly affected the number of occurrences obtained (Table 3). Furthermore, the use of different and more specific terms in the queries allowed to better highlight the differences in the amount of researches about the topic. First, results from queries showed a limited set of papers dealing explicitly with CES (60 for Scopus, 42 for Wok) out of the total literature about ES and Indicators (716 for Scopus, 798 of WoK). Combining the terms "cultural ecosystem services" and "indicators" narrowed the results down further (11 for Scopus, 8 for WoK); and returned one solitary result when adding the term "urban" as a further attribute (1 for Scopus, 0 for WoK). These results clearly indicate how the real application of indicators for Cultural Ecosystem Services in urban contexts is still unexplored, even if urban contexts are places with a high density of CES.

Since 1 only occurrence resulted from the Q4 query, we used the a set of papers from merging occurrences from queries Q2 and Q3 in both Scopus and WoK (Annex 1). Those papers have been analysed according to the two evaluations presented in the Method.

Results from the analysis with VOSviewer software are reported in a map of the co-occurrence terms (Fig. 2). This map shows the most relevant of the analysed set of 2078 terms according to a "relevant score" calculated by VOSviewer. In the figure, each of the 53 most relevant terms is mapped with a circle, where the diameter of the circle and size of the relative label represent the frequency of the term, its proximity to another term indicates the degree of relatedness of the two terms and its colour represents the cluster to which it belongs. The term analysis showed as "indicator" (10

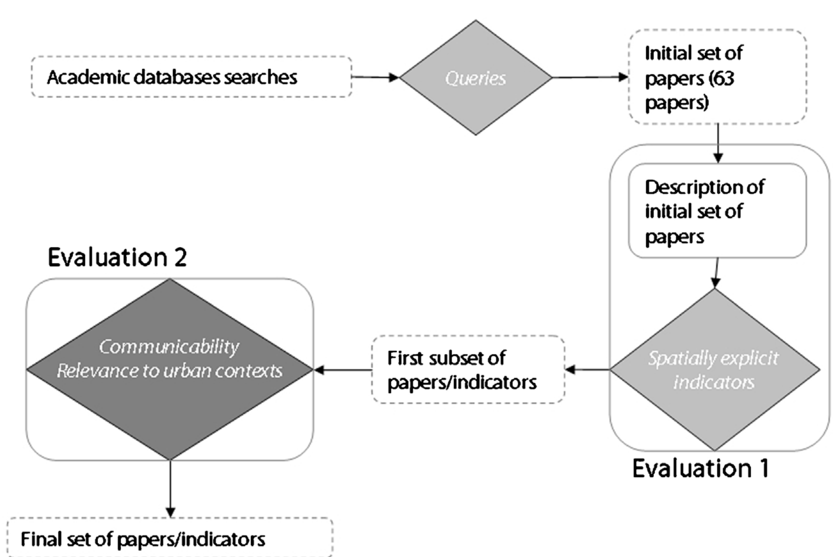


**Fig. 1.** Graphical outline of the adopted approach for the review.

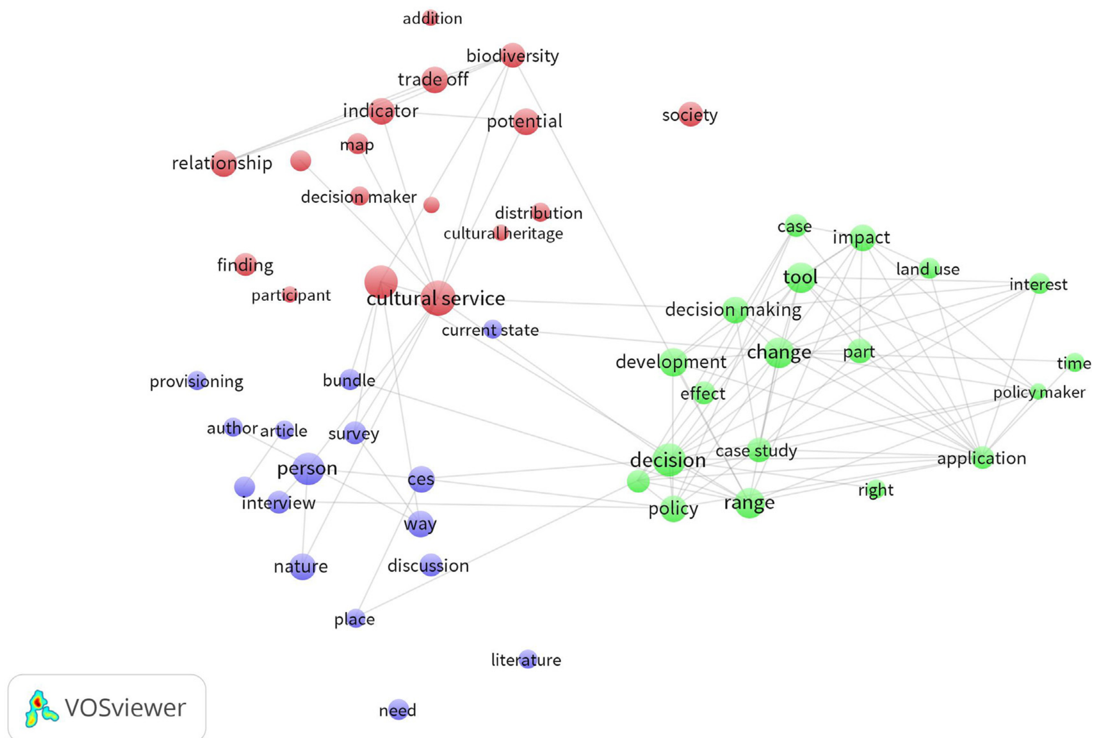


**Fig. 2.** Results from the analysis of VOSviewer software.

occurrences) was not the most frequent or relevant term and other keyword of our review such as "planning" or "urban" were absent.

### 3.1. First evaluation of papers

Table 4 shows the papers and their descriptive attributes after the first set evaluation was applied. An extended version of Table 4, with all the descriptive attributes introduced in the Method section can be found in the appendix (Annex 1).

#### 3.1.1. Categories of CES

Most frequently evaluated category of CES was "recreational and ecotourism", which was referred to 29 times. Within this category, other terms such as "forest recreation" (Raudsepp-Hearne et al., 2010), "recreational fisheries" (Van Poorten et al., 2011), "freshwater recreational fishing" (Villamagna et al., 2014) or related categories like "leisure-activities" (Norton et al., 2012) are included. The second most referred to CES category (22 references) is "aesthetic values" services, sometimes specifically named "landscape aesthetic" (Brandt et al., 2014; Frank et al., 2014) and "scenic quality" (Sander and Haight, 2012).

Other CES categories referring to MEA framework (2005) are reported in Table 5.

Some of the CES categories are described in very general way as "social values" (Sherrouse et al., 2014), "constituents of wellbeing" (Russell et al., 2013), "public goods" (Swallow, 2013) or "contribution of peri-urban woodlands to wellbeing" (O'Brien et al., 2014).

#### 3.1.2. Assessment methods of CES

The papers we analysed used different assessment methods. Almost a third – 21 out of 63 studies (33%) – were based on interviews with different stakeholders. This has been the most common approach. Delphi method (Nahuelhual et al., 2013) and hedonic models (Escobedo et al., 2014; Sander and Haight, 2012) were also used. Other methods included foresight assessments like "scenario simulation" (Frank et al., 2014) and stakeholder workshops (Fletcher et al., 2014), GIS based mapping (e.g. Raudsepp-Hearne et al., 2010), participatory mapping (Van Berkel and Verburg, 2014), field observations, expert-based scoring (Moore and Hunt, 2012), Lindahl framework (Swallow, 2013) and narratives (O'Brien et al., 2014). Most of these assessment methods were GIS-based, including GIS tools developed appositely for the purpose (Plieninger et al., 2012; Sherrouse et al., 2014; Sherrouse and Semmens, 2014) and web applications (Liekens et al., 2013).

#### 3.1.3. Type of data

Type of data used in the papers had diverse sources and nature, according to assessment method used. As stated above, 33% of the analysed manuscripts used data obtained directly from interviews. Methods based on interviews were: online, phone-based and face-to-face surveys. Some were described as "semi-structured cultural scoping interviews" (Fletcher et al., 2014). Some other surveys were based on different images or photographs (Casalegno et al., 2013; Frank et al., 2013). Thirteen papers (21%) used spatial data about land use/land cover like Corine Land Cover (e.g. Burkhard et al., 2012; Maes et al., 2012; Paracchini et al., 2014).

Some studies used detailed data available from different local public and private institutions (e.g. Ripoll-Bosch et al., 2013; Sander and Haight, 2012), site-specific publications and reports (e.g. Ripoll-Bosch et al., 2013), or historical photos and maps (e.g. Davis and Kidd, 2012).

#### 3.1.4. Geographic location and spatial extent

Most of the papers (46) presented case studies located in the Americas, 15 papers were located in Europe, 1 in Australia and 1 in Africa. One manuscript discussed two case studies, one located in Europe and one in Africa (Tengberg et al., 2012).

In most cases, papers dealt with very large geographical areas (e.g. Paracchini et al., 2014). Other papers focused on a particular geographical location, such as the coastline (Fletcher et al., 2014; Klain and Chan, 2012). It is worth mentioning that 17 papers (27%)

**Table 4**
Categories of CES and used for the indicators in the 63 reviewed papers.

| Paper no. | Source | Categories of CES evaluated | Indicator (s) | Spatial indicator/pertinence |
|---|---|---|---|---|
| 1 | Abson and Termansen (2011) | Essay | N | N |
| 2 | Barrena et al. (2014) | Agricultural heritage | 2.1. Willingness to pay | N |
| 3 | Bieling et al. (2014) | 1. Aesthetic values<br>2. Sense of place<br>3. Recreation and ecotourism<br>4. Inspirational values<br>5. Spiritual–religious values<br>6. Educational values | – | N |
| 4 | Bieling et al. (2014) | 1. Identity<br>2. Heritage<br>3. Spiritual–religious values<br>4. Inspiration<br>5. Aesthetic<br>6. Recreation | – | N |
| 5 | Bieling and Plieninger (2013) | 1. Identity<br>2. Heritage<br>3. Spiritual services<br>4. Aesthetic services<br>5. Recreation | 5.1. Benche<br>5.2. Hiking trails and signs<br>5.3. Recreational facilities<br>5.4. Subsistence gardens<br>5.5. Hunting facilities<br>5.6. Memorials, commemorations, historical sites | Y |
| 6 | Brancalion et al. (2014) | 1. Aesthetic values<br>2. Recreation and tourism values<br>3. Religious and psychological values<br>4. Educational values knowledge generation | – | N |
| 7 | Brandt et al. (2014) | 1. Aesthetic values<br>2. Recreational and ecotourism | 7.1. Landscape aesthetics proxy<br>7.2 Park visitation | Y |
| 8 | Broekx et al. (2013) | 1. Recreation, amenity,<br>2. Education<br>Bequest values | 8.1. Willingness to pay (WTP) | N |
| 9 | Brown et al. (2012) | 1. Recreation<br>2. Aesthetic<br>3. Social interaction<br>4. Science<br>5. Spiritual<br>Cultural | 9.1. Frequency distribution of Ecosystem Services | N |
| 10 | Burkhard and Gee (2012) | 1. Visual aesthetics<br>2. Seascape character<br>3. Sense of place<br>4. Cultural heritage<br>5. Habitat and species value<br>6. Regional image Inspiration<br>7. Informal education<br>8. Knowledge systems<br>9. Recreation | – | N |
| 11 | Burkhard et al. (2012) | 1. Recreation and tourism<br>2. Landscape aesthetics and inspiration<br>3. Knowledge systems<br>4. Religious and spiritual experience<br>5. Cultural heritage and cultural diversity<br>6. Natural heritage and natural diversity | – | N |
| 12 | Casalegno et al. (2013) | Aesthetic value | 12.1. Density of photographs | Y |
| 13 | Chan et al. (2012) | Review paper | – | N |
| 14 | Daniel et al. (2012) | 1. Landscape aesthetics,<br>2. Cultural heritage,<br>3. Outdoor recreation,<br>4. Spiritual significance | – | N |
| 15 | Davis and Kidd (2012) | 1. Recreational values<br>1. Aesthetic amenity (only mentioned, not measured) | – | N |
| 16 | Dominati et al. (2010) | Cultural services in general | – | N |
| 17 | Egoh et al. (2007) | Cultural services in general | – | N |
| 18 | Escobedo et al. (2014) | Cultural services in general | 18.1. Property value | N |
| 19 | Fletcher et al. (2014) | 1. Aesthetic information,<br>2. Recreation,<br>3. Inspiration for art and design,<br>4. Cultural heritage | 19.1. Frequency of terms | N |

Table 4 (*Continued* )

| Paper no. | Source | Categories of CES evaluated | Indicator (s) | Spatial indicator/pertinence |
|---|---|---|---|---|
| 20 | Frank et al. (2013) | Landscape aesthetics | 20.1. Shannon's Diversity Index (SHDI),<br>20.2. Shape Index (SHAPE)<br>20.3. Patch Density (PD) | Y |
| 21 | Frank et al. (2014) | Landscape aesthetics | 21.1. Shannon's Diversity Index (SHDI),<br>21.2. Shape Index (SHAPE)<br>21.2. Patch Density (PD) | Y |
| 22 | Gee and Burkhard (2010) | Cultural services in general | – | N |
| 23 | Hernández-Morcillo et al. (2013) | Review paper | – | N |
| 24 | Iverson et al. (2014) | Editorial | – | N |
| 25 | Jakubowski et al. (2010) | – | 25.1. Annual dry matter production | N |
| 26 | Kimmel and Mander (2010) | – | – | N |
| 27 | Kirchhoff (2012) | Letter | – | N |
| 28 | Klain and Chan (2012) | 1. Natural beauty<br>2. Cultural heritage site<br>3. Recreation<br>4. Unique natural feature<br>5. Ceremonial site<br>6. Stewardship activities<br>7. Scientific study site<br>8. Spiritual-inspiration<br>9. Education<br>10. Peace<br>11. Sense of place-home<br>12. Transformational<br>13. Intergenerational<br>14. Community identity<br>15. Existence | 28.1. Proxy of value of some ecosystem services<br>28.2. Proxy of threats to some ecosystem services | Y |
| 29 | Krasny et al. (2014) | – | – | N |
| 30 | Liekens et al. (2013) | 1. Recreation<br>2. Amenity<br>3. Nonuse value | 30.1. Willingness to pay | N |
| 31 | Lundy and Wade (2011) | 1. Spiritual value<br>2. Educational value<br>3. Aesthetics<br>4. Recreation | – | N |
| 32 | Maes et al. (2012) | Opportunities for recreation and tourism | 32.1. Recreation potential | Y |
| 33 | Mangi (2013) | Some CES cited together with data needed for their assessment | – | N |
| 34 | Milcu et al. (2013) | Review paper | – | N |
| 35 | Moleón et al. (2014) | – | – | N |
| 36 | Moore and Hunt (2012) | 1. Recreation (public accessibility, physical accessibility, and recreation infrastructure)<br>2. Education (proximity to schools or other educational centres, history of use for educational purposes, and the presence of educational infrastructure) | 36.1. Score criteria for the used categories of CES | N |
| 37 | Nahuelhual et al. (2014) | 1. Heritage value associated to Chiloé native potato as a culturally significant species;<br>2. Systems of knowledge;<br>3. Relations (or social networks) established in the agri-cultural society of Chiloé Island | 37.1. Agriculture Heritage (AH) as s spatial proxy of different dimensions that are spatialised with kernel density estimation | Y |
| 38 | Nahuelhual et al. (2013) | 1. Recreation<br>2. Tourism | 38.1. Recreation<br>38.2. EcoTourism | Y |
| 39 | Norton et al. (2012) | 1. History<br>2. Place<br>3. Inspiration<br>4. Calm<br>5. Leisure-Activities<br>6. Spiritual<br>7. Learning<br>8. Escape | 39.1. Cultural score (combination of LULC features with more qualitative landscape feature) | Y |
| 40 | O'Brien et al. (2014) | Contribution of per-urban woodlands to well being | – | N |
| 41 | Olschewski et al. (2010) | – | – | N |

Table 4 (*Continued* )

| Paper no. | Source | Categories of CES evaluated | Indicator (s) | Spatial indicator/pertinence |
|---|---|---|---|---|
| 42 | Paracchini et al. (2014) | Outdoor recreation | 42.1. Outdoor recreation | Y |
| 43 | Pleasant et al. (2014) | All according to MEA framework | – | N |
| 44 | Plieninger et al. (2013) | 1. Spiritual services<br>2. Educational values<br>3. Inspiration<br>4. Aesthetic values<br>5. Social relations<br>6. Sense of place<br>7. Cultural heritage values<br>8. Recreation and ecotourism<br>Disservices:<br>1. Unpleasantness<br>2. Scariness<br>3. Noisiness | 44.1. One indicator question per CES | Y |
| 45 | Plieninger et al. (2012) | 1. Aesthetics<br>2. Cultural heritage<br>3. Recreation<br>4. Sense of place<br>5. Spiritual | 45.1. CES as motivators for owning land | N |
| 46 | Raudsepp-Hearne et al. (2010) | 1. Deer hunting<br>2. Tourism<br>3. Nature appreciation<br>4. Summer cottages<br>5. Forest recreation | 46.1. Deer kills<br>46.2. Tourist attractions<br>46.3. Rare species<br>46.4. Tax value of cottages<br>46.5. Forested land | Y |
| 47 | Ripoll-Bosch et al. (2013) | In general CES | 47.1. Value of CES | Y |
| 48 | Ruiz-Frau et al. (2013) | Recreation services | 48.1. The average spent per person per day for each of the following activities: recreational scuba-divers, sea-kayakers, customers of wildlife viewing boat trips and seabird watchers | Y |
| 49 | Russell et al. (2013) | 10 constituents of well-being (connections between nature and human well-being): | – | N |
| 50 | Sander and Haight (2012) | (i) outdoor recreation,<br>(ii) scenic quality and tree cover<br>Used as a “mix” providing a series of cultural, supporting, regulating, and provisioning services, | (Variables)<br>50.1. Mean percent tree cover on the home’s parcel [%],<br>50.2. Mean percent tree cover in neighbourhood<br>Land cover measured in home’s viewshed:<br>50.3. Impervious land cover<br>50.4. Lawn<br>Area of short grass (lawn)<br>50.5. Area of maintained tall grassland cover<br>50.6. Area of forest<br>50.7. Area of shrub<br>50.8. Area of unmaintained grassland<br>50.9. Area of emergent vegetation<br>50.10. Area of open water<br>50.11. Area of woody wetland<br>50.12. Area of agricultural land | Y |
| 51 | Satz et al. (2013) | Perspective essay | – | N |
| 52 | Sherrouse and Semmens (2014) | 1. Aesthetic, recreation | 52.1. Social-value indicator | Y |
| 53 | Sherrouse et al. (2014) | Social values:<br>1. Aesthetic,<br>2. Biodiversity,<br>3. Cultural,<br>4. Economic,<br>5. Future,<br>6. Historic,<br>7. Intrinsic,<br>8. Learning,<br>9. Life sustaining,<br>10. Recreation,<br>11. Spiritual,<br>12. Subsistence,<br>13. Therapeutic | 53.1. Social-value indicator | Y |
| 54 | Swallow (2013) | Public goods | – | N |
| 55 | Tarolli et al. (2014) | Not specified | – | N |

Table 4 (*Continued* )

| Paper no. | Source | Categories of CES evaluated | Indicator (s) | Spatial indicator/pertinence |
|---|---|---|---|---|
| 56 | Tengberg et al. (2012) | 1. Heritage values<br>Identity | – | N |
| 57 | Turner (2012) | Briefing note | – | N |
| 58 | Urquhart and Acott (2014) | Sense of place | – | N |
| 59 | Van Berkel and Verburg (2014) | 1. Recreation,<br>2. Aesthetic<br>3. Beauty,<br>4. Cultural heritage,<br>5. Inspiration,<br>6. Spirituality | 59.1. Respondents' willingness to pay (WTP) for landscape maintenance,<br>59.2. Travel time-cost estimate | Y |
| 60 | Van Poorten et al. (2011) | Recreational fisheries | – | N |
| 61 | Villamagna et al. (2014) | Freshwater recreational fishing (key benefits: relaxation, communication with nature, spiritual renewal, social bonding) | Biophysical capacity<br>61.1. Surface water availability<br>61.2. Game-fish species richness<br>61.3. Water quality<br>61.4. Forested riparian areas<br>61.5. Boating access sites<br>Social capacity<br>61.6. Publicly accessible areas<br>61.7. Fishing spots<br>61.8. Fish stocking<br>Demand<br>61.9. Fishing licenses<br>Ecological pressure<br>61.10. Licensed anglers within 16.09 km of fishable waterbody | Y |
| 62 | Von Heland and Folke (2014) | Not specified | – | N |
| 63 | Weyland and Laterra (2014) | Recreation potential (such as: angling, hiking, trekking, cycling, horse-back riding and bird-watching) | 63.1. Campsite density as independent variable explained by landscape metrics (variables):<br>mean annual temperature, annual thermal amplitude, roughness, coastline density, Normalised Difference Vegetation Index (NDVI), Standard Deviation in NDVI (NDVI SD), tree cover, bare soil cover, crop area | Y |

were review papers, did not have a precise geographical context or study area or dealt with issues that were not spatial.

The papers analysed referred to different spatial extents. Thirty-five studies (56%) referred to regional case studies and seven (11%) referred to national or international case studies. Remaining 33% of the case studies did not have a precise geographical context. Most of the case studies dealt non-urban ecosystems like marine/coastal areas (Klain and Chan, 2012; Pleasant et al., 2014; Ruiz-Frau et al., 2013), inland waters (Lundy and Wade, 2011; Ripoll-Bosch et al., 2013) and forests (Sherrouse et al., 2014). As noted by MEA (2005) boundary limits for mapping of urban ecosystems are limited to "known human settlements with a population of 5000 or more, with boundaries delineated by observing persistent night-time lights or by inferring areal extent in the cases where such observations are absent". None of the case studies, as a whole, can be characterised as "urban ecosystems". More detailed assessment of the relevance of the urban context is provided in Table 6.

### 3.2. *Second evaluation of papers*

#### 3.2.1. *Presence of spatial indicators and their pertinence for urban planning*

As showed by the last column of Table 4, indicators were used in only 30 papers (48%). Of these papers, 21 manuscripts (33%) used spatial indicators and 58 different indicators were identified. These papers are reported in Table 6, together with the results of the second evaluation which was based on the criteria of "communicability" and "relevance of the urban context". Furthermore, Fig. 3 summarises the number of indicators with respect to their relevance to urban contexts.

Eighty-nine percent of the indicators included in Table 6 fulfilled the "communicability" criterion described in the Method. 66% pre-

**Table 5**
Categories of CES and relative number of papers.

| Categories of CES | # of papers referred | Other terms used |
|---|---|---|
| Recreational and ecotourism | 29 | – |
| Aesthetic values | 22 | – |
| Spiritual and religious values | 14 | "Spiritual significance" (Daniel et al., 2012), "Spiritual-inspiration" (Klain and Chan, 2012), "Spiritual value" (Lundy and Wade, 2011), |
| Cultural heritage | 12 | "Natural heritage" (Burkhard et al., 2012) |
| Educational values | 9 | "Informal education" (Burkhard and Gee, 2012), "social value learning" (Sherrouse et al., 2014) |
| Inspiration | 8 | – |
| Sense of place | 6 | – |
| Cultural diversity | 5 | "Cultural" (Brown et al., 2012, Sherrouse et al., 2014.), "Cultural services" (Dominati et al., 2010; Egoh et al., 2007; Escobedo et al., 2014) |
| Knowledge systems | 4 | "Knowledge generation" (Brancalion et al., 2014) |
| Social relations | 3 | "Social interaction" (Brown et al., 2012), "relations (or social networks)" (Nahuelhual et al., 2014) |

**Table 6**
Criteria for the usability of the indicators for urban planning.

| No | Source | Indicator(s) | Relevance of the urban context | Communicability | Possibility for using in urban planning |
|---|---|---|---|---|---|
| 5 | Bieling and Plieninger (2013) | 5.1. | A (Natural landscape context) | Y | Y, major adjustments |
| | | 5.2. | A (Natural landscape context) | Y | Y, major adjustments |
| | | 5.3. | A (Natural landscape context) | Y | Y, major adjustments |
| | | 5.4. | A (Natural landscape context) | Y | Y, major adjustments |
| | | 5.5. | A (Natural landscape context) | Y | Y, major adjustments |
| | | 5.6. | A (Natural landscape context) | Y | Y, major adjustments |
| 7 | Brandt et al. (2014) | 7.1 | B (urban context limited) | Y | Y, minor adjustment |
| | | 7.2 | B (urban context limited) | Y | Y, minor adjustment |
| 12 | Casalegno et al. (2013) | 12.1 | B (urban context limited) | Y | Y, minor adjustment |
| 20 | Frank et al. (2013) | 20.1. | A (Natural landscape context) | N | Y, major adjustment |
| | | 20.2. | A (Natural landscape context) | N | Y, major adjustment |
| | | 20.3. | A (Natural landscape context) | N | Y, major adjustment |
| 21 | Frank et al. (2014) | 21.1. | A (Natural landscape context) | N | Y, major adjustment |
| | | 21.2. | A (Natural landscape context) | N | Y, major adjustment |
| | | 21.3. | A (Natural landscape context) | N | Y, major adjustment |
| 28 | Klain and Chan (2012) | 28.1. | B (urban context limited) | Y | Y, minor adjustment |
| | | 28.2. | B (urban context limited) | Y | Y, minor adjustment |
| 32 | Maes et al. (2012) | 32.1. | A (European scale) | Y | Y, major adjustment |
| 37 | Nahuelhual et al. (2014) | 37.1. | B (Regional scale) | Y | Y, minor adjustment |
| 38 | Nahuelhual et al. (2013) | 38.1. | B (Regional scale) | Y | Y, minor adjustment |
| | | 38.2. | B (Regional scale) | Y | Y, minor adjustment |
| 39 | Norton et al. (2012) | 39.1. | A (Regional scale) | Y | Y, major adjustment |
| 42 | Paracchini et al. (2014) | 42.1. | A (Regional scale) | Y | Y, major adjustment |
| 44 | Plieninger et al. (2013) | 44.1. | A (Natural landscape context) | Y | Y, major adjustments |
| 46 | Raudsepp-Hearne et al. (2010) | 46.1 | A (different specificity of indicator) | Y | Y, major adjustments |
| | | 46.2 | B (National scale) | Y | Y, minor adjustment |
| | | 46.3 | B (National scale) | Y | Y, minor adjustment |
| | | 46.4 | B (National scale) | Y | Y, minor adjustment |
| | | 46.5 | B (National scale) | Y | Y, minor adjustment |
| 47 | Ripoll-Bosch et al. (2013) | 47.1. | A (natural landscape context) | Y | Y, major adjustments |
| 48 | Ruiz-Frau et al. (2013) | 48.1. | A (natural landscape context) | Y | Y, major adjustments |
| 50 | Sander and Haight (2012) | 50.1. | B (county scale) | Y | Y, minor adjustment |
| | | 50.2. | B (county scale) | Y | Y, minor adjustment |
| | | 50.3. | B (county scale) | Y | Y, minor adjustment |
| | | 50.4. | B (county scale) | Y | Y, minor adjustment |
| | | 50.5. | B (county scale) | Y | Y, minor adjustment |
| | | 50.6. | B (county scale) | Y | Y, minor adjustment |
| | | 50.7. | B (county scale) | Y | Y, minor adjustment |
| | | 50.8. | B (county scale) | Y | Y, minor adjustment |
| | | 50.9. | B (county scale) | Y | Y, minor adjustment |
| | | 50.10. | B (county scale) | Y | Y, minor adjustment |
| | | 50.11. | B (county scale) | Y | Y, minor adjustment |
| | | 50.12. | B (county scale) | Y | Y, minor adjustment |
| 52 | Sherrouse and Semmens (2014) | 52.1. | A (natural landscape context) | Y | Y, major adjustments |
| 53 | Sherrouse et al. (2014) | 53.1. | A (natural landscape context) | Y | Y, major adjustments |
| 59 | Van Berkel and Verburg (2014) | 59.1. | B (limited presence in landscape scale study) | Y | Y, minor adjustment |
| | | 59.2. | B (limited presence in landscape scale study) | Y | Y, minor adjustment |
| 61 | Villamagna et al. (2014) | 61.1. | B (limited presence in landscape scale study) | Y | Y, minor adjustment |
| | | 61.2. | B (limited presence in landscape scale study) | Y | Y, minor adjustment |
| | | 61.3. | B (limited presence in landscape scale study) | Y | Y, minor adjustment |
| | | 61.4. | B (limited presence in landscape scale study) | Y | Y, minor adjustment |
| | | 61.5. | B (limited presence in landscape scale study) | Y | Y, minor adjustment |
| | | 61.6. | B (limited presence; landscape scale study) | Y | Y, minor adjustment |
| | | 61.7. | B (limited presence in landscape scale study) | Y | Y, minor adjustment |
| | | 61.8. | B (limited presence in landscape scale study) | Y | Y, minor adjustment |
| | | 61.9. | B (limited presence in landscape scale study) | Y | Y, minor adjustment |
| | | 61.10. | B (limited presence in landscape scale study) | Y | Y, minor adjustment |
| 63 | Weyland and Laterra (2014) | 63.1. | B (National scale) | Y | Y, minor adjustment |

sented a "medium relevance (B) of urban context" and no indicators were found to be of "high relevance of urban context". This implied none of the indicators could be used in urban planning without adjustments: 64% were considered usable after minor adjustments and 36% after major adjustments.

Papers rendered usable for urban planning after minor adjustments formed the final set of 37 indicators reported in Table 7, together with their features (name, measurement, calculation unit, remark for their use).

Table 8 and Fig. 4 report how the 37 selected indicators correspond to the MEA (2005) categories, showing huge differences in addressed categories: while almost all indicators referred to "Recreational and ecotourism", no indicator was related to "Cultural diversity" and "Knowledge systems" (Table 8). Almost

**Table 7**
Synthesis of spatial indicators suitable for urban planning.

| No | Source | Correspondence with CES category | Indicator(s) code | Indicator name | Proxy indicator | Measurement unit | Calculation resolution |
|---|---|---|---|---|---|---|---|
| 7 | Brandt et al. (2014) | Aesthetic values | 7.1 | Landscape aesthetics | Y | Spatial proxy | Unknown resolution grid |
| | | Recreational and ecotourism | 7.2 | Park visitation | Y | Spatial proxy | Unknown resolution grid |
| 12 | Casalegno et al. (2013) | Aesthetic value | 12.1 | Density of photographs | Y | # photographs per 1 $km^2$ | 1 km grid |
| 28 | Klain and Chan (2012) | Aesthetic values, cultural heritage, recreational and ecotourism, spiritual and religious values, inspiration, sense of place | 28.1. | Monetary value of marine ES | Y | Spatial proxy of the preference value of some ES | 500 m resolution grid |
| | | | 28.2. | Number of threats to marine ES | Y | Spatial proxy of perceived threats to some ecosystem services | 500 m resolution grid |
| 37 | Nahuelhual et al. (2014) | Cultural heritage, knowledge systems, social relations | 37.1 | Agriculture Heritage | Y | Spatial proxy of different dimensions that are spatially estimated with kernel density | 100 resolution grid |
| 38 | Nahuelhual et al. (2013) | Recreational and ecotourism | 38.1. | Recreation potential | Y | Spatial proxy of different aggregated variables | Different spatial resolutions |
| | | | 38.2. | EcoTourism potential | Y | Spatial proxy of different aggregated variables | Different spatial resolutions |
| 46 | Raudsepp-Hearne et al. (2010) | Recreational and ecotourism | 46.2. | Tourist attractions | Y | Number of tourist attractions in certain area (Tourist attractions/$km^2$) | Municipality |
| | | | 46.3. | Rare species | Y | Number of observations of rare species in certain area (Observations of rare species/$km^2$) | Municipality |
| | | | 46.4. | Tax value of cottages | Y | Tax value of cottages (Tax value of cottages/$km^2$) | Municipality |
| | | | 46.5. | Forested land | Y | Percent of land that is forested | Municipality |
| 50 | Sander and Haight (2012) | Recreational and ecotourism, aesthetic values | 50.1. | Mean percent tree cover on the home's parcel | Y | Mean percent of home's parcel that is forested | County |
| | | | 50.2. | Mean percent tree cover in neighbourhood land cover measured in home's viewshed | Y | Mean percent of land that is forested in neighbourhood limited by home's viewshed | County |
| | | | 50.3. | Impervious land cover | Y | Area of land that is covered with impervious surface ($m^2$) | County |
| | | | 50.4. | Lawn area of short grass | Y | Area of land that is covered with short grass ($m^2$) | County |
| | | | 50.5. | Area of maintained tall grassland cover | Y | Area of land that is covered with maintained tall grass ($m^2$) | County |
| | | | 50.6. | Area of forest | Y | Area of land that is forested ($m^2$) | County |
| | | | 50.7. | Area of shrub | Y | Area of land that is covered with shrub ($m^2$) | County |
| | | | 50.8. | Area of unmaintained grassland | Y | Area of land that is covered with unmaintained grassland ($m^2$) | County |
| | | | 50.9. | Area of emergent vegetation | Y | Area of land that is covered with emergent vegetation ($m^2$) | County |
| | | | 50.10. | Area of open water | Y | Area of land that is covered with open water ($m^2$) | County |
| | | | 50.11. | Area of woody wetland | Y | Area of land that is covered with woody wetland ($m^2$) | County |
| | | | 50.12. | Area of agricultural land | Y | Area of land that is used for agriculture purposes ($m^2$) | County |
| 59 | Van Berkel and Verburg (2014) | Recreational and ecotourism, aesthetic values, cultural heritage, inspiration, spiritual and religious values | 59.1. | Respondents' willingness to pay (WTP) for landscape maintenance | N | Estimation of the monetary value of environmental and cultural services (€) | Vector Landscape features (unknown resolution) |
| | | | 59.2. | Travel time-cost estimate | N | Calculation of estimated respondents' travel costs (€/km) | Vector Landscape features (unknown resolution) |

Table 7 (*Continued* )

| No | Source | Correspondence with CES category | Indicator(s) code | Indicator name | Proxy indicator | Measurement unit | Calculation resolution |
|---|---|---|---|---|---|---|---|
| 61 | Villamagna et al. (2014) | Recreational and ecotourism | 61.1. | Surface water availability | Y | Length/area of waterbodies | Hydrologic units |
| | | | 61.2. | Game-fish species richness | Y | Number of species found | |
| | | | 61.3. | Water quality | Y | Length/area impaired for aquatic life | |
| | | | 61.4. | Forested riparian areas | Y | Forested riparian area | |
| | | | 61.5. | Boating access sites | Y | Number of boat access sites | |
| | | | 61.6. | Publicly accessible areas | Y | Waterbody shoreline and length within public use area | |
| | | | 61.7. | Fishing spots | Y | Number of fishing spots | |
| | | | 61.8. | Fish stocking | Y | Number of stocked fish | |
| | | | 61.9. | Fishing licenses | Y | Number of licenses | |
| | | | 61.10. | Licensed anglers within 16.09 km of fishable waterbody | Y | Number of licenses | |
| 63 | Weyland and Laterra (2014) | Recreational and ecotourism | 63.1. | Campsite density with landscape metrics | N | Campsite density explained by landscape metrics (variables): | 32 km resolution grid |

all indicators (92%) were proxies. The final set of indicators included simple percentages of land covers types or their extension, number/density of particular features, monetary estimations or aggregated raster indices.

25 indicators (68%) were calculated by GIS, with different calculation units, spanning from different resolution raster grids (40%), to vector polygon unit (60%).

## 4. Discussion

In this section we explore the usability of CES indicators for planning in urban contexts, at the light of results of our review. We will focus the discussion on three main issues: (1) usability of analysed CES indicators for urban planning; (2) other emerging issues concerning CES in urban contexts that are poorly addressed in peer-review literature, namely CES disservices and CES within ES bundles; (3) criteria for the performed literature review, with relative pros and cons.

### 4.1. Usability of CES indicators for urban planning

The review showed a lack of conceptual clarity and ambiguity in the use of CES categories for urban contexts. This makes selection of proper indicators difficult for certain CES categories. Several examples of indicators with unclear CES categories were identified: (i) “’seascape character”, “habitat and species value” (Burkhard and Gee, 2012) (ii) “unique natural feature”, “ceremonial site”, “stewardship activities”, “scientific study site”, “peace”, transformational”, “integration”, “community identity”, “existence” (Klain and Chan, 2012); (iii) “amenity”, “nonuse value” (Liekens et al., 2013), (iii) “history”, “place”, “calm”, “escape” (Norton et al., 2012); (iv) “contribution of per-urban woodlands to well being” (O’Brien et al., 2014); (v) “deer hunting”, “nature appreciation”,” summer cottages”(Raudsepp-Hearne et al., 2010); (vi) different social values like “biodiversity”, “economic”, “future”, “historic”, “intrinsic”, “life sustaining”, “subsistence”, “therapeutic” (Sherrouse et al., 2014); (vii) “identity” (Tengberg et al., 2012); (viii) “beauty” (Van Berkel

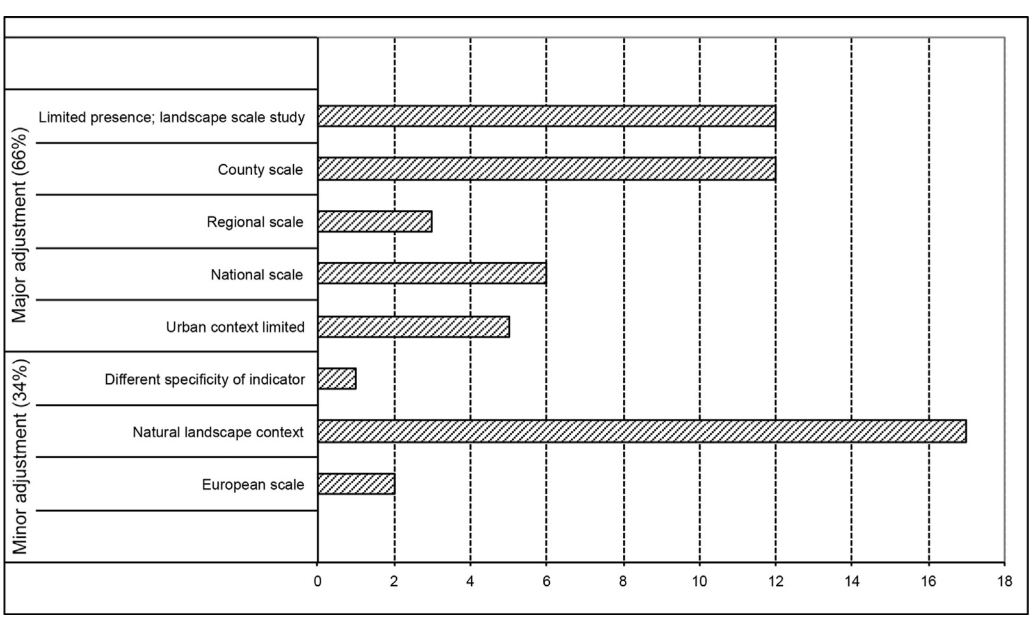


**Fig. 3.** Number of indicators that can be used for urban planning.

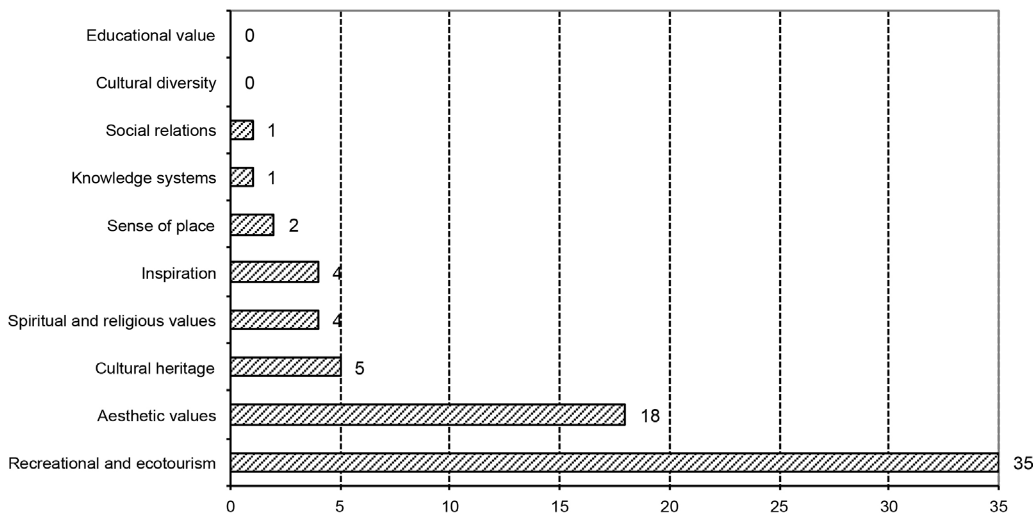


**Fig. 4.** Final selected indicators and relative categories.

and Verburg, 2014). Papers with above-mentioned CES categories were actually not included in research results, as these categories were used as theoretical references only, without specifying the nature of the indicators and their clear relation to the CES using MEA or another similar framework. A better operationalisation of CES categories is needed to simplify and better address the selection of more effective CES indicators for urban planning. This can be done by referring to the most prevalent CES categories like MEA (2005) or TEEB frameworks (Van der Ploeg et al., 2010) and using an appropriate urban scale able to display spatial distribution of CES.

However, in many cases the assessments end up as a nominal reference of the ES concept, aiming to prove the use of the framework but without conceptual clarity in terms of what the indicator specifically should measure in order to be a dimension of the specific CES under assessment.

"Recreational and ecotourism" and "aesthetic values" were the most often assessed categories in the papers we analysed, confirming other recent research about CES (e.g. Plieninger et al., 2013). For those categories not covered by the indicators selected in Table 7 ("cultural diversity" and "educational values") indicators like density or diversity of different types of cultural items could be easily used as proxies. As defined by World Resources Institute (ESID, 2012), a proxy indicator for Ecosystem Services is a "substitute measure used to provide insight into the area of interest when it is not possible to measure the issue directly. Proxy measures must behave reasonably in sync with a good direct measure".

An assessment method does not necessarily lead to a valuation where a specific value structure has already been put into play. Valuation is, in terms of urban planning, a matter of policy discussion on the basis of assessment and measurements already done. Some methods were clearly conceived to lead to specific types of valuation, like hedonic pricing or willingness to pay for landscape maintenance which gives prices as a valuation results (Klain and Chan, 2012; Sander and Haight, 2012; Van Berkel and Verburg, 2014), and others were neutral measurements like narratives assessments (e.g. Weyland and Laterra, 2014).

All the final 37 indicators were communicable to decision makers, thanks to a general use of related maps. This confirms the recent and well-developed stream of research into mapping of ES (Nahuelhual et al., 2013, 2014; Paracchini et al., 2014; Sherrouse et al., 2014; Plieninger et al., 2013).

Regarding which level of decision-making concerning CES is appropriate for urban planning purposes, Pleasant et al. (2014) noted that CES are generally managed at the state level, but the benefits that they generate are experienced both locally and internationally. For this reason, it is probably at the local level (i.e. municipal level) that planning decisions about CES might be more effective in improving the overall quality of the urban environment (Pleasant et al., 2014).

If land-use planning processes are aimed at the design and organisation of urban space both physically and socio-economically, they need to find appropriate measures to address problems in the management of urban complexity. For an indicator to really serve as a base for decision makers in urban planning contexts, there is the need to be spatially explicit (La Rosa et al., 2014). This would also allow producing choices that are spatially differentiated within the urban context under exam. With this in mind, scenarios about new land uses in urban contexts should be based on spatial configurations resulting from spatially differentiated indicators scores. Among the final 37 indicators selected in Table 7, 25 indicators produced spatially differentiated scores. However, urban areas were never the precise contexts of the indicators, that were mainly calculated for regional (i.e. Nahuelhual et al., 2014; Frank et al., 2014), national (Weyland and Laterra, 2014) or continent (i.e. Norton et al., 2012) level. Urban contexts were always present as a portion of a wider geographical context and their relevance was

**Table 8**
CES categories for the final selected indicators.

| Categories of CES | # indicators | Indicator code |
|---|---|---|
| Recreational and ecotourism | 35 (95%) | 7.2, 28.1, 28.2, 37.1,38.1, 38.2, 46.2, 46.3, 46.4, 46.5, 50.1, 50.2, 50.3, 50.4, 50.5, 50.6, 50.7, 50.8, 50.9, 50.10, 50.11, 50.12, 59.1, 59.2, 61.1, 61.2, 61.3, 61.4, 61.5, 61.6, 61.7, 61.8, 61.9, 61.10, 63.1 |
| Aesthetic values | 18 (53%) | 7.1, 12.1, 28.1, 28.2, 50.1, 50.2, 50.3, 50.4, 50.5, 50.6, 50.7, 50.8, 50.9, 50.10, 50.11, 50.12, 59.1, 59.2 |
| Spiritual and religious values | 4 (11%) | 28.1, 28.2, 59.1, 59.2 |
| Cultural heritage | 5 (13%) | 28.1, 28.2, 37.1, 59.1, 59.2 |
| Inspiration | 4 (11%) | 28.1, 28.2, 59.1, 59.2 |
| Sense of place | 2 (5%) | 28.1, 28.2 |
| Cultural diversity | – | – |
| Educational value | – | – |
| Knowledge systems | 1 (3%) | 37.1 |
| Social relations | 1 (3%) | 37.1 |

thus extremely limited for the choice and development of CES indicators. No specific indicator was found for which the urban context was of high relevance or predominant within the study area of the paper.

The limited relevance of the urban context is also reflected by a lack of appropriate data used: most of the data used in the papers we reviewed had a very general level of detail not appropriate for capturing particular urban items like cultural objects, architectures, monuments, configurations of land uses, etc. Such features, as elements of the urban ecosystem, significantly influence ability of such urban ecosystem to provide CES.

Previous considerations indicate some difficulties implementing CES in urban planning and decision making, highlighting a mismatch between the potential of communicable information by spatial indicators so far developed for CES and their real usability in urban contexts. Results from our review showed the need for some adjustments for their applicability and use in urban contexts, such as the use of a different set of spatial data (density of cultural items/tourist places, data from geocoding services about urban features, etc.) or an increase in the spatial resolution of information used (i.e. land use/land cover datasets).

Furthermore, the review showed that almost all selected indicators useful for CES were proxies (Table 7), like the presence of particular physical features (Raudsepp-Hearne et al., 2010; Nahuelhual et al., 2013, 2014) or set of indicators used within hedonic pricing assessments (Sander and Haight, 2012).

Other indicators were used to assess CES only in a wider framework of multi-indicator approaches (Villamagna et al., 2014) or as spatial proxy to denote the preference of particular ES (Klain and Chan, 2012). The widespread use of proxies highlighted the complexity of transferring the concepts from the ES framework onto the cultural dimension in spatial terms, and the difficulty in finding quantitative indicators able to express the cultural dimension of specific ES in a spatially explicit way. This trend also shows that there is still space for new indicators addressing CES specificities (Hernández-Morcillo et al., 2013).

### 4.2. Emerging issues

As noted by Costanza (2008) ES "flow from sites where they are produced to sites where they are consumed". Thus, areas that benefit from ES are very often human dominated, characterised by relatively low biodiversity, like urban systems (Burkhard et al., 2012; Spyra, 2014). Therefore a better understanding of spatial locations of areas benefiting from a service and areas providing a service is necessary, as well as a careful assessment of the capacity of certain ecosystems to provide CES and other ecosystems to absorb CES. Such assessments can lead to better planning decisions concerning to urban environments in particular and other less anthropogenised environments in general.

CES are very often part of an ES bundle. Ecosystem service bundles are "sets of ecosystem services that repeatedly appear together across space or time"(Raudsepp-Hearne et al., 2010). According to CES, bundles are shaped by social and ecological processes (Raudsepp-Hearne et al., 2010; Ripoll-Bosch et al., 2013). Since within urban systems certain ecosystems provide cultural services beside or together with other services, CES have to be planned and managed in a bundle. CES are an ES directly responsible for the quality of life in urban systems and are directly experienced and appreciated by urban systems inhabitants and visitors (Plieninger et al., 2013). Both facts should be perceived as important motivators for CES sustainable management in urban systems ES bundles (Plieninger et al., 2012).

The potential effectiveness of managing CES through socio-economic policies remains unclear, probably because they are still unfamiliar concepts to "normative makers" or decision makers and not explicitly included in national, regional and local norms and regulations. Difficulties in monetary valuation of CES can lead to overlooking such services in a certain bundle or being marginalised as externalities (Chan et al., 2012; Urquhart and Acott, 2014). Particularly in urban contexts, this might lead to inappropriate planning decisions (Ruiz-Frau et al., 2013).

In the context of the applicability and usefulness of CES for urban planning, the presence of disservices is an important issue with increasing relevance. CES disservices have a negative impact on urban users by negatively affecting their activity (Piwowarczyk et al., 2012) and are understood as "functions of ecosystems that are perceived as negative for human wellbeing" (Lyytimäki and Sipilä, 2009, p. 311). CES disservices are very often effects of human activities in an urban environment (Plieninger et al., 2013) and suggest a trade-off between ecosystems and quality of life (Haase et al., 2014). In the review, only one of the papers analysed (Plieninger et al., 2013) dealt with disservices such as unpleasantness, scariness, and noisiness: indicators for CES disservices are still not widely enough discussed (Haase et al., 2014).

### 4.3. Criteria used for the literature review

The review was based on some specific terms used in the database queries. The results obtained were thus affected by the combination of terms used for the queries. The use of a broader scope of terms with a more "urban" or "spatial" meaning directly related to types of urban ecosystems providing certain services (e.g. "park", "urban forest", etc.) or particular parts of urban systems (e.g. "periphery", "urban fringe", "peri-urban", etc.) would have provided different results. Even though there might still be a set of papers that have not been targeted, due to this lack of an extended word search using CES terms specifically, we concentrate the search for peer-reviewed articles referring specifically and explicitly to the ES assessment framework (MEA, 2005; Van der Ploeg et al., 2010). We are aware that other papers might address some specific issues of CES without mentioning it in the title, abstract or keywords. But with our method we gain a clearer image of research published in peer-review journals which directly concerns CES by using or trying to use the ES framework.

However, to avoid narrowing the results of our query too much, we reviewed a set of papers dealing with indicators and cultural ecosystem services in general and not cultural urban ecosystem services, as we aimed to find elements about the use of CES in urban contexts from the existing research ongoing on CES in general. This approach was necessary because only one paper was found when using the keywords "cultural ecosystem services", "indicators" and "urban" (see Table 3).

Finally, it is worth pointing out differences of this work with previous reviews about CES. First, this paper investigates which are CES indicators that can be used for planning purposes and especially for urban planning. Other existing reviews have dealt with more general issues about CES (Haase et al., 2014; Milcu et al., 2013), without focusing on indicators and their possible use in decision making processes. Furthermore, the other review about CES indicators (Hernández-Morcillo et al., 2013) strongly differs from the structure of this review, in terms of objectives, methodology and reported results. A detailed investigation of articles dealing with CES in relation to urban planning is presented here, analysing in detail and discussing particular features of indicators (used data, scale, geographical units, reproducibility) that were not taken into account into previous studies.

## 5. Conclusions

CES are produced by human perceptions of a certain ecosystem, thus CES are the most "human made ES" (Raudsepp-Hearne et al., 2010). Urban ecosystems are complex, adaptive and dynamic systems, which are shaped by interactions between human and biophysical agents (Alberti, 2008). Since urban ecosystems are the most anthropogenised among ecosystem types, the role of CES is significant for them. That indicates an urgent need for an adequate incorporation of CES within urban planning.

This paper presents a review of indicators for the assessment of CES, based on existing literature retrieved from academic databases. Papers resulting from database queries were evaluated, in order to obtain a list of CES indicators suitable for use in urban planning processes. Criteria of spatial features, communicability to planning and relevance of urban context were chosen as particular characteristics for indicators that should be used for urban planning.

The results showed that no indicator specifically addresses CES in an urban context and, on the contrary, urban environments seem to play a minor role within current ES assessments, although they are places with high density of CES. From the first set of papers we selected 37 indicators that might be used in urban context with some adjustments, according to the chosen criteria of evaluation.

This lack of an adequate urban concept can be easily observed in the scale of the assessments and in the non-urban nature of most indicators. Almost all the indicators found have problems when displayed at a proper urban scale, where the explicit evidence of spatial anisotropies is indispensable for an indicator to be useful for urban planning purposes. We have found a limited usefulness for indicators when the calculation refers to the entire area of municipalities. This implies the need for spatially differentiated indicator scores in order to enable planning tools to make effective use of the information they are providing. Identifying the spatial distribution of CES is a fundamental aspect to advance the inclusion of the ES framework into urban planning. Even though there are some suitable and potentially good indicators for planning purposes, most of them are borrowed from other sciences and disciplines. Furthermore, when looking in more detail at the indicators, it was found that most of them were proxies, thus having a tangential relationship with specific CES measurement. This indicates scope for developing new indicators addressing CES specificities. These results clearly indicate how the direct application of indicators for CES in urban context is still unexplored. Good quality of CES indicators will help to make wiser and ecologically focused decisions in urban planning processes (Daily et al., 2009; Xiang, 2014).

## Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.ecolind.2015.04.028

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# IV

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Research Article **Open Access**

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# Requirements for cross-border spatial planning technologies in the European context

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**Abstract:** This communication paper investigates requirements for cross-border spatial planning technologies. We refer to European cross-border regions, which are located in the European Baltic Sea Region. We hypothesize that there is no efficient cross-border spatial planning without engagement from various stakeholders, supported by novel spatial planning technologies. This study presents the results from a survey that identifies the requirements for spatial planning technologies adequate for cross - border regions. On the basis of this survey, carried out within the INTECRE project partners coming from the Baltic Sea Region, the study provides general recommendations about cross - border spatial planning technologies. Addressed in the survey are the following central issues: definition of the scope of such technologies, the data base and international planning data provision, features and properties of planning technologies, and stakeholder involvement. The research findings are transferable to wider European and extra-European contexts.

**Keywords:** Cross-border spatial planning, spatial planning technologies, cross-border regions, Baltic Sea Region

## 1 Introduction

This communication paper intends to showcase and discuss recommendations for technology requirements and approaches to improved natural resources governance in the context of cross-border spatial planning and is based on experiences made in the Baltic Sea Region (BSR). **Spatial planning** is a generic term that subsumes a complex field within policy and administration. In general, spatial planning concerns complex landscape systems, which are characterized by a large variety of natural assets (e.g. land uses, physical elements), stakeholders, and energy and matter fluxes [2]. It deals with "the problem of coordination or integration of the spatial dimension of sectoral policies through a territorially-based strategy" [5: 91]. More specifically, we address regions that are divided by the national border. Therefore, we use the term **cross-border spatial planning**.

Spatial planning manages the balancing of demands made by manifold stakeholders regarding an integrative re-organization of land-uses [37, 3]. Planners have to consider changes in natural processes and societal demands, i.e. they need to shift from "end-state design" to collaborative processes and iterative decision making [35]. Consequently, spatial plans need to be constantly monitored and updated. Such adaptive planning raises important requirements in regard to **spatial planning technologies**, particularly in cross-border contexts. With spatial planning technologies, we refer to digital tools and instruments that provide spatially explicit planning support by enabling knowledge-based participatory development, assessment of scenarios, and consensus building. Most of the tools and instruments are GIS-based, thus they require good quality, reliable, detailed, thematically adequate, spatially explicit data. Moreover, spatial planning technologies have theoretical bases in different methodological approaches (e.g. ecosystem services, sustainability, green infrastructure). It also means that while performing spatial planning with such technologies, the planner (user) should have a good understanding of specific approaches, and the spatial planning technology allows for assessments of different issues related to these approaches (e.g. assessments of ecosystem services provision / demand). Approaches that are often used in spatial planning were discussed in our research.

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**Cross-border cooperation concerning spatial planning** in Europe is rising in importance and gaining more attention among various actors [32]. A process of "debordering" has been described, which refers to increasing interactions across (European) borders, since the original function of the border as a barrier has diminished and the economic and cultural exchanges have increased due to globalization effects and, in particular, European Union cohesion policies. According to Sohn and Giffinger [32], a heterogeneous network of actors is the basis for functioning cross-border spatial planning. It is characterized by a large number of various stakeholders, who act across the national border and struggle to overcome different problems associated with difficulties due to language, cultural and legal differences and technology barriers, i.e. internet and other infrastructure access [11,38]. Strengthening the cross-border networks of various stakeholders is an important requirement for sustainability in spatial planning in general and for the European Integration in particular [14,41].

The study was conducted in the context of a network project called INTECRE - Innovative Technologies for Multi-dimensional Integrated Spatial Development (INTECRE) and refers to Baltic Sea Region (BSR) states. Our communication paper presents a survey among INTECRE experts from the BSR states, which we perceived to be a highly representative area for the need to harmonize cross-border collaboration on energy, transport, nature protection, and the sustainable use of natural resources [7, 17]. Our study aimed to **identify requirements** for suitable spatial planning technologies and to **provide and discuss recommendations** for their future development and implementation.

## 2 Method

INTECRE project objective was to surmount unsustainable resource and infrastructure management issues by identifying requirements for technologies that particularly facilitate the governance of participatory planning and natural resources that are complementary to national regulations. The INTECRE project consisted of 17 partner institutions from six BSR states (DE, DK, EST, FI, PL, and SE).

The experts in our consortium acted as focus group for the derivation of technology requirements, and an online one-time survey was conducted using LimeSurvey 2.x. 59 % of the survey participants were connected with research institutions and 41 % answered the questions from a practical perspective, being SME members (Figure 1).

The survey consisted of seven questions, structured into the following four thematic groups:

A. Regional differences in requirements and usability
B. Data requirements for technologies and instruments
C. Methodological approaches for spatial planning technologies
D. Users

Regarding (A.), the participants were asked whether different support mechanisms are needed for different regions regarding cross-border regional planning. Alternatively, flexible spatial planning technologies (tools and instruments) which can be applied for various regions were suggested.

In part (B.), open lists of data sets which reflect the real needs of stakeholders in the context of regional planning were suggested for selection. CORINE[1], Large Urban Zones (LUZ)[2], and INSPIRE data (Infrastructure for Spatial Information in the European Community[3], based on an INSPIRE regulation) were suggested. Additionally, the participants were asked to select spatial data which are required as a minimum for cross-border regional planning. The open list of answers comprised protected areas, regional planning restrictions (e.g. priority areas for certain land use), infrastructure plans, climate data, soil data, land tenure types and location, demographic data, hydrological data, economic data, and "other" (to be specified by the participant).

The aim of question block (C.) was to figure out which methodological approaches are predominantly applied in the context of spatial planning by which user. Methodological approaches to spatial planning simultaneously address different issues (e.g. green systems, ecosystems, landscape design). It was requested that the following matrix be filled in (Table 1). The core aim of the concept has been explained within the survey.

Part (D.) consisted of two questions. From a user's point of view, the participants were asked to select the most important peculiarities (D1) of spatial tools and instruments in order to be relevant for practice and asked about the biggest challenge in the context of cross-border regional planning and respective support tools and instruments (D2).

## 3 Results

In part (A.), 75 % of the participants indicated that flexible tools are needed which are applicable to different regional

1 http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2006-raster-3
2 http://ec.europa.eu/eurostat/web/cities/statistics-illustrated
3 http://inspire.ec.europa.eu/index.cfm/pageid/3

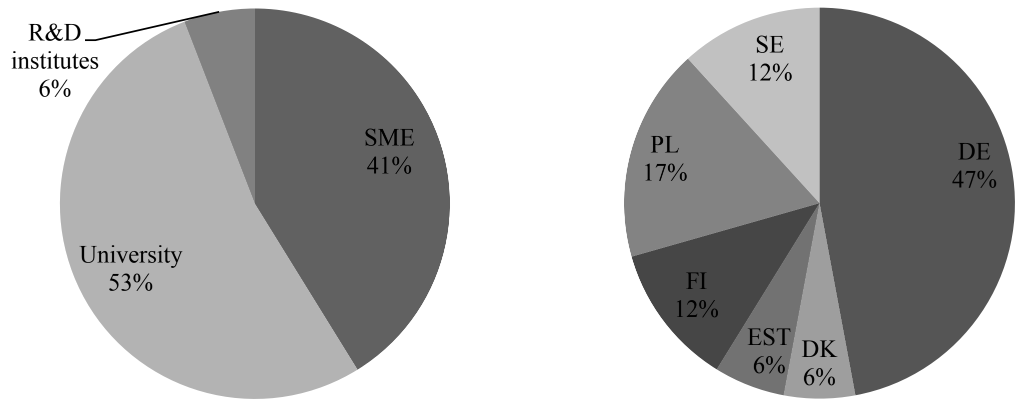


**Figure 1:** Participants according to their institution (left, clockwise: small & medium enterprises [SME], universities, and research & development [R&D] institutes) and nationality (right, clockwise: Germany, Denmark, Estonia, Finland, Poland, Sweden); n=14

**Table 1:** Answer matrix for question C (question not mandatory; to be rated on a Likert scale including 1 = Always, 2 = Very Often, 3 = Sometimes, 4 = Rarely, or 5 = Never)

| Concepts: / Application: | Ecosystem services | Sustainability | Multi-functionality | Environmental accounting | Geo-design | Green infrastructure |
|---|---|---|---|---|---|---|
| In science | | | | | | |
| In politics | | | | | | |
| In planning | | | | | | |
| In education | | | | | | |

contexts, temporal and spatial scales, (Table 2). 17 % stated that specific tools according to regional conditions are needed. One participant additionally indicated: "if smaller regions are addressed, I suggest that specific tools are needed; if large cross national regions are addressed, a generic tool might work".

Regarding the usability of land use data sets, the results from (**B.)** indicated that some participants found several data sets appropriate for stakeholder's needs in a cross-border planning context (Table 3). INSPIRE data were rated best (89 %). However, also Large Urban Zones (LUZ) were considered to be useful according to the votes by 56 % of the participants. CORINE land cover received the fewest votes. Still, 44 % of the participants considered it to be a reflection of stakeholder's needs. No further data were suggested (Table 3, "other").

Figure 2 illustrates data that are required as a minimum for cross-border regional planning from the perspective of the consortium (question in block B.). Although the participants of the survey covered mainly ecology-related experts, demographic and economic data were chosen as most meaningful in addition to the land use data. 90 % of the participants rated climate and 80 % rated hydrological/ infrastructure-related/ planning-related/ and protection-related data to be essential for regional cross-border planning. Soil data and the location of land tenure types were mentioned by 55 % of the participants.

Results obtained from question block (C.) give

**Table 2:** Answers in Block (A.) regarding the regional differences in requirements and usability

| Answer | Count | Percentage |
|---|---|---|
| A tool which supports cross-border regional planning should be applicable for various types of regions, because the conditions (e.g. the degree of marginalization) can vary a lot beyond (administrative) borders. | 9 | 75.00% |
| Specific tools are needed according to regional conditions (e.g. for rural regions, metropolitan regions, and marginalized regions). | 2 | 16.67% |
| Other | 1 | 8.33% |

**Table 3:** Answers for the first question in block (B.), regarding the usability of land use data sets.

| Answer | Count | Percentage |
|---|---|---|
| CORINE | 4 | 44.44% |
| Large Urban Zones (LUZ) | 5 | 55.56% |
| INSPIRE data – based on an INSPIRE regulation | 8 | 88.89% |
| Other | 0 | 0.00% |

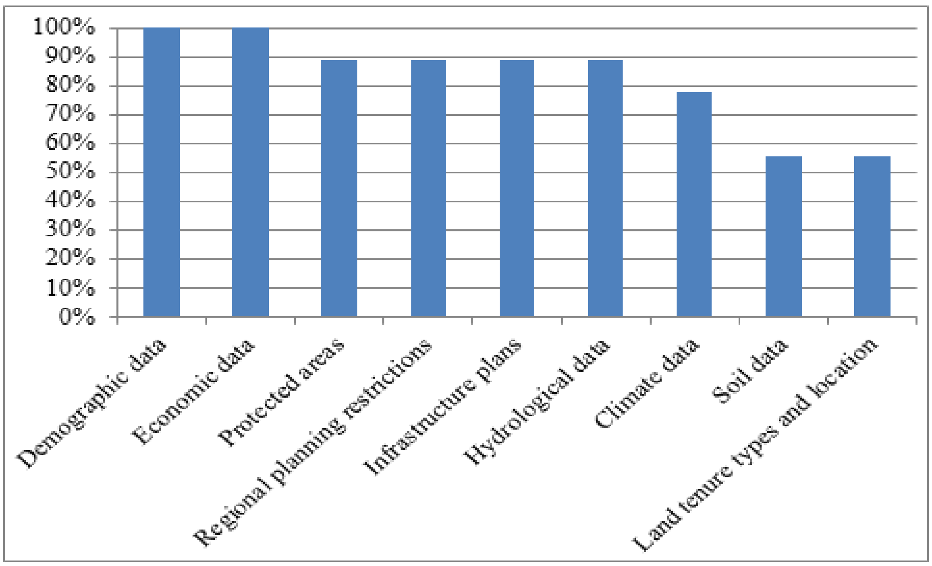


Figure 2: Answers from block (B.) regarding spatial data, which are required as a minimum for cross-border regional planning. Multiple answers were possible.

an overview of methodological approaches of spatial planning and its users (Figure 3). The experts were asked to indicate which approach is rarely, sometimes, or often used by four different user groups. The most important approach for politicians and planners is the green infrastructure. But for planners, as well as for scientists and teachers, especially the well-established sustainability approach is often applied. In science and education also the ecosystem services based approaches play an important role. Although not most often applied, multi-functionality is a widely used approach (in science, planning, and education). The very specific approach of geo-design is equally of wide use; however, it is noteworthy that it is rarely used by policy-makers.

Essential peculiarities of spatial planning technologies are indicated in Figure 4 (**questions D2**). None of the proposed peculiarities was considered to be unimportant. Most features were voted as “very important” or “important”. Most votes had the features “data harmonization”, “mapping”, and “impact assessment”. Moreover, two characteristics were emphasized by the survey participants, namely transparency and transdisciplinarity.

Answers for the open **question D2**, which asked for the biggest challenge related to cross-border planning and planning technologies, could be classified into two key issues – namely, “data and modeling” (six answers) and “stakeholders and laws” (five answers) (Table 4). Under “stakeholders and laws”, two related aspects are concluded. First, the willingness of stakeholders to participate in the planning process was pointed out as a challenge. However, funding for cooperation activities was mentioned as a prerequisite for such collaborations. Hence, a legal basis is required to ensure financial support and therefore resilient cross-border networks. Under “data and modeling” the challenge of data comparability was raised. As long as data definitions and data processing routines are not harmonized in a transparent way, cross-border modeling for decision-support remains difficult.

| Application field | Science | | | Politics | | |
|---|---|---|---|---|---|---|
| **Frequency** | often | sometimes | rarely | often | sometimes | rarely |
| Ecosystem services | 6 | 2 | | 1 | 4 | 3 |
| Sustainability | 8 | | | 4 | 4 | |
| Multi-functionality | 5 | 3 | | 3 | 3 | 3 |
| Environmental accounting | 4 | 4 | | 4 | 2 | 2 |
| Geo-design | 5 | 3 | | | 1 | 7 |
| Green infrastructure | 3 | 4 | 1 | 5 | 2 | 1 |

| Application field | Planning | | | Education | | |
|---|---|---|---|---|---|---|
| **Frequency** | often | sometimes | rarely | often | sometimes | rarely |
| Ecosystem services | 4 | 3 | 1 | 5 | 2 | |
| Sustainability | 6 | 2 | | 8 | | |
| Multi-functionality | 5 | 3 | | 5 | 2 | 1 |
| Environmental accounting | 2 | 2 | 4 | 2 | 5 | 1 |
| Geo-design | 4 | 4 | | 4 | 2 | 2 |
| Green infrastructure | 6 | 2 | | 4 | 4 | |

**Figure 3:** Answers for the question C1. Frequency of ratings (1 = always/very often; 2 = sometimes; 3 = rarely/never) are indicated as blue bars.

| Features | very important | important | moderately important | of little importance | un-important |
|---|---|---|---|---|---|
| Data harmonization of different data sets and processing routines | 7 | 1 | | | |
| Mapping of functions, goods, services, demand and supply, etc. | 1 | 7 | | | |
| Simulation of spatially explicit land use alternatives | 2 | 4 | 2 | | |
| Impact assessment to reveal synergies and trade-offs | 2 | 6 | | | |
| Multi-user sensitivity: adaptive routines, user profiles | 1 | 3 | 4 | | |
| Knowledge management system to maintain existing knowledge | 3 | 3 | 2 | | |
| Examples as showcases for the purpose of learning | 2 | 3 | 2 | 1 | |
| Language: easy adaptation to a multi-language context | 2 | 4 | 2 | | |
| **Properties** | **very important** | **important** | **moderately important** | **of little importance** | **un-important** |
| Transparency: methods explained, replicable; sources are provided | 2 | 5 | 1 | | |
| Transdisciplinary: Participation options for stakeholders | 3 | 5 | | | |
| Interdisciplinary: different scientific disciplines integrated | 3 | 3 | 2 | | |
| Open source: the tool or approach is available for free | | 4 | 2 | 2 | |
| Online-solution: option of inter-regional exchange in the internet | | 5 | 1 | 2 | |

**Figure 4:** Answers for the question D1 and D2. The number of ratings is indicated by a blue bar.

**Table 4:** Answers for the question D3, categorized according to socio-economic and methodological/technical issues.

| Stakeholders and laws (socio-economic dimension) | Data and modeling (methodological and technical dimension) |
|---|---|
| The honest will of different **stakeholders** to conduct the **planning process** and then to implement it in everyday life. | National **modeling standards** (every country should have their own set of models, meaning that you cannot pool resources to create powerful tools together). |
| Lack of **funding** for this kind of rather applied research and development. | **Definitions of data** (supporting the national models, but not those across the border). |
| To bring all participants to a **common table** and to develop operational solutions | **Data** harmonization and |
| [...], the challenge of cross-border planning requires that stakeholders are willing to commit to the process and enter into the process with an **understanding of the benefits of planning at a scale larger than administrative boundaries**. | Harmonization of different **processing routines** |
| The use of support tools is simply a **method of enhancing communication** between stakeholders - so any tool which is developed must have a **linguistically correct translation**. | [...] meeting the two demands 1) making the tool as simple as possible to ensure **applicability** for the user and 2) make the data processing and methods scientifically detailed enough to support **sound and reliable decision-making**. |
| | **Transparency** |

# 4 Discussion and conclusion

The sample of stakeholders was limited to the participants of the INTECRE project. Since the INTECRE stakeholders come from various contexts and different BSR countries, we argue that our results are generalizable to the BSR region and can also be interesting to other actors working on planning issues of cross-border regions.

Recently developed planning support technologies predominantly focus on very specific and individual case studies, e.g. on integrated beach planning [1] nature conservation [29] or water management [21]. For regional and especially cross-border spatial planning, **generic tools are needed** which are able to handle heterogeneous regions.

A crucial factor for the successful application of planning support tools is the **data basis**. In addition to this scope, data quality strongly affects the evaluation outcome [20,10]. The survey revealed that the harmonization of data and modeling approaches for cross-border spatial planning is required firstly at the national and secondly at the international level (cf. Table 4, Figure 3). In this context, higher **thematic resolution** of the harmonized European land use data sets is preferred. In contrast, the CORINE data are not useful for working with urban scale, since the area of patches provided in this data set do not reflect the complexity of urban systems. Also LUZ data do not contain detailed data about buildings, for instance, which are the main anthropogenic elements creating the technotope of urban system. Such a shortcoming represents the key obstacle when assessing the cross-border landscape asymmetries, thus making planning in such contexts more difficult. In contrast to CORINE and LUZ data bases, INSPIRE-based data have a wider scope and more detailed thematic resolution (cf. Table 3). This allows more detailed assessments, and the data could also form the basis for the monitoring of landscape changes. The INSPIRE Directive (Directive 2007/2/EC) is an instrument for sharing spatial planning data within the European community. For each member state, publishing data and metadata concerning the subject of spatial planning is mandatory. Therefore, this data classification scheme is recommended for application in spatial planning [19]. Besides the considered data sets in the survey, satellite imageries can also serve as a basis for land use / land cover information. Examples for moderate and high resolution imageries that are widely used are MODIS[4] (MODerate Resolution Imaging Spectroradiometer), Quick Bird[5] (high resolution), or Rapid Eye[6] data. Further promising data are for instance LiDAR[7] (Light Detection and Ranging) data, which examine the surface of the Earth based on a remote sensing method. However, these data sources are not classified according to planning-relevant themes – as are INSPIRE data.

Our research provided insights regarding required features and properties, respectively. Results showed that most of the suggested criteria were considered important (Figure 4). In accordance with the literature, most important for cross-border spatial planning is the **harmonization and transparency of data sets** and processing routines [27,30,4]. These issues were also raised in other BSR studies [40]. According to the authors, not only harmonized data, but especially the data exchange

4 http://modis.gsfc.nasa.gov/
5 http://www.satimagingcorp.com/satellite-sensors/quickbird/
6 http://www.dlr.de/rd/en/desktopdefault.aspx/tabid-2440/3586_read-5336/
7 http://www.lidarmap.org/international/

among countries is essential for effective cooperation. Less importance was assigned to the properties "open-source" and "online-solution". Hence, case-by-case, also desktop software and/or licensed software might be suitable. However, online approaches already play an important role in qualitative scenario planning. According to Raford [28] such online approaches

– enhance participation (amount and diversity),
– increase volume and speed of data collected and analyzed,
– increase transparency, and
– decrease costs of project administration.

In accordance with our results, the importance of transdisciplinarity and interdisciplinarity was also stated in the literature, e.g. by McCall and Dunn (2012).

Although the survey actually focused on the technological requirements for planning support tools, the open questions revealed that the social component plays a key role in this field (cf. Table 4). In addition to the availability and application of planning support technology, a central issue is the **willingness of the stakeholders to participate** [34]

According to the outcomes regarding the four survey categories (A-D) and finalizing discussions within the expert group of INTECRE, we derive the following **general recommendations** about cross-border spatial planning technologies in the European context:

A. *Regional differences in requirements and usability:* A tool which supports cross-border regional planning should be applicable for various types of regions, because the conditions (e.g. the degree of marginalization or urbanization) can vary considerably beyond (administrative) borders.

B. *Data requirements for technologies and instruments:* Cross-border spatial planning requires the integration of cross-sectoral data in order to take all main issues into account. For this purpose (i) a multitude of data are needed, which (ii) should meet the specific regional planning issues.

C. *Methodological approaches of planning technologies and instruments:* Crosscutting concepts that are used by all considered user groups (politicians, planners, teaches, scientists) are sustainability and green infrastructure. Despite the fact that more modern approaches, such as the ecosystem services concept, are perceived and used by some user groups (in science and education), an interdisciplinary communication concept cannot yet be guaranteed.

D. *Users:* Essential features and properties of spatial planning technologies, rendered from a user-perspective, cover a multitude of aspects. Most important is data harmonization, as well as the realization of transdisciplinarity through the involvement of various stakeholders. Main challenges can be classified into (i) socio-economic and (ii) methodological/technical issues, whereas, for example, the willingness of stakeholders to participate, and data harmonization have been identified as challenges, respectively.

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# A review of approaches and challenges for sustainable planning in urban peripheries

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## HIGHLIGHTS

- We reviewed the content of 102 papers.
- Research about theories and methods of sustainable planning for urban peripheries is still rather limited.
- The transferability of the proposed methods is rarely discussed.
- There are unexploited opportunities to enhance planning practice in urban peripheries.

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## ABSTRACT

As urban systems continue to grow worldwide, urban peripheries increase in number and typologies, which makes their planning a challenge for sustainable development. The aim of this article is to explore approaches and challenges related to the application of sustainable planning to urban peripheries. We reviewed the content of 102 papers related to sustainable planning in urban peripheries by applying a framework built on two main research questions that address: i) the type of peripheries and sustainable planning approaches considered; ii) the challenges and recommendations reported. The results show that urban peripheries are difficult to synthesize in operative classifications, and are not central in the discourse on sustainable planning approaches. The studies described are mainly context-specific and solution-oriented, aimed at responding to local socio-economic and ecological issues, and the analysis reveals uncertainties about their transferability to other geographical contexts. Few common trends can be highlighted, but many authors acknowledge the cross-cutting risks and trade-offs related to the complexity and dynamism of urban peripheries, which may eventually lead planning to unsustainable or unlivable outcomes. Integration among different scales and sectors emerges as a requirement for effective sustainable planning. We conclude with a remark on the underexploited opportunities offered by urban peripheries, especially with regard to ecological planning approaches.



## 1. Introduction

This paper presents a review of the literature on sustainable planning approaches and solutions to address the challenges of urban peripheries. Generally speaking, the concept of periphery refers to distance or separation with respect to a core, in terms of geographic, economic, political or social factors (Bourne, 2010). In Europe, the term has been used to describe disadvantaged areas characterized by dependence, disconnection, poverty and outmigration (Kühn & Bernt, 2013). In this view, peripheral areas lack the resources to sustain their own growth over time, hence their potential for development largely depends on processes that occur within the core area (Portnov & Pearlmutter, 1999). In contrast, in North America, other terms, like suburban and exurban, are used when referring to urban peripheral contexts. These terms are more commonly adopted to describe lower density development at the edge of a city, and these terms are not associated with disadvantage.

Today, urban peripheries continue to grow worldwide with different intensities and features (UN-Habitat, 2013). Recent modifications to existing urbanization patterns due to the opposite trends of urban development and shrinkage, and large urbanization

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processes worldwide, mostly in emerging countries, have progressively modified the concept of periphery, and made it more complex and difficult to capture (Taylor & Lang, 2004). Studies on the emergence of urban peripheries recognized different processes, ranging from the addition of new urban agglomerations far from existing nodes to the "peripheralization" of inner areas following changes in their economic and social conditions (Bernt & Rink, 2010). For example, once flourishing cities may stop their growth and start to decline, thus losing their centrality (Lang, 2012). At the same time, economic opportunities and innovation rise from peripheral areas (Fitjar & Rodríguez-Pose, 2011). Peripheries have thus acquired a diverse set of dimensions (spatial, social or economic) that go beyond the simplest indicator, i.e. the distance from a city core. This requires updated definitions, a strong re-framing of consolidated theories, and new models for planning and governance (DiGaetano & Strom, 2003; Rumford, 2002).

Sustainable planning, as considered in this paper, is related to physical and spatial planning, which aims to optimize the distribution and allocation of land and human activities, in a space-limited context or within certain administrative boundaries, providing indications and/or regulations for land-use and related activities. Sustainable planning aims at integrating knowledge on socio-ecological contexts to take community-determined public-interest action to effect improved change (Riddell, 2004) and implement principles of sustainability (Ahern, 2006). Since its formulation, the concept of sustainable development has been adopted by planners as a "belief system" or ideology, thus providing a type of underlying rationale for planning activities and decisions (Faludi, 2000; Persson, 2013). In the last three decades, approaches to sustainable spatial and urban planning have tried to incorporate socio-ecological issues in planning methods and processes. The types of sustainable planning approaches are extremely varied, including movements in urban planning and design, participatory and community based planning and design, environmental/ecological planning, and more recent approaches using nature and ecosystems within cities to provide numerous socio-ecological services and benefits to people (Gómez-Baggethun & Barton, 2013; Pickett et al., 2013; Schmandt, 1998; Wheeler, 2013).

However, many challenges to integrating sustainability in the real-world planning processes remain, and they are not much different from the challenges envisaged at the beginning of the millennium (Berke, 2002; Wheeler, 2013). For urban peripheries, challenges are directly related to their highly heterogeneous mosaic of physical environments (with different densities and land uses), their fast changing social and cultural structures, and diverse forms of governance that encompass several institutional regimes at different administrative levels (Allen, 2003; Friedmann, 2016; McGregor, Simon, & Thompson, 2006). The adequacy and effectiveness of the existing sustainable planning approaches for tackling the various, complex and dynamic systems represented by contemporary peripheries should be understood to improve current planning practices and identify needs for future research.

This paper reviews the existing literature on sustainable planning approaches to urban peripheries, by addressing two main research questions: i) What types of urban peripheries and sustainable planning approaches are considered? and ii) What challenges and recommendations are identified? The overall purposes are to better understand the relations between sustainable planning and different types of urban peripheries, to provide lessons learned from existing applications, and to formulate existing challenges for the future development of planning research. Section 2 presents the methodology used to select and analyze the literature, Section 3 reports the results of the review, and Section 4 discusses the main findings. Finally, Section 5 draws some conclusions for future practice and research.

**Table 1**
Combinations of keywords used for the search and respective occurrences in the Scopus database.

| Keywords | Occurrences in "Social Science" and "Environmental Science" subject areas |
|---|---|
| **peripher*** OR **fringe** OR **edge** OR **periurban*** OR **suburban*** OR **exurban*** | 59,020 |
| (**peripher*** OR **fringe** OR **edge** OR **periurban*** OR **suburban*** OR **exurban***) AND **planning** | 4520 |
| (**peripher*** OR **fringe** OR **edge** OR **periurban*** OR **suburban*** OR **exurban***) AND **planning** AND **sustainab*** | 660 |

## 2. Materials and methods

### 2.1. Sample selection

The sample of papers was selected by performing a series of queries in the Scopus database (last update: August 1, 2015), using different combinations of keywords that include relevant synonyms, as shown in Table 1. We chose to use a broad set of keywords in the attempt to capture all the terms that may be used in the literature to refer to the broad concept of urban peripheries, such as fringe, edge, exurban, suburban, and peri-urban. The queries were performed in the "Article Title; Abstract; Keywords" field for the Scopus "Social Science" and "Environmental Science" subject areas, and were limited to the period 1991–2015.

The search resulted in 660 papers. Then, we checked all the abstracts to include only papers i) related to the description of a planning approach or a planning case study, and ii) explicitly addressing urban peripheries. The screening resulted in a set of 124 papers. From this set, 22 papers were not retrievable from the libraries of our institutions, mostly due to discontinuous publication history of the respective journals. The remaining 102 papers (listed in the Supplementary Material) comprise the final sample, which was analyzed through the review framework described in Section 2.2. Fig. 1 illustrates the temporal distribution of the selected papers, and Fig. 2 shows the geographical distribution of the case studies described.

### 2.2. Review framework

We performed a content analysis to address the two research questions (Table 2). Each question was decomposed into a set of sub-questions detailed by interpretation keys and criteria, which were used to guide the analysis of the papers and to analyze their content. The first part of the framework focuses on the types of urban peripheries and sustainable planning approaches considered in the papers. The framework investigates spatial and temporal dynamics, the definition and characteristics of urban peripheries, and the planning approaches adopted. The latter are classified into theoretical approaches (planning paradigms), practical approaches (planning strategies and solutions), and methodological approaches (operational methods and tools) (Table 2).

The second part investigates critical elements in the relation between sustainable planning approaches and urban peripheries. In particular, we identify the internal limitations of sustainable planning approaches, the external barriers to their implementation, the risks and trade-offs arising from their application to urban

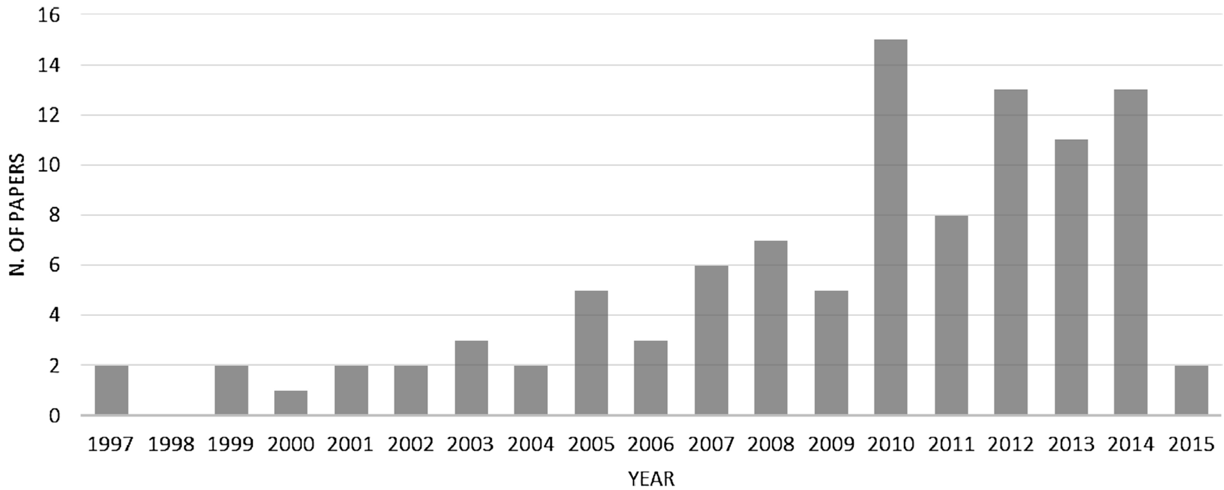


**Fig. 1.** Temporal distribution of the selected papers.

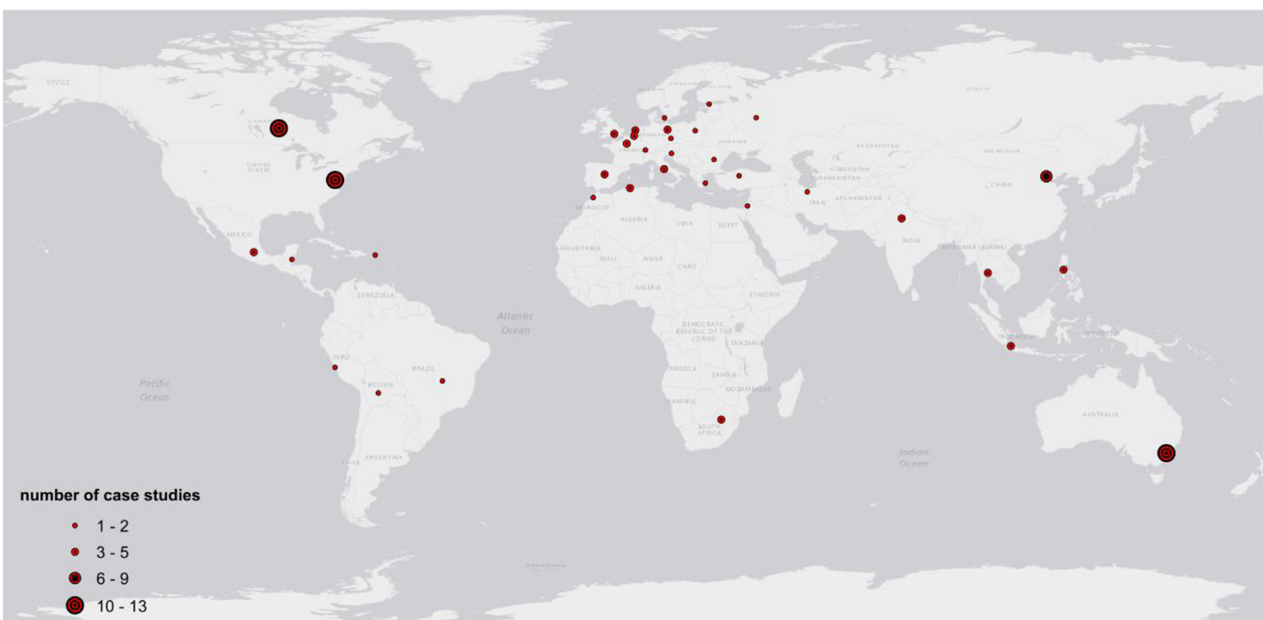


**Fig. 2.** Case studies described in the selected papers grouped by country (dots placed on the capital cities).

peripheries, and the challenges associated to their transferability across different geographical, environmental, or socio-economic contexts. Finally, based on the recommendations and suggestions included in the papers, we identify characteristics that determine the effectiveness of sustainable planning approaches.

## 3. Results

### 3.1. Urban peripheries and sustainable planning approaches

#### 3.1.1. Spatial and temporal context and dynamics

The cross-analysis of date and geographical location of the case studies is reported in Fig. 3. Full details are provided in the Supplementary Material. A very broad distinction can be made between urban peripheries in the contexts of the "Global North" and the "Global South" (Watson, 2009). Urban peripheries in the Global North represent the focus of the older papers of the sample. The main common feature is a peri-urbanization process that accumulated negative environmental outcomes over recent decades, and is considered no longer sustainable (Aguilar & Santos, 2011; Newton, 2010; Teschner, Garb, & Tal, 2010; Wigle, 2010). Urban peripheries in contexts of the Global South appear later in the selected literature and are characterized by more recent and fast urbanization processes in which environmental concerns are associated with issues related to equity and justice. In these contexts, the informality and the absence of regulations are defined as outstanding characteristics (Aguilar & Santos, 2011; Akhmat & Khan, 2011; Jiusto & Hersh, 2009).

However, most recent studies published after year 2010 point at significant differences within each of the two categories. Many of these differences emerge from an enlargement of the geographical coverage of the studies: 15 out of the 36 countries listed in Fig. 3 appear in the sample of papers only in the most recent years. Some of the reported differences have their roots in the recent past. For example, studies focusing on Central and Eastern European countries describe how the application of the peri-urbanization model relates to the physical and governance structures of the former socialist cities, thus changing the concept of peripheral neighbor-

**Table 2**
Research questions and interpretation keys used in the review.

| Sub-question | Interpretation key | |
|---|---|---|
| **What type of urban peripheries and sustainable planning approaches are considered?** | | |
| What is the overall context? | Description of the spatial and temporal dynamics associated to the development and evolution of the analyzed urban periphery. Comparison with other contexts in different parts of the world and acknowledgement of differences. | |
| How are peripheries identified and characterized? | Keywords used to define the type of urban periphery considered. Description of features and processes that characterize peripheries and their development. | |
| What types of approach are proposed? (more than one category possible) | Planning paradigms | Description of overall approaches to planning that simultaneously address different issues (e.g., transportation, urban form, functions distribution). Planning paradigms are grounded on a theoretical definition of what a sustainable city is, and how it should look, usually with reference to a theory already present in the literature. |
| | Planning strategies and solutions | Description of planning actions that address specific issues (e.g., housing strategies, mobility solutions, local food production). |
| | Operational methods and tools | Description of methods and tools – including processes – applied to operationalize planning paradigms and to implement or assess planning strategies and solutions (e.g., planning documents, assessment frameworks, participatory processes). |
| **What challenges and recommendations are addressed?** | | |
| What limitations are discussed? | Acknowledgement or evidence of the limitations, including external barriers, that hinder the effectiveness of existing planning approaches in addressing urban peripheries. | |
| What risks and trade-offs are discussed? | Acknowledgement of the risks and trade-offs that may arise in the implementation of sustainable planning approaches due to specific features of urban peripheries. | |
| Is the approach transferable? | Discussion or testing of the applicability to other geographic, environmental, or socio-economic contexts. | |
| What recommendations are formulated? | Identification of the characteristics that make planning approaches effective in the context of urban peripheries, and suggestions for improving the existing approaches. | |

hoods (Roose, Kull, Gauk, & Tali, 2013; Stanilov & Sykora, 2012; Zamfir, Pascariu, Tălângă, & Ianoş, 2012). Other differences lie in current trends of development. 15 papers address megacities in India, China and South Africa, which share certain common socio-economic dynamics, but show very different forms and processes that characterize their new peripheries (compare, for example, Cash (2014); Randhawa & Marshall (2014); Sun, Li, Gwilliam, & Jones, 2013). Another set of recent studies provides insight into the specificities of industrializing countries in East Asia and Latin America (e.g., Haller, 2014; Kim, 2012; Mehta, Allouche, Nicol, & Walnycki, 2014).

Many authors acknowledge that peripheries and peri-urban areas are part of wider metropolitan contexts (Bunker & Houston, 2003; Hudalah, Winarso, & Woltier, 2007; Kim, 2012; Stanilov & Sykora, 2012; Talen, 2012; Vagneron, 2007). This issue is particularly noted in studies that describe the links between peripheries and core centers, either in terms of physical connections and flows (of goods, ideas and people), or in terms of processes, including population and urbanization growth, and other more specific processes, e.g., eco-gentrification (Goodling, Green, & McClintock, 2015). In some cases, the context does not directly refer to a certain administrative level, but is determined by "physical" aspects, e.g., watersheds in the case of Akdim, Gartet, Laaouane, and Amyay (2013) and Burgin, Webb, and Rae (2013), or by the "social" characters of local communities (Haller, 2014; Nanninga et al., 2012; Ramos-Santiago, Villanueva-Cubero, Santiago-Acevedo, & Rodriguez-Melendez, 2014; Randhawa & Marshall, 2014).

Where a comparison is made between different contexts, local specificities emerge at the very small scale, and differences are found within the same country and even the same metropolitan context. At the same time, similarities emerge among areas far from each other, which sometimes share certain peculiar features (e.g., the spatial distribution of settlements in mountain areas, as maintained in Haller (2014)).

### 3.1.2. *Definition and characteristics of urban peripheries*

The authors of the papers use several different terms to refer to urban peripheries (see Supplementary Material for a complete list). The most commonly adopted is "suburb", which (including its variations such as "suburban area" and "suburbia") is predominantly used to identify the study area of 44 papers. The term "suburb" appears to be quite generic, thus this first cluster includes very different types of peripheries. Given its generality, the term is often followed by some further specifications, to indicate an area with specific geographical location, e.g. in (Lebeau, 2013; Saville, 2009; Soltani & Primerano, 2005), or a typology of peripheral areas with a distinctive feature, e.g. "inner-ring suburbs" (Curic & Bunting, 2006; Goodling et al., 2015; Ramos-Santiago et al., 2014; Wilson & Berry, 2005), "outer suburbs" (Binder & Dalton, 2007; Tsenkova & Damiani, 2009; Wiblin, 2010), "high-density suburbs" (Boeri & Longo, 2012). Negative attributes recur in the description of suburbs, including landscape homogeneity and poor quality of urban spaces (Boeri & Longo, 2012; Moccia 2012), the presence of pollution and brownfields, poor housing conditions and social crises (Saville, 2009), and social and environmental vulnerability (Akdim et al., 2013).

22 of the reviewed papers use the term "peri-urban", and another 18 clearly point to the boundary between urban and rural using terms such as "fringe" (11 papers), "edge" (5), and "interface" (2). This second cluster of papers focuses on the dynamics at the margins of the city, characterized by processes of rapid urbanization and population growth (e.g., in Burgin et al., 2013; Kusukuoglu & Guler Aytac, 2013; Randhawa and Marshall, 2014), the loss of agricultural and natural land (Zivanovic-Miljkovic, Crncevic, &

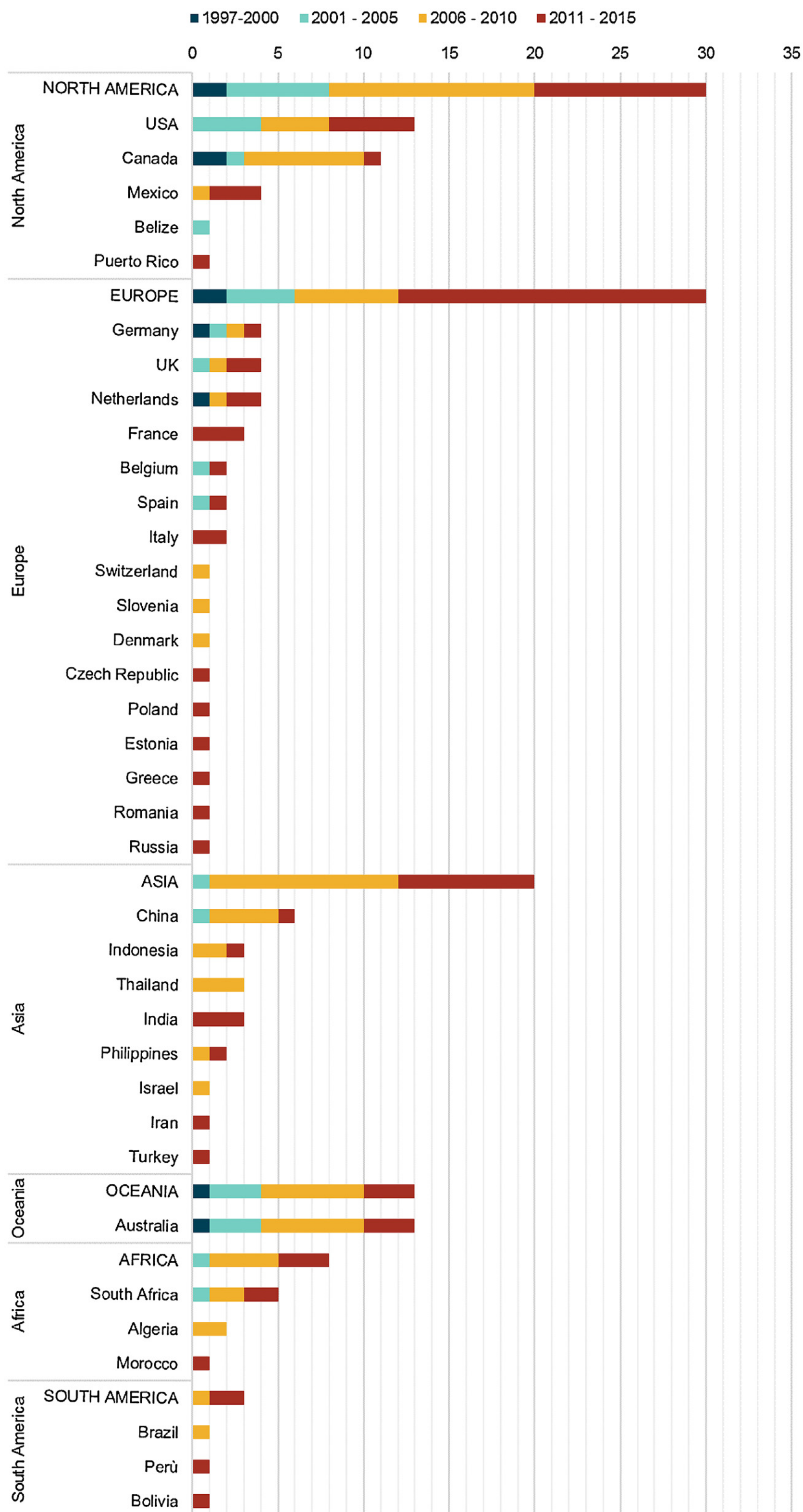


**Fig. 3.** Time distribution of case studies grouped by country and continent.

Maric, 2012), and chaotic development (Kusukuoglu & Guler Aytac, 2013). Governance is acknowledged as a key issue for these areas, which are frequently divided into different jurisdictions (Korthals Altes & van Rij, 2013; Randhawa & Marshall, 2014), characterized by administrative overlaps (Korthals Altes & van Rij, 2013; Mehta et al., 2014), or by political marginality (Cash, 2014; Nanninga et al., 2012), which may lead to informality (Mehta et al., 2014).

A third cluster of papers moves the analysis of peripheries to a wider scale by explicitly referring to peripheral/suburban/fringe municipalities and towns (5 papers), or to peripheral regions (9). A sub-group (7), cross-cutting the first two clusters, still considers a smaller scale but introduces the analyzed periphery as a part of a wider region, thus adopting a regional perspective. Here, peripheries are viewed as the result of shortcomings in urban and regional governance (Cilliers & Schoeman, 2008), where sprawl and car dependency are the main concerns (Epprecht, von Wirth, Stünzi, & Blumer, 2014; Marique & Reiter, 2012; Milakis & Vafeiadis, 2014; Stanilov & Sykora, 2012).

Overall, "sprawl" is the most frequently used term in the papers, and the most relevant feature of the majority of the analyzed urban peripheries, for example in (Epprecht et al., 2014; Talen, 2012; van Rensburg & Campbell, 2012). Resource-intensive settlements composed of a large proportion of single-family houses emerge as a common spatial trend that has appeared in the past 10–15 years at the edge of major cities all over the world (Leichenko & Solecki, 2008), leading to a multi-faceted demographic shift (Bunker & Houston, 2003).

#### 3.1.3. Planning approaches in urban peripheries

A total of 42 of the 102 papers make reference to planning paradigms, among which New Urbanism, Suburban retrofit and regeneration, and Smart Growth are the most frequently encountered. The level of planning strategies and solutions is covered by 49 papers describing a very diverse range of planning actions. The issues most commonly addressed are: urban form and density, urban functions and land uses, mobility, and building and urban design. Examples of actions include sustainable water management systems (Nanninga et al., 2012), retrofitting (Curic & Bunting, 2006), the promotion of sustainable mobility/means of transport (Soltani & Primerano, 2005), and a combination of these (Randall & Baetz, 2001). A total of 49 papers include a description of operational methods and tools, such as participatory planning, GIS-based methods, and scenario planning. The full list of planning approaches in the three categories is provided in the Supplementary Material.

### 3.2. Challenges and recommendations

#### 3.2.1. Limitations

The most common critiques address traditional planning approaches, which are viewed as difficult to apply in urban peripheries and not effective in achieving sustainability. Traditional land-use zoning is considered to act as a barrier to sustainable development in peri-urban areas. Indeed, it fails to consider their highly dynamic reality (Haller, 2014) and to safeguard the multifunctional use of spaces that support socially and environmentally sustainable practices, e.g., the use of vacant residential lots for urban agriculture (Hara, Murakami, Tsuchiya, Palijon, & Yokohari, 2013). Other traditional planning instruments, such as masterplans and design solutions at the neighborhood scale, appear unable to see peripheral areas as a whole and are hence inadequate to act as effective solutions (Cash, 2014; Roose et al., 2013; Talen, 2012). Moreover, such stand-alone instruments are vulnerable to formal and informal pressures on planning processes (Mason & Nigmatullina, 2011).

In contrast, regulations, especially at higher administrative levels, have not been criticized. Rather, there are concerns about the lack of binding norms to protect land and land uses that are considered valuable and strategic for achieving sustainable development. This is true not only with agricultural patches in peri-urban areas (Boudjenouia, Fleury, & Tacherif, 2006, Boudjenouia, Fleury, & Tacherif, 2008), but also with vacant lands in peripheral neighborhoods, where unplanned but socially relevant land uses can flourish (Foster, 2014). Additionally, regulations are believed to make sustainable planning more effective (Binder & Dalton, 2007; Boesch et al., 2008; Carruthers & Vias, 2005; Todes, 2004).

Many papers call for a revision in participatory practices to address fast-growing and changing urban contexts (Carruthers & Vias, 2005; Curic & Bunting, 2006; Hudalah et al., 2007; Todes, 2004). The existing participatory planning approaches still need major improvements and adjustments to local contexts to better promote sustainable development in urban peripheries (Burgin et al., 2013; Hudalah et al., 2007; Korthals Altes & van Rij, 2013; Todes, 2004). Nevertheless, some authors also highlight that constraints and barriers, such as the availability of human and financial resources, and time and political pressures, can hinder such improvements (Gilmour, Walkerden, & Scandol, 1999). Burgin et al. (2013) underline that stakeholder consultation is often limited to a small range of people who are not representative of the entire community. These authors also acknowledge that the engagement of more representative stakeholders and the identification of shared interests can be a lengthy process. Other authors question the genuine willingness of different stakeholders to participate in the planning process (Moccia, 2012; Poricha & Dasgupta, 2011; Saville, 2009). Moreover, external barriers may act against participatory processes. Akdim et al. (2013) cast doubt on the general extension of participatory processes to geographical contexts in which socio-economic conditions constrain community resources for participation.

Finally, other limitations raised in the papers concern the actual socio-environmental effectiveness of some sustainable planning approaches, and the measurability of the environmental effects of the sustainable development of urban peripheries (Deakin, 2002; Zimmerman, 2001). A lack of adequate spatial indicators (Tsenkova & Damiani, 2009) and good quality data (Rojas-Caldelas et al., 2008) is reported. To overcome this limitation, constant environmental monitoring, able to provide quantitative support to planning processes, is viewed as necessary (Saville, 2009; Wigle, 2010).

#### 3.2.2. Risks and trade-offs

The presence of risks and trade-offs related to the implementation of sustainable planning approaches in urban peripheries is acknowledged in over one-third of the papers. Processes of urbanization and peri-urbanization cannot be claimed as positive or negative per se, but produce both positive and negative outcomes that must be balanced by considering the local socio-economic and environmental context (Haller, 2014). When they fail to find the correct balance, even planning approaches that aim at sustainability may produce unexpected and unwanted results. In many papers, the possibility of generating sustainable and eco-compatible urban development is viewed as clashing with socio-environmental and, most of all, equity issues. Both the building of new sustainable peri-urban settlements and the retrofitting of existing peripheral neighborhoods may generate inequalities by providing opportunities for social groups to segregate and to gain preferential access to environmental amenities (Binder & Dalton, 2007; Leichenko & Solecki, 2008). It is also noted that frequently, ecological/environmental benefits (such as those offered by the proximity to natural areas) can be achieved only owing to low-density urban developments, which secure access to a limited number of people and at the cost of high environmental impacts: a model that is neither socially equitable nor environmentally sustainable (Aguilar & Santos, 2011; Zimmerman, 2001).

Focusing more on planning approaches, some authors report that the compact city may result in trade-offs with urban livability when it is not accompanied by investments in additional infrastructures and services (Westerink et al., 2013; McCrea & Walters, 2012). Above all, increase in density as a solution to sprawl poses the problem of the availability of green spaces for the growing urban population (Kusukuoglu & Guler Aytac, 2013; Ramos-Santiago et al., 2014). On the other hand, polycentric development and decentralization policies are not safe from risks, and can result in increasing fragmentation (Kim, 2012; Stanilov & Sykora, 2012).

Many other papers also discuss the trade-offs related to specific strategies and solutions that, although intended to promote sustainability, may eventually result in unsustainable outcomes. Sectoral policies that fail to consider other aspects and lack a holistic and comprehensive analysis of the urban systems of which the peripheries are a part often produce unexpected consequences (Armstrong & Ali, 2012; Boeri & Longo, 2012). In this respect, Clayton, Ben-Elia, Parkhurst, and Ricci (2014) discuss the case of park & ride facilities that aim to increase the share of public transport use, but may eventually result in the promotion of car transfers. When discussing the development of greenhouses in proximity to peri-urban residential settlements in the Netherlands, Korthals Altes and van Rij (2013) acknowledge the possible trade-off between soil sealing and the improvement in the local food chains.

"Hard infrastructure" planning that does not take into account socio-environmental aspects and the preferences and behaviors of people may generate unwanted and uncontrolled results. Examples include redevelopment projects that cause gentrification and segregation through the increase in property values resulting from large-scale greening projects (Goodling et al., 2015), and improvements in public transport facilities that increase the number of commuters, thus enlarging the distance between social and economic territories (Lebeau, 2013).

Given the many complex links among peripheries, urban centers, and rural areas, spatial and scale mismatches should be taken into account. The desire to live in pleasant (sub)urban environments may clash with the need for water conservation and sustainable management, for example, when it leads to increased water use for maintaining non-native plant species and water landscapes in dry contexts (Carruthers & Vias, 2005; Head & Muir, 2007). Local planning decisions driven by sustainable development principles but failing to foresee the externalities created at the regional level may promote unsustainable behaviors at a broader scale (Webber & Hanna, 2014). Sustainable transportation planning may resolve local issues but worsen global problems, as in the case of Chula Vista in California (Ryan & Throgmorton, 2003). In this example, planning solutions succeeded in providing safe and quiet residential neighborhoods with workplaces and shopping facilities within easy distances while also addressing local traffic problems, but they increased automobile dependency and fuel consumption.

*3.2.3. Transferability across contexts*

We identified a general tension between planning approaches that aim to be effective in facing common issues and a call for locally specific actions. For example, studies that compare and assess different urban forms (e.g., Farmani and Butler (2014) with respect to the performance of water distribution systems) involve paradigms that are supposed to be representative and valid for different contexts (e.g., the compact city, polycentric development, edge expansion). Strategies for acting on the urban form of a city are often considered generally applicable and leading to homogeneous results (see, for example, van Rensburg and Campbell (2012)). Nevertheless, a more detailed analysis of their implementation in different contexts reveals different, locally specific outcomes (Westerink et al., 2013).

The same holds for planning solutions: borrowing ideas, strategies and approaches from other geographical contexts seems to be a good starting point (Ryan & Throgmorton, 2003; Zivanovic-Miljkovic et al., 2012), but the need for a process of adjustment to the local conditions is always acknowledged. Decentralized technologies can be cost-effective and environmentally sustainable solutions for water supply and sanitation in peri-urban areas, but they must be tailored to each application context (Nanninga et al., 2012). The same strategy, e.g., the integration of car parking facilities with public transport, shows very different results when applied in different countries (Clayton et al., 2014), and principles such as those coming from Transit-Oriented Development approaches must be adapted to fit a specific reality (Milakis & Vafeiadis, 2014). All these examples reveal uncertainties about the real transferability of successful case studies to other geographical contexts, in which physical, environmental, and socio-economic conditions are different (Ryan & Throgmorton, 2003). Moreover, the institutional variable must be considered: many papers highlight that specific contexts call for specific solutions to incorporate sustainability in several respects of planning processes (Todes, 2004) and to fit the local specificities of spatial legislation (Harman & Choy, 2011).

*3.2.4. Recommendations*

The most suitable scale for planning urban peripheries is one of the main issues discussed in the papers. Some authors highlight that to be effective, planning approaches should be adjusted to fit the specificities of local contexts, in term of both spatial legislation (Harman & Choy, 2011) and institutional context (Korthals Altes & van Rij, 2013). For example, in the house scheme in the Netherlands, the national government provides only simple guidelines and money for development: this relatively de-regulated approach enables cities and regions to make their own individual plans and to tackle the specificities of each distinctive suburb (Lörzing, 2006). Frameworks and methodologies have been developed with the aim of tailoring "sustainable" principles and approaches to different contexts (Starkl, Brunner, López, & Martínez-Ruiz, 2013), particularly through the engagement of local stakeholders (Burgin et al., 2013). Enabling better civic engagement strengthen the planning process by increasing transparency and fairness (Poricha & Dasgupta, 2011; Mason & Nigmatullina, 2011).

On the other hand, authors also reported how the most suitable scale depends on the approaches or solutions applied (e.g., regional and sub-regional policies are necessary to tackle mobility issues, as in Clayton et al. (2014) and Zamfir et al. (2012)). Urban peripheries are often a cross-administrative boundary phenomenon. In particular, governance of peri-urban areas requires changes in the relations among different administration levels (i.e., at the metropolitan or regional level), making necessary new arrangements within the metropolitan areas where they are located. Overall, a combination of local and supra-local schemes (in planning, governance, regulations, agreements) is viewed as necessary (Akdim et al., 2013; Hara et al., 2013; Milakis & Vafeiadis, 2014; Webber & Hanna, 2014), and better coordination between different level of land-use planning is considered crucially important (Carruthers & Vias, 2005; Hudalah et al., 2007). This coordination may require more complex and advanced planning schemes (Lörzing, 2006) that are often unavailable.

In most cases, the integration of different planning levels also means an integration of traditional and innovative tools and approaches. Bunker and Houston (2003) maintain that the challenge lies in how to use new and traditional planning approaches and solutions in an appropriate combination. In particular, a different interpretation of zoning, e.g., "performance zoning" (Haller, 2014), can better address the characteristics of peripheries if it is embedded into a more comprehensive and strategic planning that considers peripheral areas as a whole (Cash, 2014; Roose et al., 2013; Talen, 2012). Additionally, the integration of traditional and bottom-up planning practices is identified as an important prerequisite for increasing the effectiveness of decision making, thus reaching the more ambitious goals of sustainable development (Hudalah et al., 2007). To that end, links among different planning levels should be revised and strengthened, involving all levels of the planning process, from the master plan to the subdivision plan and zoning (Gabor & Lewinberg, 1997; Lörzing, 2006; Paterson & Connery, 1997).

## 4. Discussion

### 4.1. Peripheries are not a focus of sustainable planning research

The relative low number of papers focusing on urban peripheries that was found in our search suggests that peripheries remain a marginal topic in research of sustainable planning approaches. This is also reflected in the lack of a shared definition of urban periphery among the reviewed papers. The social sciences have formulated many different definitions that describe peripheries starting from the socio-economic and institutional processes that determine their generation (Sassen, 2005). However, these definitions have a limited capacity to drive actions on peripheries, which can justify the fact that they are largely overlooked by the papers. No shared, practice-oriented classification of peripheries exists. As a consequence, those who focus on improving practices rather than framing the concept tend to use generic terms, such as the most frequent "sub-urban" (Forsyth, 2012) or "peri-urban" (Iaquinta & Drescher, 2000). Forsyth (2012), supported by numerous studies in social sciences, maintains that planning definitions shape our ability to view and tackle a problem. From this perspective, the many distinct planning approaches may be related to a not yet consolidated definition of urban peripheries.

No strong approaches emerge from the sample of papers, but instead a heterogeneous collection of case studies with a prevalent descriptive attitude. The high number of paradigms, strategies and tools that have been proposed and used in the reviewed papers (see Supplementary Material) demonstrates this finding: nearly 20 different theoretical planning paradigms have been cited in the sample of papers. The terms "sustainable development" and "sustainable planning" are widely used, but most often without an appropriate definition that goes beyond the idea of solving local negative conditions. Overall, scholars appear more focused on finding effective solutions for local issues than they are on framing these solutions in a structured and general context. Consequently, "conceptual distinctions between planning approaches important to theory become blurred in practice" (Grant, 2009).

### 4.2. Approaches are mainly context-specific and solution-oriented

As a result of what has been discussed in the previous paragraph, a very pragmatic and solution-oriented attitude, which can be summarized as "stop fighting with existing urban peripheries, but start improving them" (Wekerle & Abbruzzese, 2010), emerges from the review. Most of the papers describing planning approaches applied to face the "sustainability challenge" of peripheries tackle a specific issue (e.g., housing, mobility, water management) in a specific context. This finding is consistent with our finding that more papers focus on planning strategies and solutions than on theories. Moreover, the possibility of applying the same strategies in different contexts is hardly ever questioned or investigated. Even if, in some cases, there are doubts about the real transferability of successful case studies to other geographical and socio-economic contexts (Cilliers & Schoeman, 2008; Ryan & Throgmorton, 2003), very few researchers compare the application of the same strategies and methods to different realities (but for an outstanding exception, see Westerink et al. (2013)).

The types of planning approaches described in the papers reflect the same tension identified between global peri-urbanization trends and the local specificities of urban peripheries. Two main influences on the current planning approaches can be recognized. The first influence comes from traditional urban planning, which is mostly oriented toward the governance of physical transformations of the built environment. The second comes from the social sciences-oriented tradition, which is mostly focused on participatory processes and stakeholder involvement. The two influences reflect the distinction between "substantive" and "procedural" theories in the theoretical orientation of planning approaches (Ahern, 2006). In their paper, Scott et al. (2013) distinguish between the two alternative paradigms of spatial planning and ecosystem approach as the two "competing lenses within which to view, manage and improve policy decisions": the concept of spatial planning focuses on the built-environment, while the ecosystem approach focuses on the natural environment. Among the planning paradigms found in our sample, a great majority refer to the concept of spatial planning. This finding is consistent with worldwide diffusion of the paradigms of the compact city, Transit-Oriented Development, and New Urbanism that aim to solve the problem of sustainability by focusing on urban form and the spatial distribution of functions inside cities.

However, the real outcomes of these approaches on socio-economic, cultural, and environmental factors appear weak and sometimes questionable. Some critiques have been raised by scholars about the possibility of measuring sustainability in the development of urban peripheries and, therefore, about the possibility of assessing the effectiveness of sustainable planning approaches (Deakin, 2002; Zimmerman, 2001). Several uncertainties have emerged, especially with regard to short/long-term environmental sustainability (Berke et al., 2003; Deakin, 2002; Lörzing, 2006), and the potential unwanted outcomes and trade-offs. Sustainable models for urban peripheries have been unable to show whether the solution proposed is ecologically sound and even whether it can be considered livable (McCrea & Walters, 2012). Not only evidence from the data (Deakin, 2002), but also shared and accepted methods for assessment designed specifically for urban peripheries are missing. We found only one comprehensive assessment method to measure the overall sustainability of a new settlement (Smith, 2015), and interestingly, its criteria mix the principles of three different spatial planning paradigms, thus indirectly affirming the partiality of each of them.

On the other hand, the need for planning approaches tailored to local contexts emerges from the great number of papers that address or call for some forms of participatory planning. The engagement of local stakeholders and communities in the planning process should guarantee the consideration for local specificities (Haller, 2014), the applicability of the solutions proposed (Nanninga et al., 2012), the transparency of the process (Mason & Nigmatullina, 2011), and the relevance and equity of the results (Randhawa & Marshall, 2014). However, participatory planning itself is not safe from the uncertainties and risks related to its effectiveness: participation is conditioned by the socio-economic and cultural conditions (Akdim et al., 2013) to which the methods must be tailored (Hudalah et al., 2007), and the representativeness of the local stakeholders involved is often overestimated (Burgin et al., 2013).

The promising concept of sustainable development was expected to improve planning practice by overcoming the shortcomings of both physical design and participatory approaches (Berke, 2002). Nevertheless, planning approaches that embrace a wide understanding of sustainability by jointly addressing all its three dimensions through a coherent combination of substantive and procedural principles are still rare. Moreover, new or innovative ecological approaches (e.g., ecosystem services-based planning, geodesign) are hardly ever mentioned in the reviewed papers. Although the negative consequences of peri-urbanization processes for the environment are broadly acknowledged, this does not seem to influence how urban peripheries are planned and managed.

### 4.3. The relational character of urban peripheries requires integration among different scales and sectors

Urban systems are dynamic and complex adaptive systems that modify their spatial and socio-economic structures over time, following non-linear behaviors that may lead to diverse outcomes (Levin, 1998). Parts of the city that were once "peripheral" are today recognized as "central". Thus, the most common feature of peri-urbanization processes that we found in the papers is the progressive colonization of the agricultural and (semi)natural landscapes through different land-use changes. Peri-urban areas are progressively acknowledged as distinct areas with proper features. Some authors highlight that new functions, not properly urban or fully rural, emerge in these spaces (Korthals Altes & van Rij, 2013). Moreover, they should not be viewed as transient spaces doomed to disappear or to be absorbed by the city (Mehta et al., 2014). Changing perspective makes it possible to overcome the so-called urban-rural dichotomy (Champion & Hugo, 2004; Inostroza, 2014), and to identify some issues that arise in relation to core cities, as the more recent literature has started to acknowledge. These issues include not only negative or problematic processes, such as eco-gentrification (Goodling et al., 2015) and competition for resources (Burgin et al., 2013; Mehta et al., 2014), but also positive opportunities, such as the re-use of abandoned spaces and infrastructures (Foster, 2014) and more sustainable food production for the urban population (Hara et al., 2013; Korthals Altes & van Rij, 2013).

These recent research works strengthen the acknowledgement of the relational character of urban peripheries. Indeed, several papers recognize the need to consider contemporary urban peripheries as part of wider metropolitan systems (Ros-Tonen, Pouw, & Bavinck, 2015) that range from large urban agglomerations to smaller local metropolitan areas. This finding is in line with the current debate on the most effective administrative level at which to plan such systems (Kline, Thiers, Ozawa, Alan Yeakley, & Gordon, 2014). Understanding the continuous changes that occur in the functional and socio-political relations between the urban core and peripheries, and framing these changes in their institutional and administrative context are prerequisites for effective planning (Salet et al., 2015). The "metropolitan" condition of peripheries requires working on more complex relations than those between a specific peri-urban area and its reference core city or rural landscape. The need to face cross-administrative boundary phenomena and to address the issues that are relevant at different scales (e.g., the relation between mobility and the urban form) requires innovative tools that are able to integrate different planning levels and sectors. Planning instruments should support horizontal and vertical integration by promoting or consolidating cooperation between stakeholders.

Moreover, the dynamic character of urban peripheries calls for flexible tools that avoid "end-state" solutions through monitoring and feedback loops (Steiner, 2014). To that end, many authors suggest a combination of different approaches (i.e., traditional and innovative, top-down and bottom-up) that work at different scales (i.e., the more strategic at the regional and metropolitan level with the more operational at the very local level). The shortcomings of traditional approaches – in particular, traditional zoning – that emerge from our analysis are similar to other, more general critiques of their application in urban planning (Hall, 2011; Wickersham, 2001). However, some of the suggested solutions are not yet ready to use. For instance, this is the case with performance-based planning, in which implementation represents a major challenge even for administrations with high institutional capacity, as claimed by Baker, Sipe, and Gleeson (2006).

On the other hand, only a few papers define the "peripheral condition" as relevant to regional urban systems. What has been said about scale integration within metropolitan systems is also acknowledged at the regional level (Milakis & Vafeiadis, 2014; Todes, 2004), and some strategies explicitly address the regional scale (e.g., conservation planning (Webber & Hanna, 2014)). However, the analysis and understanding of regional peripheries remain outside the current discussion about sustainable planning approaches to urban peripheries.

### 4.4. A final remark on the opportunities offered by urban peripheries

The high number of papers that acknowledge the presence of the risks and trade-offs that possibly emerge in urban peripheries demonstrates awareness of the challenges that sustainable planning approaches must face. Actually, many different limitations and trade-offs, especially related to inequalities of access to resources and environmental sustainability over time, are acknowledged in the analyzed literature, in line with other streams of research on socio-environmental trade-offs in urban systems (Lauf, Haase, & Kleinschmit, 2014). However, resources and opportunities for sustainable planning of urban peripheries are seldom discussed. Very few papers highlight the presence of positive elements, and even fewer go beyond simple acknowledgement to demonstrate how it is possible to act on them. Some intrinsic environmental potentials of peripheries can be exploited. For example, Rothwell, Ridoutt, Page, and Bellotti (2015) demonstrate that infilling housing in peri-urban areas with food production has a lower environmental impact than a more traditional greenfield development. Abandoned spaces and vacant lands can be turned into positive resources that increase social-ecological opportunities (Foster, 2014) and offer more sustainable food production for the urban population (Hara et al., 2013), embedding agricultural values that are also increasingly attractive to the public (Friedman, 2007). Exurban areas also offer interesting opportunities for carbon sequestration, and large parcel sizes may promote carbon-storing management behaviors by exurban land owners. In planning terms, this implies that parcel size has a relevant legacy effect that may affect future carbon storage in exurban residential landscapes (Nassauer et al., 2014; Visscher, Nassauer, Brown, Currie, & Parker, 2014)

Resilient peripheries can also exploit the opportunities embedded in low-density developments (such as cross-ventilation, space for food production, on-site regulation of water run-off and power generation) to protect residents from heat stress, extreme climatic events, and disruptions in resource supply systems – especially food (Gleeson, 2008). The same also applies to social and cultural potentials. Even if it has been claimed that there is an overall contradiction between what people support in terms of sustainable development and their personal preferences and lifestyles (Delucchi & Kurani, 2014), this contradiction should not be taken as an excuse, but instead should be accepted as a challenge for planning to address sustainability issues through more holistic approaches. A positive planning attitude makes it possible to turn constraints into resources, and to disclose opportunities. For example, Head and Muir (2007) show how trade-offs among different uses of water can be useful in improving awareness about the scarcity of the resource among the residents of peripheries, thus activating engagement for sustainable water usage.

As demonstrated by these examples, the many resources that are present in peripheries, together with their dynamic character, should be considered as opportunities to test and develop win–win strategies that are able to resolve the reported trade-offs, and to guide the peri-urbanization process to more sustainable outcomes. To this aim, shifting the conceptualization of peripheries and the peri-urban interface from the traditional zoning criteria (density, morphology, land uses) to ecological approaches is crucial. This also allows a better understanding of the social and economic consequences of peri-urbanization processes (e.g., in terms of environmental intra- and intergenerational equity), and the assessment of planning approaches against the carrying capacity of the territory (Allen, 2003). Ecological approaches, especially when aiming at the implementation of ecosystem-based actions, are known to be effective, no-regret options for planning to address human well-being (Geneletti & Zardo, 2016). Given the relevance of decisions on peripheries and peri-urban areas in determining the spatial typology (densification versus sprawl) and the characteristics of city development (e.g., compliance with sustainability and climate change goals (Cash, 2014)), these options, which are already present in the portfolio of sustainable planning approaches, should not be ignored.

## 5. Conclusions

Almost 30 years after the Bruntland Report, the application of sustainability principles to real-world practice is still widely debated. The recent signature of the UN Sustainable Development Goals (UN General Assembly, 2015) demonstrated that actions towards a more sustainable planet are still at the center of international debate. The agenda defines a broad set of sustainability goals and targets, among which one goal (#11) is specifically dedicated to more resilient and sustainable cities. However, as noted by Frantzeskaki, Kabisch, & McPhearson (2016), more than half of the goals can actually be achieved only acting on cities and urban systems.

The New Urban Agenda, adopted during the 2016 UN HABITAT III meeting in Quito, clearly states the role of spatial planning in the implementation of sustainability policies for peripheries and peri-urban areas. Particularly, the agenda encourages to increase the urban – peri-urban connectivity, to be achieved by designing coordinated and sustainable transport-land use planning and sustainable urban development programmes to avoid peripheral and isolated mass housing developments detached from existing urban cores. The agenda also gives a lot of attention to improving the informal urban peripheries (urban slums), as a way to eradicating urban poverty, by improving the accessibility to important public facilities and rising the quality of public spaces (UN General Assembly, 2016). As such, “our common future” depends on the effectiveness of planning approaches in leading the sustainable transformation of urban systems, particularly of the most complex and least sustainable portions that are often represented by their peripheries.

This paper reviewed the literature on the application of sustainable planning approaches in urban peripheries. What emerges from the review is an image of diverse types of urban peripheries, difficult to reduce and to classify. As a consequence, the planning approaches, and the research streams, are also various and scattered. Overall, we found that urban peripheries are not central in sustainable planning research, and that the proposed approaches focus more on solving context-specific issues than on providing comprehensive frameworks for sustainable planning. Several papers recognize the need for considering contemporary peripheries and suburban areas as part of wider metropolitan systems in a complex relation with both the core cities and the rural surroundings. Doing so requires new and multi-scalar planning instruments and spatial policies.

Some future directions for research can be drawn from the results of our review. The first focuses on transferability of the proposed approaches by testing them in different contexts to identify their potentials and limitations. Many examples from the papers reveal uncertainties about the transferability of successful case studies to other geographical contexts. Future research should address key contextual factors, such as the scale of application, the influence of the institutional framework, and appropriate methods for the involvement of local stakeholders. The second research direction concerns methods for evaluation of the socio-environmental effects of planning approaches. As shown by many of the case studies discussed in the papers, specific strategies and solutions intended to promote sustainability may eventually result in unsustainable outcomes if effects on different sectors or at different scales are not foreseen and properly addressed. The example of urban densification that reduces sprawl but limits green space availability for the growing urban population is emblematic of the need for balancing trade-offs. Methods for the assessment of planning approaches should provide evidence about the extent to which a proposed solution can be considered sustainable and livable.

Moreover, unexploited opportunities to enhance planning practice emerge from our review. In particular, these opportunities lie in the application of planning approaches aimed at valuing the local resources of urban peripheries, including both environmental resources (e.g., through ecosystem services-based approaches) and socio-economic resources (e.g., through the integration of bottom-up processes into top-down approaches). To be effective and address trade-offs that may arise between different sectors, areas, and scales, sustainable approaches should promote the integration among different planning fields and institutional levels, and among the respective stakeholders. The implementation of adaptive and performance-based approaches, grounded in regular monitoring, should help overcome fixed and singular solutions, and increase the overall sustainability of urban peripheries.

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## Appendix A. Supplementary data

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# VI

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Editorial

# Special issue on sustainable planning approaches for urban peripheries

## 1. Aims, background and research questions

As urban systems of varying intensity and character grow worldwide, peripheries increase both in number and typology, and their growth is highly dependent on local territorial and socio-economic conditions (UN-Habitat, 2013). Peripheries are the outcome of economic and political decision-making at different scales (global, national, regional or local), including the logic of uneven geographical development in capitalist societies, which can be present in both developed and less developed countries. In some parts of the world, urban peripheries are detached from physical, social, economic, institutional and cultural networks and are thus isolated from global flows (Castells, 1989).

Approaches to sustainable planning can be considered a combination of knowledge, science and creativity to design, evaluate and implement a set of justified actions within the public domain to achieve the three major dimensions of sustainability: environmental, economic and social (Berke & Conroy, 2000). It is crucial for planning research to increase understanding of how urbanisation processes in peripheral contexts might improve sustainability of peripheries and their wider metropolitan contexts. Furthermore, despite the growing body of research on sustainable planning of urban systems, many challenges remain to integrate approaches into real processes of planning, management and design, mainly due to the separation between suppliers and users of scientific information (Brandt et al., 2013).

This Special Issue aims to increase understanding of whether and how planning approaches can achieve sustainability goals in urban peripheries. Contributions of this Special Issue addressed the following research questions:

- What are the characteristics and peculiarities of urban peripheries worldwide?
- What are some approaches to sustainable planning of urban peripheries?
- How should existing planning approaches be updated or reformulated for more effective employment in urban peripheries?
- Which are some uncertainties and limitations about the effectiveness of these approaches?
- Which trade-offs can be identified and addressed by sustainable planning approaches within the context of urban peripheries?

These research questions were elaborated and discussed in a symposium held during the IUFRO-Landscape Ecology conference in Tartu, Estonia, in August 2015, in which guest editors and contributing authors participated.

## 2. Structure and themes of the special issue

Articles included in this Special Issue cover case studies that vary in both scale and geographical coverage, describing cases in eight countries on four continents (Peru, Chile, China, Malaysia, Ghana, Switzerland, Slovenia, Scotland, Belarus, Russia). Most research about sustainable planning has been done within the Northern Hemisphere (Cilliers, du Toit, Cilliers, Drewes, & Retief, 2014), but knowledge and case studies from developing countries are fundamental to get new insights about the potentials and limits of sustainable planning approaches. For this reason, research and case studies from developing countries were important to this Special Issue, which includes a literature review (Geneletti, La Rosa, Spyra, & Cortinovis, 2017), essays on particular peripheral contexts (Haller, 2017; Shkaruba, Kireyeu, & Likhacheva, 2017), studies developing and testing decision support methods and tools (Barau, 2017; Fan, Xu, Yue, & Chen, 2017; Inostroza, 2017; Zlender & Thompson, 2017) as well as planning experiences (Grêt-Regamey, Altwegg, Sirén, van Strien, & Weibel, 2017; Kleemann et al., 2017).

### 2.1. Main themes and topics of the articles

The existing literature about sustainable planning and peripheries was reviewed by Geneletti et al. (2017), including 102 articles dealing with sustainable planning issues in urban peripheries. The relatively limited amount of literature highlighted that peripheral contexts are not central in research on sustainable planning approaches and that there is a lack of classification of peripheries that would be useful for planning. The reviewed articles describe planning approaches that are mainly context-specific and solution-oriented, aimed at responding to local socio-economic and ecological issues, and their transferability to other geographical contexts is limited. However, the authors identified some approaches to increase social-ecological opportunities and offer more sustainable food production for the peri-urban population.

A frequent topic addressed by articles of the Special Issue is how to plan for equity in accessibility to urban green spaces in peripheral contexts.

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Green spaces located outside the urban core—such as woodlands, fringe forests, country/agricultural parks, peri-urban open spaces—are sometimes appreciated by users for recreation and leisure activities even more than intensively maintained green areas because they provide a diverse kind of 'nature' and satisfy different recreational needs (Rupprecht, Byrne, Ueda, & Lo, 2015). Fan et al. (2017) addressed the issues of accessibility of greenspace at the metropolitan level for Shanghai, measuring the spatial-temporal accessibility for residents to different—in type and size—public urban green spaces located in peri-urban areas. Green spaces were characterised using accessibility and other indicators of quality (e.g., spaciousness, quietness, affordability and area size). The work's results identified hot and cold spots of accessibility deserving particular attention from urban planning. Accessibility of green spaces in peri-urban contexts has been analysed from a more social perspective by Žlender and Thompson (2017), who explored the preference of residents for the use of peri-urban open spaces in two cities (Ljubljana and Edinburg) in order to understand factors that affect the use and accessibility of these spaces. Results gathered from questionnaires and focus groups showed that citizens in Ljubljana use green wedges quite often because these spaces allow easy access to the city-centre, while the green belt in Edinburgh is used for recreational purposes much less frequently than the other green spaces present within the city.

Participatory planning and co-planning are explored by Grêt-Regamey et al. (2017) and Haller (2017). Grêt-Regamey et al. (2017) proposed that the engagement of stakeholders and other actors can be effectively facilitated through visualisation tools and generation of interactive 3D maps of development scenarios; hence, this could contribute to promoting the procedural aspects of sustainability. Haller (2017) stressed the importance of including smallholder farmers in peri-urban areas from the early stages of the planning process. He found that new dwellers of peri-urban areas demonstrated a surprising empathy toward smallholders—who perceive a number of advantages and disadvantages of urban development in the lower Shullcas Valley in the Peruvian Andes. For this reason, the improved mutual understanding would probably facilitate collaborative planning procedures in complex rural–urban peripheries and with shared solutions to the trade-offs that arise from peripheral development.

An important theme emerging from many articles is a need for new forms of spatial governance for the fast changing territories of urban peripheries. Geneletti et al. (2017) found that the 'metropolitan' condition of contemporary peripheries requires addressing more complex spatial relations than those between a specific peripheral area and its reference core city. One of the most relevant is the cross-administrative boundary phenomenon, according to which, municipalities belonging to the same metropolitan area can address the same issues in different ways. Fan et al. (2017) provided an example that concerns the accessibility of green spaces. These authors emphasized that the spatial pattern of green space accessibility should be considered at different levels (overall, neighborhood, district and city/metro-levels) in order to evaluate where green spaces are most needed. Shkaruba et al. (2017) analysed the dramatic changes in institutional systems of the former USSR, showing how the legacy of socialist planning systems (with typical top-down spatial governance systems) still strongly influences the management of urban developments in peripheral areas of Belarus and Russia. The authors describe the properties of the rural-urban peripheries of Mahilioŭ and Pskov and the land-use pressure on ecosystems; they discuss the 'regulation dilemma' in Belarus and 'sovereign democracy' in Russia. Barau (2017) focussed on the negative outcomes generated by land-use planning decisions in peripheral areas of Malaysia. The author analysed changes to the landscape that were driven by planning and development of special economic zones established by national government to promote investments in the peripheries. Among local residents, he found widespread dissatisfaction with the effects of these investments, including changes in the composition and structure of the landscape.

Informal urban development is addressed by the articles of Inostroza (2017) and Kleemann et al. (2017). Inostroza (2017) developed a method to spatially characterize and quantify the level of informality in the peripheries of three capital cities of Latin America based on specific material features of urban development. Kleemann et al. (2017) analysed the main drivers of patterns of peri-urban development in two study areas in Ghana using an interdisciplinary approach that combined expert interviews, literature review and land-use change analysis. Their results demonstrate how different patterns reflect both the effectiveness of existing land-use planning instruments and the diverging geographical, historical, cultural and economic characteristics of the two study areas.

## 3. Answering research questions

### *3.1. What are the characteristics and peculiarities of urban peripheries worldwide?*

Many contributions addressed the changing character of urban peripheries during socio-ecological transitions. Shkaruba et al. (2017) analysed examples of urban peripheries of cities in the former USSR undergoing severe social and economic changes, in which significant pressures for urban development in rural-urban fringes started after the economic transition in the 1990s. As a side effect of the very restrictive and centralized planning system of the former USSR, urban planning has often been seen as an obstacle to modern development of the city. Consequently, existing, binding planning regulations have frequently been violated in urban peripheries. The implementation of land-use plans has been further hindered by the overlap of two types of institutions: those functioning before economic transition, and those established afterwards. Shkaruba et al. (2017) presented two case studies of post-Soviet cities in Belarus and Russia where rural-urban peripheries went through a socio-economic transition that display a complex interplay of socialist and post-socialist institutions.

Peripheries in Latin America have been explored by Inostroza (2017), who discussed informal urban developments in settlements in Lima, Santiago del Chile, and Bogotà as new urban peripheral contexts that are quickly built up and grow rapidly as part of the wider metropolitan context. The author stressed the significance of informality of these peripheries, and the severe health and safety hazards, environmental degradation, pollution and inadequate sanitary conditions resulting from unsuitable settlement conditions. These peripheries vary in their spatial pattern—e.g., highly compact and attached to the more compact urban area in Bogota, highly fragmented in Lima, and diffuse with high fragmentation in Santiago. Acknowledging the difficulty in finding a particular characterization for urban peripheries in Latin America, Inostroza (2017) underlines that the growth of urban peripheries is common in all medium-big cities of Latin America.

The issue of development of informal settlements is also analysed by Kleemann et al. (2017), who identified weak forms of planning and governance as key driving forces, together with population growth, immigration from the countryside, and job opportunities in Ghana. The authors also analysed the creation of new urban centres in Ghana, where the lack of structured urban planning instruments has generated uncontrolled sprawl of new settlements. Specifically, the authors demonstrated how different peri-urban patterns in the north and south of Ghana reflect the weak effectiveness of land-use planning instruments, as well as differences in population growth, markets, industry (especially oil industry) and land tenure. Unplanned and uncontrolled city growth at the fringes often results in spatially inefficient use of the land, with scattered building densities, uneven building sizes, mixed land-uses and generally fragmented development (Kleemann et al., 2017).

Haller (2017) studied the particular peri-urban context of Huancayo Metropolitano in the Peruvian Andes, where urban development is affecting the properties of smallholder farmers. This periphery has expanded over agricultural land in recent decades following the preference of the emerging middle class for peri-urban residential locations and generating tension between farmers and new residents.

Barau (2017) analysed a different kind of social and ecological tension in Southeast Asia, where Special Economic Zones have generated ecological and social risks in urban peripheries. The author examined public opinion on the role of one of the largest Special Economic Zones in Iskandar, Malaysia. This is an area characterised by a mix of rural-urban, natural-cultural, formal and informal activities, where large infrastructure networks are rapidly transforming the landscape fabric. The research demonstrates effects on isolation and separation of communities, the distribution of and accessibility to open spaces and green areas, as well on the area's vulnerability to sea level rise.

The urban peripheries described by Grêt-Regamey et al. (2017) in the Swiss region of Thun are expected to grow considerably in the next decades, and most municipalities in the region need to identify new zones for housing. The study revealed that many of these urban peripheries play an important role in the provision of key ecosystem services, beyond food production. Particularly, calm recreational areas, ground water recharge and habitat for species/ecological connectivity are among the most important services in these urban peripheries.

### 3.2. What are some approaches to sustainable planning of urban peripheries?

Novel tools and methods to support planning and facilitate decision processes are proposed in this Special Issue. Grêt-Regamey et al. (2017) advanced a Spatial Decision Support Tool aimed at facilitating the allocation of urban development areas within a selected perimeter. The approach is based on Multi-Criteria Decision Analysis integrated into a web-based platform and allows for effective interaction between stakeholders and planners. With reference to more traditional Spatial Decision Support Systems, the model by Grêt-Regamey et al. (2017) incorporated the concept of ecosystem services into the evaluation of new urban developments in a peripheral area of Thun, Switzerland. This may be an innovative and promising way to engage stakeholders and other actors through visualisation tools and scenario generation, offering a bottom-up approach, and contributing to the promotion of the procedural aspects of sustainability.

Another example of the use of spatial information and GIS-based approach to planning is presented by Inostroza (2017), who spatially quantified and characterised the particular features of 'informality' in new urban peripheries of Bogotà, Lima and Santiago del Chile. Specifically, the degree of informality was assessed in relation to physical characteristics of the urban environment, such as the specific materials that have been used for the development of these areas. Infrastructural, material and overall informality were assessed through spatial indicators based on census data.

GIS-based approaches have also been the focus of the work of Fan et al. (2017), which developed a Green Accessibility Index to spatially analyse access to green space located in the peri-urban contexts of the metropolitan area of Shanghai—an exemplar case study for fast and massive urban development. The use of the proposed index allowed authors to depict a rather differentiated picture of green space provision, both in terms of quantity and accessibility to citizens, demonstrating how peripheries still fell behind average values of green spaces' accessibility when considering the entire city.

Barau (2017) describes planning approaches for the re-development of urban peripheries that are not likely to generate sustainable outcomes. The case of Special Economic Zones in Asian peripheries is described as a top-down planning approach that may undermine the culture of private land development initiatives of the emerging middleclass, which creates private urban spaces based on aspirations, economic status and cultural horizons.

In analysing dynamics of land-use with reference to open space and related ecosystems for the cities of Mahilioŭ (Belarus) and Pskov (Russia), Shkaruba et al. (2017) found two very different approaches for the planning of open spaces and green areas: one that pushed for a more compact city inherited by socialist planning tradition (and existing spatial regulations/governance), and another that pushed for low-density sprawled settlements.

### 3.3. How should existing planning approaches be updated or reformulated for more effective employment in urban peripheries?

The implementation of a Multi-Criteria Decision Support approach within a web-based spatial decision support tool described in Grêt-Regamey et al. (2017) provides two main contributions to update and adapt planning processes in urban peripheries: (1) raising awareness about nature's limited resources and nature's different values in urban-rural landscapes; and (2) integrating stakeholder preferences by individual selections of criteria and weights that can be tailored to the need of the local context. Results from Grêt-Regamey et al. (2017) also showed that the Ecosystem Services framework must be embedded in a precise policy context such as spatial planning normative (at the national, regional or municipal level) in order to be truly effective.

This is in line with what Geneletti et al. (2017) found in their review: planning regulations, especially at higher administrative levels, are seen as valuable and strategic to frame the objective of sustainable development (i.e. the farmlands' protection in peri-urban areas) within a normative framework to which spatial plans must adhere. New planning instruments are therefore needed to integrate planning levels and sectors and support horizontal and vertical integration by promoting or consolidating cooperation among stakeholders. To this end, links among different planning levels should be strengthened. For example, Fan et al. (2017) stressed the need for coordination amongst different levels of planning for a more equal inclusion of green spaces in urban contexts and to take into consideration the preferences of residents for different types of green space.

Kleemann et al. (2017) proposed that in order to decrease pressures for housing development and informal settlements at the urban fringes, municipalities should adopt spatial plans aimed at densification of urban centres (for example with multi-storey buildings) and public housing. This should be linked to planning laws and regulations to be developed by national and regional governments and new planning bills could be introduced to improve and unify existing laws and regulations.

Inostroza (2017) recommended that urban planning should pay more attention to informality and its specific spatial patterns in relation to urban development and the emergence of urban peripheries. To this end, effective methods for understanding and measuring informal urban development are needed to define planning solutions that are able to revisit existing planning decisions by considering tenure factors. For example, informality might allow adaptability to local social tensions and, if governed by planning, might provide complementary services (i.e. alternative transportation services as in Oviedo Hernandez & Titheridge, 2016) that are inadequate in peripheries.

The peripheral contexts analysed by Shkaruba et al. (2017) need to shift from urban planning based on functional zoning (typical of Soviet planning systems) to more flexible and inclusive planning. The zoning-based planning systems, implemented under great pressure from the 'socialist economy' paradigm, reduced planning actors to just one—the most powerful one, the state, which acts within a certain economic (e.g. neoliberal) framework (Shaw, 2016). There is an urgent need to make the outcomes of participatory planning usable for and reflected in official and binding planning documents. One way to achieve this is to strengthen civic society and encourage its representatives to take active part in the planning process (Shkaruba et al., 2017). The same authors advocated an increase in transparency of participatory planning applied to urban peripheries and the participation of civic society to counterbalance the domination of the state in the planning process.

Fan et al. (2017) identified areas with low accessibility to green spaces in high-density peripheries that require greater attention from planning and policy; for example, financial transfers from the municipal government are seen as necessary to improve green accessibility. The comparison of accessibility to green spaces made by Žlender and Thompson (2017) (green wedges for Ljubljana and green belts for Edinburgh) showed how different strategies for green space planning can determine access to and use of peri-urban green spaces. To this end, the authors recommend including green corridors as part of wider green space strategies and making these areas more accessible by integrating sustainable means of transport (i.e. walking, cycling or the use of public transport).

Haller (2017) stressed the importance of including peri-urban smallholder farmers from the early stages of the planning process in peri-urban areas, in order to improve the mutual understanding of needs and expectations of the different stakeholders involved in the planning process (particularly for the urban development in peripheral farmlands).

### *3.4. Which are some uncertainties and limitations about the effectiveness of these approaches?*

It is not clear that sustainable planning approaches that are relevant to one place are transferable to other peripheral contexts. Strategies and approaches must always be adjusted to local conditions and needs of a particular peripheral context (Geneletti et al., 2017). Kleemann et al. (2017) has stressed that each case of urban development or transformation is place-specific, so planning decisions must always be specifically adapted to the given political, economic and cultural context of the region. Similarly, Inostroza (2017) proposed that, given the diverging conditions of informal developments in peripheries, planning approaches should be specifically adapted to the local spatial and functional patterns and the degree of informality in a place.

Grêt-Regamey et al. (2017) pointed to uncertainties related to the choice of criteria and factors that should be considered in Multi- Criteria Decision Support Systems when identifying areas for new development in urban peripheries. This seems to be a limitation that can be addressed by fostering public participation to ensure that local values are reflected in planning choices.

In their review, Geneletti et al. (2017) identified a limitation of traditional planning approaches, which are viewed as inadequate to increase the sustainability of peripheries. For example, rigid land-use zoning, is an obstacle to sustainable development of peripheral contexts when it fails to safeguard their multifunctionality.

Though the central role that participatory planning plays in sharing sustainability objectives has been acknowledged in many articles (Grêt-Regamey et al., 2017; Haller, 2017; Kleemann et al., 2017), the review performed by Geneletti et al. (2017) identified some concerns regarding the effectiveness of participatory planning. These concerns particularly regard the actual representativeness of involved stakeholders, their willingness to participate in the planning process over longer periods and the time and financial resources required. Participatory planning approaches need to be adapted to local contexts to better promote sustainable development of urban peripheries; for example, establishing formalized platforms where all actors can meet and cooperate is a necessary step in adapting existing planning approaches to urban peripheries (Hedblom, Andersson, & Borgström, 2017). Furthermore, in some cases, participatory processes are perceived as difficult to understand or communicated ineffectively to non-professional actors. This allows planning decisions to be taken ad-hoc and ex-cathedra by the strongest actors involved in the process (Shkaruba et al., 2017).

Žlender and Thompson (2017) identified some disadvantages in planning strategies for green space in the case studies of Edinburgh and Ljubljana. For example, the green belt in Edinburgh has been rarely used for recreational and leisure purposes because of the time needed to reach it.

### *3.5. Which trade-offs can be identified and addressed by sustainable planning approaches within the context of urban peripheries?*

Geneletti et al. (2017) discussed many trade-offs identified in current literature. When they fail to find a correct balance, even sustainable planning approaches may produce unexpected outcomes, such as issues of social and spatial equity in new “sustainable” peri-urban settlements. In fact such settlements may generate inequalities by providing opportunities of access to environmental amenities or services for specific social groups, or can produce ecological or environmental benefits for only a limited group and at the cost of environmental impacts.

Social inequality is also the main trade-off associated with the economic-oriented development of urban peripheries reported by Barau (2017). Public accessibility to common pool resources was either reduced or entirely blocked as a result of land development activities. Early residents of the peripheries were deprived of access to socially and ecologically important ecosystems, such as forests and mangroves. Indigenous landscapes and common pool resources were converted into recreational areas to the exclusive benefit of the financially able people.

Kleemann et al. (2017) put forward the example of Takoradi, Ghana, where a new town concept promotes living in peri-urban areas through the construction of affordable public housing. This contributed to urban expansion, but simultaneously decreased pressure for the housing market and the share of informal housing units. Such initiatives could also help addressing peri-urban informality toward spaces formally planned for urban development by attracting former dwellers of informal housing sites. Inostroza (2017) argued that entitling informal dwellers with legal property titles can help control developments and reduce further fragmentation. On the other hand, formalization of informal settlements has sometimes led to an increase in informal peri-urban settlements. Žlender and Thompson (2017) found that green wedges in Ljubljana are more easily accessed by residents, but for this reason they tend to be overused, which results in under-use of green spaces located in the peri-urban areas.

Shkaruba et al. (2017) discussed the trade-off between the pressures for new housing coming from residents in older urbanised areas and the further loss and fragmentation of semi-natural ecosystems that these new developments may cause. They further identify a trade-off between the flexibility of urban planning in constantly adapting to changing conditions, and the need for protection of remaining open spaces through traditional zoning as requested by suburban residents.

## 4. Conclusions

As re-emphasized during the UN HABITAT III meeting in Quito, Ecuador (UN, 2017), spatial planning plays a key role in guiding transitions towards sustainable developments of urban systems and urban peripheries. In support of this claim, this Special Issue, although diverse in its themes, approaches and case studies, presents new perspectives on sustainable planning for the highly heterogeneous and complex territories of contemporary urban peripheries. The key findings presented here suggest that more research should be developed on how the planning of peripheries can achieve better levels of sustainability, with a focus on how to measure and quantify these levels. This would allow greater transferability of successful approaches to other geographical and social contexts. This Special Issue also indicates that new forms of spatial governance are needed to integrate different planning levels and therefore to consider peripheries as inseparable parts of wider metropolitan areas. By the case studies and experience presented, we hope to have contributed both to theoretical and practical advancements of planning research, highlighting the many challenges still to be tackled but also proposing new and locally-attuned planning approaches to deal with pressing socio-ecological challenges that characterize contemporary peripheries.

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La Rosa, D., Geneletti, D., Spyra, M., Albert, C., & Fürst, C. (2018). Sustainable planning for peri-urban landscapes. In P. Ajith H., U. Peterson, G. J. M. Pastur, & L. R. Iverson (Eds.), Ecosystem Services from Forest Landscapes: Broadscale Considerations
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# Sustainable Planning for Peri-urban Landscapes

**Daniele La Rosa, Davide Geneletti, Marcin Spyra, Christian Albert, and Christine Fürst**

## 1 Peri-urban Landscapes

In the past decades, different typologies of peripheral landscapes have emerged as a result of dynamic processes of urban development and relative change in natural, seminatural, and agricultural areas. Historically, the concept of periphery has expressed a distance (or separation) with respect to a core, in terms of geographic, economic, political, and social factors (Bourne 2000). The addition of new urban agglomerations far from existing poles, the "peripheralization" of areas that had no peripheral characters previously following changes in economic and social conditions (e.g., migration), and the development of infrastructure are the most relevant of these processes. Peripheries have been characterized by particular features such as remoteness, isolation, and harsh natural conditions, but, on the other hand, they could sometimes offer favorable conditions to attract new urban developments.

Among the different types of peripheries, peri-urban contexts are located somewhere in between the urban core and the rural landscape (Meeus and Gulinck 2008) and represent an "uneasy phenomenon" (Allen 2003) to be defined, both geographically and conceptually. Attempts in establishing a comprehensive set of criteria for the definition of peripheral landscapes which make it possible to capture their

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different features (Piorr et al. 2011) are incomplete or not robust enough to ensure transferability to other geographical contexts besides the ones where they have been elaborated. The changing, dynamic, complex, and heterogeneous nature of peripheral landscapes remains irreducible to single interpretations and approaches for their definitions and therefore for their planning and management.

Many attempts have been made to identify and classify peri-urban areas using parameters such as urban centrality, hierarchy, urban–rural relationships, and the degree of urbanity and remoteness (OECD 2002; Dijkstra and Poelman 2008; EUROSTAT 2010). All these research showed the limit of using administrative units such as NUTS levels as geographical units of the analysis, therefore not considering that the spatial extent of peri-urban areas cannot be reducible to administrative boundaries.

For European countries and in the context of the PLUREL project, Zasada et al. (2013) delineated a method to identify degrees of peri-urbanity by using population density of particular classes of Corine land use/land cover and logistic regression models. These authors showed that peri-urban areas occur in the United Kingdom, the Netherlands, Belgium, Northern Italy, Western and Southern Germany along the Rhine valley, and in Southern Poland, mainly within bigger urban conurbations or metropolitan areas.

This chapter outlines the main characteristics and peculiarities of peri-urban landscapes and introduces examples of planning approaches and topics that can be found in current research about sustainable planning. We will refer to peri-urban landscapes as those areas that are partly located outside the more compact part of a city and can spread to the surrounding rural area following low-density patterns of development and covering larger areas than peri-urban neighbors of single municipalities. They are characterized by low density and a mixture of diverse land uses, including non-urban and seminatural uses (Gallent et al. 2006). Peri-urban landscapes represent a diffuse and blurred territory where urban and rural development processes meet, mix, and interact at the edge of the cities.

Being at the edge of cities' limits, peri-urban areas are planned through diverse instruments or schemes: they can be planned by municipal land-use plans regulating the use of the land within administrative border of the municipality (master plans, land-use plans, zoning regulations) or be under the spatial jurisdiction of metropolitan, regional, or landscape plans implemented by regional authorities. This means that peri-urban areas can be planned under diverse planning levels, therefore requiring an appropriate coordination (see section "The need of a metropolitan planning and governance for the peri-urban").

One of the most common features of peri-urbanization processes deals with the progressive colonization of the agricultural and forest landscapes through different land-use changes (Geneletti et al. 2017). Peri-urban areas are progressively acknowledged as areas with peculiar features. Some authors highlight that new functions, not properly urban or fully rural, emerge in these spaces (Korthals Altes and van Rij 2013).

Peri-urban landscapes cannot be understood only in terms a progressive intensification of urban functions in the rural or seminatural environment but rather as a space of "interaction between urban and rural elements" (Rauws and de Roo 2011, in Loupa Ramos et al. 2013).

The following subsections of this chapter introduce and describe different types of peri-urban landscapes, particularly focusing on some categories of forest, agricultural, and other ecosystems that can be found in peri-urban contexts, often highly mixed and intertwined with other human uses of the land. These categories represent general families of landscapes that can be found in peripheral contexts of Europe, where a varied range of mixed land uses and land covers can be observed in areas where the influence of humans is dominant. Despite the urban environment these categories belong to, they refer to particular urban ecosystems characterized by low or null presence of built-up areas. Some particular types of ecosystems, such as private green spaces or domestic gardens (DTLR 2002), will not be included in the previous categories because they are mostly part of urban patches and private owned.

As it will be described, these landscapes are able to provide important functions and relative ecosystem services, such as biodiversity in urban areas, production of $O_2$, reduction of air pollutants and noise, regulation of microclimates, reduction of heat island effect, and supply of recreational value, and play a fundamental role in health, well-being, and social safety (La Rosa and Privitera 2013; Vejre et al. 2010).

### *1.1 Peri-urban Forests*

In this chapter, urban and peri-urban forests are considered as the most natural ecosystems in an urban–rural context, whose composition, structural diversity, and overall character rely greatly on the demands for (non-monetary) goods and services. An accepted definition of urban forestry is the one based on Miller (1997), who describes urban forestry as "the art, science, and technology of managing trees and forest resources in and around urban community ecosystems for the physiological, sociological, economic, and aesthetic benefits trees provide society." Therefore, urban forestry is strictly related to the positive impacts of trees on human well-being (Fig. 1).

According to Forrest et al. (1999), a range of possible definitions of urban forests have been used in different European countries, demonstrating how the concept and term are open to different interpretations and planning approaches. These definitions highlight once again one of the most important features of urban forest, that is, their ability to connect the human need for the natural environment in urban areas with life support systems of a persistent forest ecosystem. This connection substantially contributes to the well-being of urban societies.

A comprehensive review of definitions of an urban forest is provided in Konijnendijk (2003): in this work the author focuses on the difficulties in finding a shared definition of what is meant by "urban" or "forest." The term "forest," for instance, may be related to its more traditional definition, while in urban areas terms such as "other wooded land" and "trees," used by FAO for its forest resource assessments (FAO 2002), can be particularly more appropriate to describe urban parks, gardens, and street trees. By including small woods, parks, and gardens with

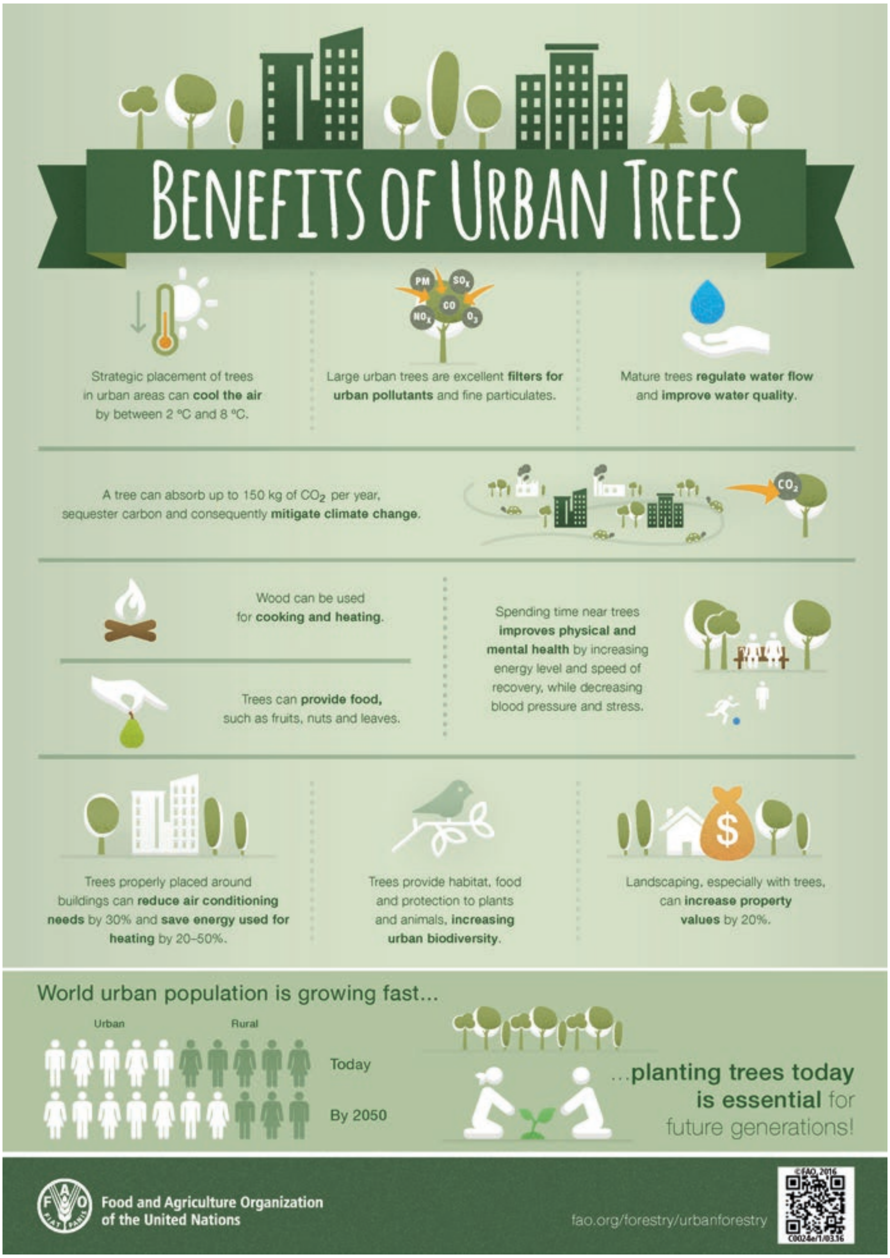


**Fig. 1** Benefits of trees in urban contexts (Source: FAO, available at http://www.fao.org/documents/card/en/c/427898a5-e452-4dbb-87ed-4b25286de3b4)

an area size or canopy cover that are below thresholds for "forest," the traditional forest concept has been broadened considerably.

This definition can be also extended to peri-urban contexts, located between the urban core and rural or (semi)natural surroundings, where the size of forests could be larger but proximity and accessibility by urban residents of the city centers are lower. Peri-urban forests form a kind of mixed system, with higher societal influence on management objectives compared to other sides, but still acting as connective element to rural sites with their demands on classical forest ecosystem services.

Furthermore, as it will be discussed later on, peri-urban forests can suffer from high pressure of urban development or request for further farmland. However, the difference between urban and peri-urban could be very smooth and difficult to be defined, as boundaries of cities are extremely difficult to identify, especially in large or sprawled urban areas or metropolitan regions.

Peri-urban forests are particularly under pressure as they are continuously used for recreation and (non-) monetary provisioning services (mushrooms, berries, hunting, drinking water), while they can supply many regulating ecosystem services (e.g., providing cool, clean, and fresh air to the urban environments, protection against flooding).

As the actor groups in peri-urban forests are much more complex compared to pure urban or rural forests, societal processes can be considered as the key drivers in how intense and with which key objectives peri-urban forest planning and management are conducted. Being part of urban systems, some actors might expect well-designed road infrastructure for hiking, cycling, horse riding, or country skiing and relative good accessibility and the availability of parking space for these activities. This might require, for example, more investments into the nice design of forest edges with more mixed or deciduous tree species and more structural diversity. Indirectly, the increased usage of these forests for recreational activities leads also to more needs for protective measures, for example, against further urban development (see section "Peri-urbanization and sprawl processes") or forest fires (fire strips). On the other hand, in their more rural context, peri-urban forests are expected to provide also jobs and traditional forest products such as timber (lumber, fuel wood, industrial wood) for creating income and contribute to sustainable rural development. In addition, expectations to conserve a high biodiversity levels are enhanced through the more intense perception of biodiversity from urban contexts.

Urban forest structure is a determinant of ecosystem function, which has been documented as a mean of mitigating environmental quality problems associated with the urban-built environment (Nowak et al. 2006). The structure and subsequent function of the urban forest will therefore determine the provision of ecosystem services and goods (De Groot et al. 2010). Thus, by modifying the structure of the urban forests, as well as their size and composition, planners may be able to modify certain ecosystem functions in order to maximize human well-being in cities. From a planning perspective, peri-urban forests should connect the more rural landscape parts with the rest of the urban green infrastructure to ensure that all relevant cultural and regulating services are sustained (see section "Trace-Gas Driven Ecosystem Services"). On the other hand, disservices from the movement of some species such as foxes, wild boar, or other animals might become an issue for peri-urban residents.

## 1.2 Farmlands and Peri-urban Agriculture

Agricultural areas, in use or abandoned, are one of the most typical landscapes of peri-urban contexts and can be the result of fragmentation processes due to urbanization pressures (Fig. 2). Agriculture in metropolitan areas contrasts sharply with its non-urban counterpart. As observed by Heimlich (1989), the longer areas are affected by urban pressures, the greater the adaptation they reflect in some farm characteristics. Since these areas are part of wider metropolitan contexts, their


**Fig. 2** Example of cultivated vineyards (left 2**a**) and abandoned agricultural terraces (right 2**b**) in Italy located in peri-urban contexts in Sicily (southern Italy)

services assume higher importance for the number of people that can benefit from them (Swinton et al. 2007). In fact, agriculture both provides and receives services that extend beyond the provision of food, fiber, and fuel, so that only in their absence do they become most apparent (Fig. 3). Among the managed ecosystems, farmlands offer special potential because of their variety of generated ecosystem services. This potential arises from both their broad spatial extent and human management objectives focused on biotic productivity (Swinton et al. 2007). At the same time, agriculture offers an important potential to diminish its dependence on external agrochemical inputs by reliance on enhanced management of supporting ecosystem services (Fig. 3).

New Forms of Urban Agriculture (NFUA) are typical in peri-urban contexts and are characterized by high level of multifunctionality and general post-productive attitude (Zasada 2011). Urban agriculture is defined as “the growing, processing, and distribution of food and non-food plant and tree crops in farmlands that are mainly located on the fringe of an urban area” (Zezza and Tasciotti 2010). A growing evidence from empirical and experimental research also suggests that incorporating NFUA into the urban environments may improve the sustainability level of cities, taking advantage of the multiple benefits and services that can be generated.

Urban agriculture is particularly present in developing countries and often produces perishable products such as fruits and vegetables. This type of agriculture

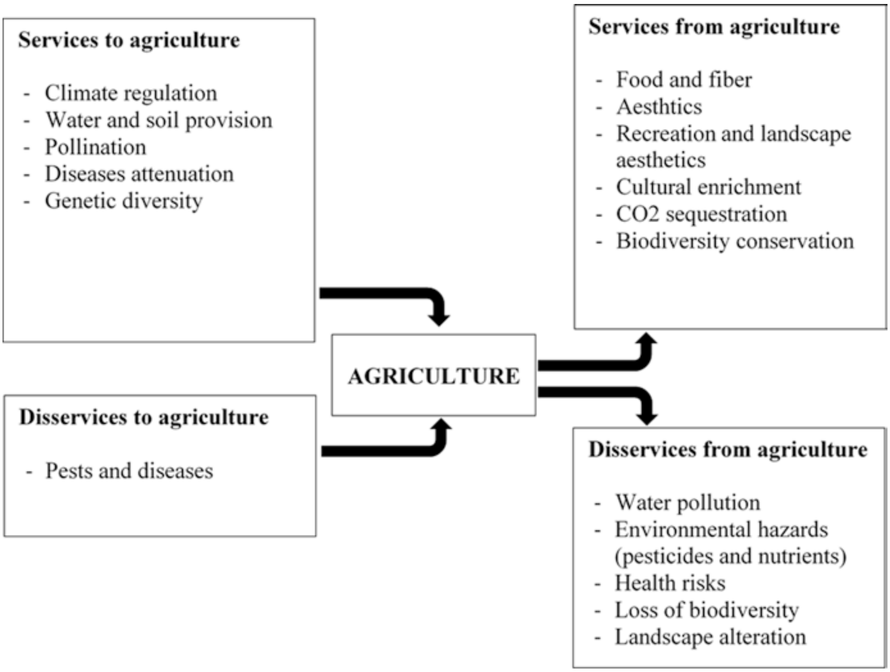


**Fig. 3** Main ecosystem services and disservices of agriculture (Modified from Swinton et al. (2007))

meets a local and growing urban demand for food, but it also generates an intensifying conflict "between the maintenance of local agricultural production and the rapid and often uncontrolled consumption of land by growing urban activities and infrastructures" (Aubry et al. 2012).

In China, peri-urban agriculture has also been characterized by the specialization and diversification of traditional agriculture. In the Beijing areas, such NFUA have been mostly initiated by local residents and include agro-tourism, enterprise-based food processing, high-tech agro-enterprises/agro-parks, and farmer collective activities (Yang et al. 2016). In Europe and North America, NFUA are emerging in response to low-density urbanization patterns and aim at producing "local" food as a way to enhance food security by shortening food supply chains (Benis and Ferrao 2017).

A highly differentiated set of NFUA can be found in peri-urban landscapes (La Rosa et al. 2014). Urban farms represent a partnership of mutual commitment between farms and communities of users/supporters which provide a direct and short link between the production of agricultural goods and their consumption. Community-supported agriculture consists of agricultural practices that are directly economically supported by users and communities that take advantage of food produced in the supported farms. They can provide environmental benefits due to an environmentally friendly production process as well as reduced "food miles" thanks to the proximity of production and consumption. Allotment gardens are more oriented to generate social values, including active participation in the management of gardens by particular social groups such as children and retired or unemployed people. Finally, agricultural parks are larger agroforestry systems where food production (mainly by private farms) is promoted and safeguarded along with more general rural and seminatural landscapes. They are public-managed areas that support existing wildlife management and protection and promote the fruition and access of the park, therefore providing important cultural and aesthetics services.

Peri-urban agriculture differs from urban agriculture often practiced by urban residents as part-time activity on available open spaces. Peri-urban agriculture is characterized by small- or medium-sized farms in urban fringe areas, where these farms have to deal with both market globalization and urban urbanization processes (Clark and Munroe 2013). In between globalization and urbanization, peri-urban agriculture is therefore struggling to re-create networks of food provision that are alternative to the global agri-food system that is consumed in cities (Paül and McKenzie 2013).

Farmlands within or near towns are no longer considered simply as reserves of land for future urbanization and are becoming a challenging issue in urban planning that aims at conserving and enhancing productive function and ecosystem services provided by urban and peri-urban farmlands. There are two key concepts that must be kept in consideration by planners when dealing with urban and peri-urban agriculture: the sustainability of the production, both at the farm (internal) and territorial (external) level, and the multifunctionality of the activities achieved by agriculture (Aubry et al. 2012).

### *1.3 Other Types of Peri-urban Landscapes*

Peri-urban landscapes include other forms of seminatural ecosystems, which, in Europe, are mainly made up of shrub and grass vegetation, typical green elements with a limited height of less than 5–6 meters. In Mediterranean areas, shrublands are ecosystems with a long history of grazing by domestic animals, and their biome can reach its maximum extent. Much of these formations are considered a subclimax developed on degraded and eroded soils and maintained in part by fire and goats or sheep. In arid and semiarid areas, such as Mediterranean landscapes, low amounts of rain do not allow for a continuous vegetation cover, resulting in a typically patchy landscape. In addition to their role in plant interactions, shrubs strongly modify plant dispersal patterns by processes such as trapping of water-, wind-, and bird-dispersed seeds (Aguiar and Sala 1999). Thus, they are a key element for community structure and dynamics in semiarid ecosystems, and they act as “hot spots” of diversity in these areas (Pugnare and Lázaro 2000).

In peri-urban contexts, grasslands are habitats that can be present in parks, brownfields, and other derelict land, disused quarries, and along roads or transportation buffers. The type of grassland varies with the geographic features, acidity of soils, and moisture level (dry or damp grassland). They also support a range of grasses and wildflowers, such as grasses, forbs, shrubs, trees, vertebrate animals, and invertebrate animals. Remnant seminatural grasslands, in particular those serving as habitat fragments, are essential to the maintenance of diverse terrestrial arthropod communities in human-dominated landscapes. These temperate biomes are extremely important, as they include diverse and productive terrestrial ecosystems that are among the most threatened in the world, suffering from pressures by urbanization and agricultural processes. In many urban contexts, these areas are often restricted to linear remnants along roads and railways. These linear patches are, however, at a great risk of edge effects that alter vegetation composition by promoting exotic species invasion (Forman 1995). Understanding and mitigating these impacts are of increasing importance for biodiversity conservation in peri-urban areas.

Another important category of peri-urban landscapes are urban lawns, typical and frequent urban biotopes in cities, especially found in urban parks, private gardens, playing fields, golf courses, public places (squares, plazas, etc.), schoolyards, and along streets, roads, and tramways. The presence of lawns is also widespread in private gardens and front- and backyards, especially in suburban areas, where detached houses represent the typical form of urban settlement.

All these types of peri-urban landscapes are particularly sensitive to human activities and continuously under pressure from them. Characterizing the different drivers of changes in peri-urban landscapes can provide relevant information to set up policies aimed at their protection and management.

## 2 Drivers of Changes in Peri-urban Landscapes

All types of landscapes described in the previous section may provide a complete array of ecosystem services, as also described in chapters "Ecosystem Services From Forest Landscapes: An Overview" and "Ecosystem Services From Forest Landscapes: Where We Are and Where We Go".

However, peri-urban landscapes have a unique characteristic that makes them highly different from other landscapes: their proximity to or partial inclusion in urban systems makes them particularly vulnerable to pressures by urban development or related activities. Peri-urban landscapes have gone through a series of socioeconomic transitions that have deeply modified their territorial assets and spatial land uses. Particularly, agricultural and seminatural areas have been deeply affected by low-density urban developments. Such developments have fragmented farmlands and seminatural areas, producing not-continuous, low-density, and highly mixed urban patterns.

### *2.1 Peri-urbanization and Sprawl Processes*

Despite a decreasing population in many European countries, urban expansion due to spatial development pressure has been an impressive driver of very high consumption of land and agricultural resources. In the period between 1990 and 2000, at least 2.8% of Europe's land experienced a change in use "including significant increase in urban areas" (Commission of the European Communities 2006). The European Environment Agency (EEA) has described the process of urban sprawl "as the physical pattern of low-density expansion of large urban areas, under market conditions, mainly into the surrounding agricultural areas" (EEA 2006). It is an urban development process that "separates where people live from where they shop, work, recreate and educate—thus requiring cars to move between zones" (Sierra Club 1999).

Sprawl is the leading edge of urban growth, and it is usually related to limited planning control in land allocation. Urban development is usually patchy, scattered, and strung out, with a tendency for discontinuity. It leapfrogs over areas, leaving agricultural enclaves (Fig. 4). Sprawling cities, the opposite of compact cities, are full of empty spaces that indicate the inefficiencies in development and highlight the consequences of uncontrolled growth (EEA 2006). More recently, EEA has advocated for a reuse of developed land that is not used anymore to address the risks of further sprawl (EEA 2015).

Among all definitions that can be found in the literature, some recurrent terms highlight the main (negative) features of sprawl: "spreading," "scattered," "low density," "car dependent," "environmental externalities," and "social disparities." The externalities and impacts of sprawl on the environment and landscape have been the focus of several studies and include the loss of fragile environmental lands, increases in air pollution and energy consumption, decreases in the aesthetic appeal of the landscape, the loss or fragmentation of farmland and forests, a reduction in biodiversity, increases in water runoff and risks of flooding, and ecosystem fragmentation (Johnson 2001).

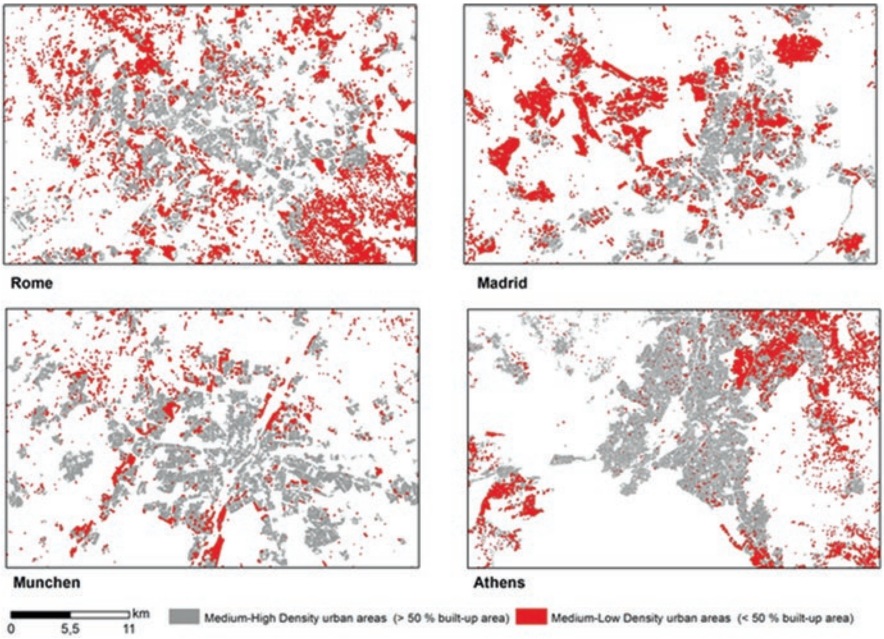


**Fig. 4** Low-density peri-urban areas in the metropolitan areas of four European capitals according to 2012 Urban Atlas data (EEA 2015). It can be seen that low-density peri-urban patches are largely the prevailing categories of urban areas when considering the metropolitan contexts

Land sustains many ecosystem functions (e.g., production of food, habitat for species, recreation, water retention, and storage) that are directly linked with existing land uses. Impacts on natural areas are also exacerbated by the increased proximity and accessibility of urban activities to these areas, which in the past were farther from "urban influence." This proximity produces stress on ecosystems and species through noise and air pollution. Moreover, the fragmentation caused by transport infrastructures and other urban-related activities creates significant barrier effects that can degrade the ecological functions of natural habitats. From an ecological point of view, fragmentation can heavily modify corridor spaces for species or can isolate populations by reducing habitats to extend below the minimum area required for the survival of these species. The loss of agricultural and forest land also has major impacts on biodiversity, involving the risk of losing some valuable biotopes for many species, particularly birds.

According to the EEA (2006), in Europe urban development tends to "consume the best agricultural lands, displacing agricultural activity to both less productive areas (requiring higher inputs of water and fertilizers) and more remote upland locations (with increased risk of soil erosion). In addition, the quality of farmlands that are not urbanized but in the vicinity of sprawling cities has also been reduced." The loss of agricultural land is often directly connected to land consumption due to sprawl processes (Thompson and Stalker Prokopy 2009). There are several consequences to this: landscape fragmentation and simplification, loss of biodiversity, decreased agricultural land value, and increased externalities of urban sprawl (Johnson 2001). New urbanizations often occur in proximity to already urbanized areas or existing infrastructure because the price of agricultural land is lower if compared to residential zone land. Agricultural land usually becomes a highly attractive target for investors and urban developers (EEA, 2006). For these reasons, the hazard of loss of agricultural land may be potentially higher in areas close to already urbanized lands or roads. In contemporary metropolitan contexts, rural land and its agroecological features are exposed to dramatic pressures that are driven by the expansion of the urban influence on areas that once were considered as purely rural (Donadieu 1998). In this context, farmlands suffer from a wide range of pressures by urbanization processes. These pressures are physical, environmental, and socioeconomic (EEA 2006).

Urban developments in peri-urban contexts are not continuous and show low-density patterns so that outside the main city, the landscape is characterized by a strong degree of farmland fragmentation and mixes of urban and non-urban uses. The relationship between the agricultural landscape and the city has produced a particular contemporary peri-urban landscape, where residential low-density settlements are mixed with farmlands that have been partially modified and reduced by urbanizations. A low-density settlement has widely become the main landmark of new metropolitan areas.

More and more people in Europe are moving away from the center of metropolitan areas, apparently attracted by the imagined quality of life in these rural settings, to live in residential developments built on converted peri-urban farmlands. "The detached terrace-houses and semi-detached houses condense the new type of residential landscape in the metropolitan peripheries of the cities of southern Europe" (Munoz 2003), and settlements belonging to different municipalities, once far from another, are getting closer and closer and become parts of larger metropolitan areas.

In these new metropolitan areas, the concept of rural–urban fringe, as appeared in the geography and planning literature from the 1930s (Whitehand 1988), is today more and more smooth, and it may be difficult to distinguish what is urban from what is rural. A chaotic set of land uses is "a product of post-war planning legislation that has partly fossilized some patterns of use, but it is also a reflection of dynamic change as certain components of these areas have grown as part of complex and singular developments" (Gant et al. 2011). Moreover, in new metropolitan contexts, rural land and the relative ecosystems are exposed to dramatic pressures that are driven by the expansion of the urban influence on areas that once were considered as purely rural (Donadieu 1998).

What's left today of the seminatural and agricultural areas in peri-urban landscapes? A different mix in types and sizes of residual and non-urbanized areas deeply characterizes metropolitan landscapes in many European regions, such as farmlands (abandoned or still in use), small orchards, wood and shrub areas, local parks, regional parks, reserves and natural protected areas, and grasslands (Fig. 5).

Gallent and Shaw (2007) identified a number of anthropic land uses in the transition zone from urban to rural of the greenbelts in the United Kingdom: (i) service functions and commercial activities, (ii) noisy and unsociable uses pushed away

**Fig. 5** Examples of non-urbanized areas of different types and sizes in peri-urban contexts: agricultural spaces and other non-urbanized areas are intertwined with low-density urban settlements in the metropolitan area of Rome

from people, (iii) transient uses such as markets, (iv) bulk retail, (v) light manufacturing, (vi) warehousing and distribution, (vii) public institutions, (viii) degraded farmland, (ix) fragmented residential development (often centered on road junctions), and (x) areas of unkempt rough or derelict land awaiting reuse. These land-use patterns are very similar to the ones that can be found in other European contexts, with various ranges of size and extent.

## *2.2 Climate Change*

Climate change has been predicted to have many consequences for human health arising from the direct and indirect impacts of changes in temperature and precipitation (Patz et al. 2005). One of the primary public health concerns is an increase in the intensity and frequency of heat waves, which have been linked with heat stroke, hyperthermia, and increased mortality rates (Tan et al. 2004).

These consequences appear to be more dramatic in urban and peri-urban areas, which will be especially vulnerable to the negative aspects of climate change (such as more frequent and severe floods and heat waves), due to the higher concentration of people and human activities, although at a lesser extent than in dense urban areas. Climate change impacts on peri-urban landscapes include impacts on the peri-urban agriculture systems: for example, impacts of flooding, groundwater salinization, sea level rise, heat stress, drought, and changes in resources availability are likely to intensify with climate change and especially in Africa and Asia (Padgham et al. 2015). Therefore, the existence of peri-urban agriculture can be threatened by the convergence of urban development (as discussed in the previous section) and climate change pressures.

Thus, there is a pressing need to evaluate strategies that may adapt against further increases in temperature in peri-urban areas and the associated negative impacts on human health. The most common adaptation strategy is to “green” urban areas, essentially by increasing the abundance and cover of vegetation (Gill et al. 2008). As a complement to such adaptation measures, particularly in peri-urban contexts, there is a need to ensure that future land-use development does not worsen the current risk level (especially hydrological risk), either through influencing the hazards themselves or through affecting the future vulnerability and adaptive capacity of the urban system.

Spatial planning of peri-urban landscapes therefore has a critical role to play in mitigating the severity of hazards and in reducing the levels of exposure and vulnerability experienced by the urban system. Different scales of planning from macroscale land-use planning to microscale urban design are both important to this process, responding to the different scales over which risk and vulnerability are expressed (O’Brien et al. 2004).

This recognizes that although many aspects of adaptive behavior associated with vulnerability reduction strategies are the result of a decision-making process that operates at an individual level, the government and other policy makers can address this process through their activities. Given the length of time involved in the strategic planning process, and the long lifetime of urban infrastructure, it is critical that decision-making aimed at mitigation of or adaptation to climate change does not reinforce negative feedback in any part of the process (Lindley et al. 2006). The urgency for information to assist with "climate conscious" planning is evident and asks for detailed tools for the assessment of different urban features that are involved in climate change processes.

For peri-urban forests, an increased awareness of climate change leads in many countries to an increase in the harvesting of fuel wood through private actors, so that in trend, less woody debris are available for supporting biodiversity and for being incorporated in the organic matter cycles. Other indirect drivers connected with urban activities are larger emissions of pollutants, namely, NOx and particulate matter. These disturb matter cycles, might lower the competitiveness of some species, and thus shape the development of forest species communities. Forests close to large urban congestions often suffer from decline and are more vulnerable to climate change. Typical climax communities might now develop due to these disturbances.

### *2.3 Farmland Abandonment*

Among the many available definitions, farmland abandonment can be defined as the cessation of land management which might lead to modifications in biodiversity and ecosystem services provision (Terres et al. 2015). There are several different reasons for it, and these reasons are often concurrent, hardly separable, and context specific. Drivers of abandonment depend on the result of their co-occurrence and interactions (Coppola 2004) and can be natural/geographical constraints (including changes in geo-climatic features), land degradation, socioeconomic factors, or political changes in national or regional assets.

Terres et al. (2015) classified the driving forces of abandonment into unsuitable environmental conditions, low farm stability and viability, and the regional context. They identified the most relevant drivers as low farm income, low farm dynamism/adaptation capacity, aging farmer population, low farmer qualifications in farm management, small farm size, and enrollment in specific agricultural schemes. Drivers from the regional context were identified as the presence of weak land markets, previous farmland abandonment, and remoteness and low population density.

In peri-urban contexts, processes of farmland abandonment are also linked to sprawl processes (Thompson and Stalker Prokopy 2009). Urban development and agriculture compete for the same land, as farmlands closer or adjacent to urban areas are ideal places for urban expansion. Farmers' reasons for selling farmlands in this process are clear, as they can get substantial financial benefits by the sale of farmland for new housing or other urban developments, especially in times of a general crisis of agriculture. On the other hand, agricultural soils need to be conserved, since they are almost nonrenewable resources and soil sealing reduces or eliminate soils' capacity to perform their essential functions.

Farmland abandonment can also generate contrasting perceptions in people living in peri-urban areas (Benjamin et al. 2007). Abandoned farmlands can be seen as “useless spaces” with no proper status or even as elements not aesthetically pleasant or even unsafe. But they can also generate poetic connotation and feelings of freedom or be considered as important ecological spaces where natural field succession processes are taking place.

This contrasting perception by residents and neighbor farmers should be carefully considered when imagining new planning scenarios for abandoned farmlands. In fact, because of their proximity to city but also to existing farmlands or forests, abandoned farmlands in peri-urban areas represent an interesting opportunity for the sustainable spatial planning of metropolitan areas, as they can be considered as new components of new agricultural landscapes (see section “Planning New Forms of Agriculture in peri-urban contexts”). Proximity to the city can provide an advantage for diversification and innovation, offering new opportunities for farmers to sustain or even increase their income by reaching new short-distance markets (Benjamin et al. 2007).

## 3 Existing Sustainable Planning Approaches for Urban Peripheral Landscapes

Sustainable planning can be considered as a combination of knowledge, science, and creativity to design, evaluate, and implement a set of justified actions in the public domain, which encompass the different dimensions of sustainability such as environment, economy, and social sphere (Friedmann 1987; Berke and Conroy 2000). In this section, we present some examples of planning approaches, solutions, and topics proposed by current academic research and planning practice that might be suitable to be applied to define new planning scenarios aimed at conserving and/or enhancing the sustainability of peri-urban landscapes as defined in section “Peri-urban Landscapes”.

### *3.1 Planning and Design of Peri-urban Greenery*

One of the objectives of sustainable spatial planning is to promote equitable access to social and economic resources and therefore improve environmental health of people living in urban contexts (Berke and Conroy 2000). To this end, socially inclusive planning approaches to greenery in peripheral urban contexts should maximize its social benefits based on convergence of human interests (accessibility and qualities of goods and services, culturally appropriate development and fulfillment, self-reliance, etc.), considering equity and disparity within the current population and between present and future generations (van Herzele et al. 2005). This is particularly relevant in peripheries worldwide, where access to resources is often limited or disputed among different social groups. Since access to green spaces is important to human health and well-being, the reduction of the uneven distribution of green spaces within cities (especially those most populated) is one of the key objectives of sustainable planning (e.g., Dai 2011), as urban areas with lowest green land covers have been related to residents with lower socioeconomic status (Aquino and Gainza 2014).

However, within the large body of research on accessibility to greenery (e.g., Neuvonen et al. 2007; Schipperijn et al. 2010; Sugiyama et al. 2008; Swanwick 2009; La Rosa 2014), peri-urban areas have been less explored. Green spaces located outside the urban core such as seminatural areas, woodlands, fringe forests, country/agricultural parks, and peri-urban open spaces are appreciated by users for their recreation and leisure activities even more than intensively maintained green areas (Žlender and Ward Thompson 2017), because they are able to provide a diverse kind of "nature" and satisfy different recreational needs (Rupprecht et al. 2015).

Žlender and Ward Thompson (2017) recently compared two cities (Ljubljana and Edinburgh) with relative different green space strategies for the peripheries (green wedges for Ljubljana, greenbelts for Edinburgh) and demonstrated how the specific strategy of each city affects people's access and their use of peri-urban greenery. While the strategy of green wedges for Ljubljana is used by people because they reach the city center from periphery, the greenbelts in Edinburgh are mostly used for recreational purposes much less than the green spaces within the city (Žlender and Ward Thompson 2017).

This research also highlighted the importance of preference for greenery of different social groups as important information for urban planners. Results from the same authors showed that residents of the most central parts of cities preferred seminatural green spaces and other linear greenery (e.g., green corridors) that can be easily accessed from home. Tu et al. (2016) explored the heterogeneity of people's preferences for green spaces by using a choice experiment in Nancy (France). Authors showed that the willingness to pay for having peri-urban forests in the vicinity of their home increases with the frequency of forest visits, although the respondents' preferences varied significantly with income differences and the possible ownership of private green (as a substitute for being close to parks).

Shkaruba et al. (2017) explored how green space planning has been affected by the interplays of socialist and post-socialist systems, in the context of rural–urban peripheries of two middle-sized cities in Belarus (Mahilioŭ) and Russia (Pskov). Authors discussed how planning options in the two cities are looking for a compromise between a compact city cherished by the socialist planning tradition (still supported by existing spatial regulations and frameworks) and an increasing tendency toward urban sprawl as the western way of modern development. These options have consequences for green spaces that remain somehow under high pressure by urban development: in fact, the most common outcomes of urban development include ecosystem fragmentation, major disturbance of ecosystems, and loss of forest and other valuable ecosystems, and these negative outcomes can be the results of planning choice or failures of planning implementation (Shkaruba et al. 2017).

Conedera et al. (2015) performed a quantitative survey in a peri-urban area of the Southern Alps in Switzerland about the importance of green and the frequency of the visits to green spaces. Results showed that maintaining a visual relation with the green area and vegetation is important to the perceived general quality of life for the peri-urban residents that live far from the city center and closer to the mountain slopes. These findings suggested that land planners and managers should consider the proximity of the place of residence and the background green of the mountain slopes, for example, by ensuring and conserving visibility of the greenery when designing urban development.

### 3.2 *Ecosystem Services-Based Planning*

The integration of ecosystem services into spatial planning has recently attracted interest of current research about sustainability issues (see chapter "Ecosystem Services From Forest Landscapes: An Overview"). Spatial planning processes lead to decisions that usually modify land uses and may affect the quantity, quality, and distribution of a wide set of ecosystem services that are benefited by humans. Hence, it is crucial to use information on ecosystem services to support planning processes (Geneletti 2013).

Many scholars believe that ecosystem services might be able to improve decisions on land use by adding the information on the services (with relative values) provided by ecosystems in an urban context and also highlighting trade-offs among different planning scenarios (Albert et al. 2014; Dorning et al. 2015). Several authors have suggested that the ES concept has a potential to facilitate land-use planning and landscape governance by facilitating knowledge exchange between involved stakeholders and connect them at different spatial scales or administrative levels (Opdam et al. 2015). Particularly, the spatial dimension of ES is a key issue for involving stakeholders in the planning process, since they are usually more interested in knowing where a decision is made rather than the reasons behind the decision itself (Fürst et al. 2014).

However, the integration of ES in real planning processes and the use of information coming from ES assessments are still not consolidated and/or not yet producing relevant results in terms of improved sustainability, especially for urban systems (Haase et al. 2014).

There are several reasons for this incomplete integration, such as differences in terminology, the emphasis on existing assessment methods and economic values, and the dominant scale of application (Opdam et al. 2015). Also, the lack of binding norms in national planning systems hampers or delays the integration. To this end, Woodruff and BenDor (2016) believe that the missing integration between ES and planning is also due to the inability of plan quality guidance to incorporate ecosystem services and to guide practitioners in how to include ES information to improve spatial plans.

Geneletti et al. (2017) showed that in peri-urban landscapes, ES-based planning approaches have been rarely applied and that the research on these contexts is still limited and under development. Some exceptions are present in researches that explore how to plan new spatial configuration of remnant peri-urban agricultural lands and other types of non-urbanized areas in new planning scenarios (Lee et al.

2015; La Rosa and Privitera 2013). The management and protection of services by agro-ecosystems is considered crucial in the context of urban growth of peri-urban landscapes and thus appropriate tools to inform and guide planning choices for highly complex landscapes such as those in peri-urban areas. Focusing on farmlands as part of the peri-urban green infrastructure (see section "Trace-Gas Driven Ecosystem Services"), Lee et al. (2015) proposed a set of metrics to assess ecosystem services with landscape composition and configuration metrics for each of the research sites. Results for the case study of a plain area in Taiwan showed that agroecosystem services are related with the spatial configuration of paddy rice fields and that it is possible to guide the agricultural land-use change to optimize spatial configuration and therefore to conserve the agroecosystem services—especially the regulation of potential flooding events.

La Rosa and Privitera (2013) developed a planning scenario of new land uses for existing open unmanaged spaces in peri-urban contexts of South Italy, by evaluating their suitability to new land uses that increase the overall provision of ecosystem services for the entire metropolitan area. The obtained results showed a new spatial configuration of land use that provide municipalities or other metropolitan public bodies in charge of spatial planning (provinces, metropolitan areas) different possibilities for the planning policies aimed at the conservation and increased provision of ecosystem services.

The high complexity of peri-urban contexts in terms of pressure on land and possible conflicts that the use of land can generate characterizes the work by Gret-Regamey et al. (2016) that developed a spatial decision support tool to support the allocation of new urban development zones for the city and hinterland of Thun in Switzerland. The tool evaluates different alternatives of new urban developments based on ecosystem services and locational factors, and it reveals that when ecosystem services are taken into account, the most suitable locations of developments are given by the more compact part of urban centers rather than those in the peri-urban areas. This means that the ecosystem services provided in peri-urban areas were considered important to be conserved by the stakeholders that used the tool.

## *3.3 Nature-Based Solutions and Green Infrastructure*

In urban contexts, there is a growing interest in using and deploying natural ecosystems to provide solutions to several urban issues and improve the overall sustainability of urban environments (Cohen-Shacham et al. 2016). These nature-based solutions provide sustainable, cost-effective, multipurpose, and flexible alternatives for various planning objectives and can significantly enhance resilience of cities. They can be many types of "actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" (Cohen-Shacham et al. 2016). Furthermore, by reshaping the built environment, nature-based solutions can enhance the inclusivity, equitability, and livability of cities, regenerate deprived districts through urban regeneration programs, improve mental and physical health and quality of life for the citizens, reduce urban violence, and decrease social tensions through better social cohesion (particularly for some vulnerable social groups, such as children, elderly, and people of with low socioeconomic status).

Many definitions are available for green infrastructure (GI) (see Pulighe et al. 2016 for a comprehensive review): among the available definitions, Tzoulas et al. (2007) define GI as “all natural, semi-natural and artificial networks of multifunctional ecological systems within, around and between urban areas, at all spatial scales.” This definition emphasizes the holistic ecosystem vision of urban environments (including the abiotic, biotic, and cultural functions) and claim for multi-scale approaches able to take into account the scale-dependent relationships of ecological processes occurring in cities, with particular reference to the human health and well-being of citizens and residents. For these reasons, GI can be considered as a nature-based solution that has become the focus of increasing interest in sustainability science and planning.

In particular, for peri-urban areas, GI aims at the following actions:

(i) Environmental protection and integration of agriculture into urban context, providing specific new urban agricultural land-use types such as agricultural parks, community-supported agriculture, and allotment gardens. These land uses can provide various improvements, such as increasing local food production in the city, becoming areas for leisure, and supporting the integration of socially deprived population groups.
(ii) Development of suburban green areas in order to provide a more equal distribution of public parks and gardens.
(iii) Enhancement of current urban green spaces by improving quality, usability, and accessibility (La Greca et al. 2011; O’Brien et al. 2017).

According to these objectives, the planning of GI in peri-urban contexts should also include agriculture and farmlands. If green areas act as an infrastructure for the well-being of contemporary society, agricultural areas must be included in this infrastructure of spaces providing ES.

Planning GI requires different strategic objectives to be defined for peripheral landscapes, such as environmental protection, leisure, local green services, and urban agriculture. This might allow the identification of new metropolitan scenarios of land uses (La Rosa and Privitera 2013). In fact, planning strategies for peripheral landscapes should be related to the entire urban and peri-urban surroundings, and metropolitan areas appear to be the most appropriate scale for such scenarios.

### 3.3.1 Sustainable Urban Drainage Systems

Urbanization processes are responsible for altering natural flow patterns in terms of runoff volumes and peaks. Conventional storm water systems are pushed beyond their drainage capacity and may lead to more frequent and intense floods.

Urban planning can deeply affect the hydrologic response of catchments. Then, understanding potential effects of urban development on the water runoff drainage system represents a crucial issue in the planning process (Miguez et al. 2009), and the use of sustainable urban drainage systems (SUDS) can help minimizing these effects.

Specifically, SUDS are particular NBS that consist "of a range of technologies and techniques used to drain storm water/surface water in a manner that is more sustainable than conventional solutions" (Fletcher et al. 2014). They are based on the philosophy of mimicking the natural predevelopment site hydrology and follow the principles and goals of low-impact development (Ahaiblame et al. 2012). Conventional techniques collect and channel water out of the catchment as fast as possible through structural storm water conveyance systems (channels, pipes, pumps, regulators, and end-of-pipe solutions) at the outlet of a drainage area. On the contrary, SUDS aim at keeping water on-site as much as possible using landscape features and natural processes (Pappalardo et al. 2017).

Despite the relevance of peripheral contexts in current processes of urban development, limited attention has been given to the hydrological impacts of urbanization on previously rural areas. Existing research confirms the evident changes in hydrological regime in peri-urban areas and particularly underlines the complexity of catchments that present a mix of fast and slow hydrologic response as a result of combining artificial with natural flow pathways (Miller et al. 2014).

Two challenges are raised for the adoption of SUDS in peripheral urban landscapes (Barbedo et al. 2014): (i) to promote the preservation of existing (semi)natural ecosystems with related functions and services and (ii) to apply new technologies for the transformation of land and water resources. Peri-urban landscapes are subject to major socioeconomic pressures for further development and land transformations, posing a big challenge to the implementation of measures aimed at the regulating ecosystem services of water runoff.

Barbedo et al. (2014) use a model to test hypothetical changes in the land uses of a coastal city in Brazil. Authors tested how different scenarios of urban densification can respond to the needs of a growing population while safeguarding cultural landscapes of high environmental value. They demonstrated how water flow regulation services of runoff can be improved and that restoring natural functions of peri-urban floodplains may reduce events of urban flooding.

Pappalardo et al. (2016) modeled the effect of urban development for a peri-urban catchment in Italy, evaluating the potential impact of development on the urban storm water drainage systems (Fig. 6). Authors compared flow peak catchment releases under scenarios of pre- and post-urban development and derived a set of flow release restrictions to be included in the local land-use master plan in order to ensure hydraulic invariance in the two scenarios. Results from the modeling showed that release restrictions could be achieved by SUDS modeled for runoff events with low return periods (1–3 years) and that release restrictions should be defined among areas involved in the urban development proportionally to the extent and type of these developments.

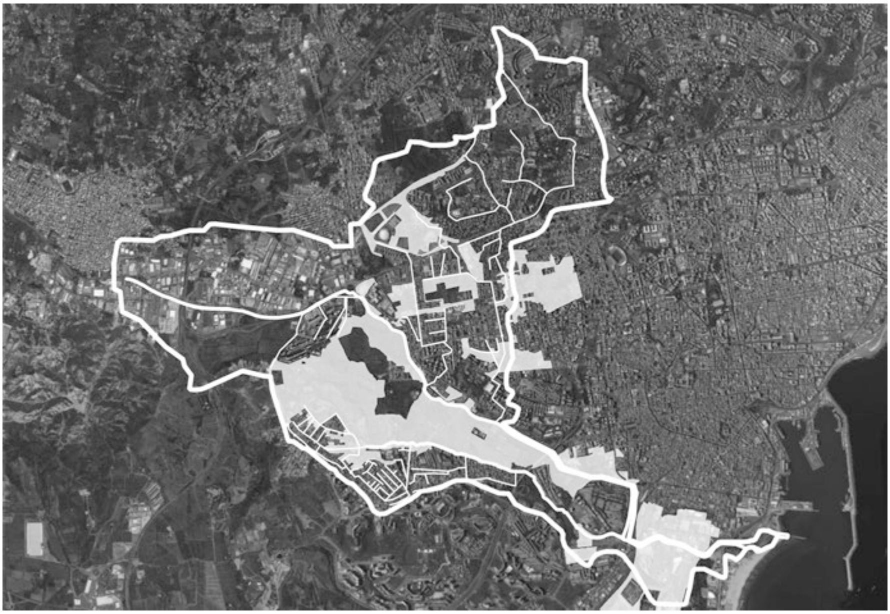

**Fig. 6** Modeling of the effects of new urban developments on runoff for a peri-urban basin in Sicily (Italy): in white the areas for the new urban developments for which the release restrictions are defined (Modified from Pappalardo et al. (2016))

### *3.4 Planning New Forms of Agriculture in Peri-urban Contexts*

Spatial planners and decision-makers are required to consider New Forms of Urban Agriculture (NFUA), as defined in section "Farmlands and peri-urban agriculture" in peri-urban contexts, since in these areas, low-density urban development keeps growing and threatening agricultural lands (European Environmental Agency 2006). To this end, a better understanding of the different features of current peri-urban landscapes would allow identification of the land uses that are most suitable to fulfill the multifunctional aims of NFUA and take part of new planning scenarios (La Rosa et al. 2014).

Areas for urban agriculture can be planned and designed in different forms and to different scales to contribute to biodiversity conservation and provide a massive range of ecological benefits for urban residents (Deelstra and Girardet 2000). The integration of urban agriculture into densely populated areas might greatly extend opportunities for mixing food production with social, cultural, and recreational functions of urban green spaces (Taylor Lovell 2010).

To be a feasible alternative in cities and cohabit with other urban land uses, urban agriculture should include ecological and cultural functions in addition to the direct benefits of food production (Taylor Lovell 2010). A transition from traditional agriculture into a multifunctional one can produce several benefits for society (Zasada 2011), thanks to the localization of farms near or inside dense urban areas and the consequent easier transfer of services and goods from the agriculture activities to the urban environment.

Urban planning needs to include in planning scenarios for peri-urban landscapes a wide range of functions including urban agriculture and other typologies of green spaces for leisure, biodiversity protection, and recreation. This scenario has to be designed according to the specific features of geographical contexts (Hough 2004). However, the integration of urban agriculture in land-use planning has been seldom considered in top-down urban planning, and urban agriculture practices have often been implemented from the bottom-up and spontaneously (Taylor Lovell 2010).

As an example of planning of NFUA, a recent research by La Rosa et al. (2014) proposed a GIS-based multi-criteria model to check the suitability of land-use transitions of current open spaces (farmlands, abandoned farmlands, seminatural areas, mainly located in the peripheral areas of the city) to New Forms of Urban Agriculture, by delineating scenarios that aim to increase the provision of ecosystem services such as food production in urban contexts and access to green spaces. The model returned some scenarios for NFUA that integrate urban agriculture in peri-urban contexts of the city and provide useful information for urban planning policies aimed at reaching a multifunctional and sustainable land use for current urban open spaces and protecting existing productive farmland from urban development pressures (Fig. 7).

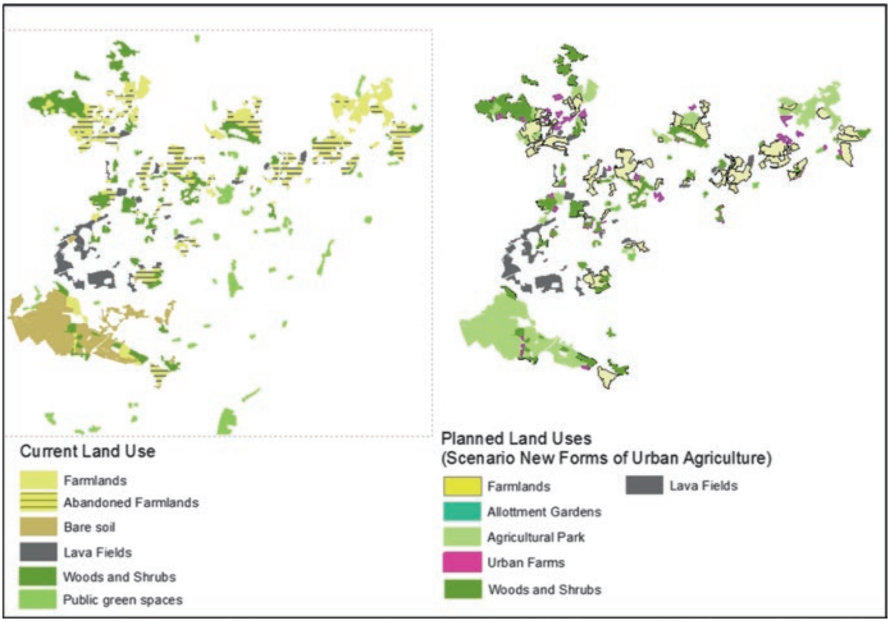


**Fig. 7** Example of planned scenarios of New Forms of Urban Agriculture for the peri-urban context of Catania, Italy (Modified from La Rosa et al. (2014))

In an analysis of the peri-urban agriculture in the Beijing peri-urban area, Yang et al. (2016) highlighted the importance of multifunctionality and diversity in agricultural development literature. The authors also recognized the role of the local municipal government in promoting bottom-up local initiatives for the inclusion of these activities into land-use plans. However, both the built-up land and lands needed for peri-urban agriculture activities require collective land with ambiguous property rights, which hinders large-scale projects of peri-urban agriculture and discourages long-term investments (Yang et al. 2016). Provè et al. (2016) suggested that NFUA could hardly benefit from a governance strategy that only stimulates advocacy and institutional support. Adding more specific needs coming from the urban world (e.g., request for specific goods or creating local markets) and integrating other functions (e.g., leisure and tourism) can stimulate peri-urban agriculture toward its full potential. Furthermore, NFUA can be part of municipal programs and investments for public greenery and environmental conservation, but their planning cannot be reduced to the administrative boundaries of a single municipality as their extent go beyond these boundaries. To this end, synergies and coordination among different administrative levels should be pursued within larger metropolitan regions (see next section).

## 4 Planning and Challenges for peri-urban Landscapes

### *4.1 The Need of a Metropolitan Planning and Governance for the peri-urban*

Current literature is increasingly debating the role of peri-urban areas as part of wider metropolitan contexts (Ros-Tonen et al. 2015; Salet and Savini 2015) that range from large urban agglomerations to smaller local metropolitan areas. This character reflects the manifold links and relations between peri-urban areas and core centers, either in terms of geographical assets, physical connections, and flows (of goods and people) or in terms of processes, including population and urbanization growth and other more specific processes, for example, eco-gentrification (Goodling et al. 2015).

This argument is in line with the current debate on the most effective administrative level at which to plan peri-urban systems (Kline et al. 2014). Understanding the continuous changes that occur in the functional and sociopolitical relations between the urban core and peri-urban areas and framing them in their institutional and administrative context are a prerequisite for effective planning (Salet et al. 2015).

The metropolitan condition of peripheries requires working on more complex relations than those between a specific peri-urban area and its reference core city or rural landscape represented by the traditional core–periphery model. First and most important, peripheries as part of metropolitan systems need to face cross-administrative boundary phenomena and to address the interlinked issues that are relevant at different scales (e.g., the relation between mobility and the urban form).

This is particularly relevant for the accessibility of several urban functions (health, commercial, retail, parks, and other recreational activities) that could be limited or not present in peri-urban areas. In some instances, functions can be shared among different municipalities belonging to the same metropolitan area. Contemporary metropolitan areas require forms and instruments of spatial governance that are able to integrate different planning levels and sectors but are often not presented in national planning instruments or schemes.

Although the dynamics of the transformation of peri-urban areas are certainly not independent from the dynamics of the more central parts in the city, peri-urban areas of developing metropolises exhibit specific characteristics that make their governance (as defined below) a distinctive challenge that deserves the attention of planners. These specific and interlinked characteristics result from a combination of rapid socio-ecological transformations, conflicting stakes and interests, environmental vulnerability, and a lack of an adequate political–administrative jurisdiction.

As an example of the relation between peri-urban areas and metropolitan systems, Padeiro (2016) studied the relation between land-use changes and municipal management plans in the Lisbon Metropolitan Area. The author found that the distance to the capital and former urban dynamics were more significant drivers of land-use change than the land-use plans.

Due to the complexity and highly changing features of peri-urban landscapes, planning of these regions might therefore have to shift away from traditional land-use design and act as a flexible platform to imbalance the activity of public policies and private initiatives, where trade-offs between different uses of the land can be negotiated (Moreira et al. 2016).

### *4.2 Planning Instruments, Spatial Governance, and Transferability of Approaches*

The planning of peri-urban landscapes requires changes in the relations among different administration levels (e.g., local, metropolitan, or regional level), making necessary new political arrangements within the metropolitan areas where they are located. Overall, a combination of local and supra-local schemes (in planning, governance, regulations, and agreements) is viewed as necessary (Webber and Hanna 2014). Furthermore, an effective coordination between different levels of land-use planning is considered crucially important (Carruthers and Vias 2005).

To achieve this coordination, more complex and advanced planning schemes and instruments are needed. In some cases, the integration of different planning levels also means an integration between traditional planning based on spatial administrative units and more innovative tools. To this end, links among different planning levels should be revised and strengthened, involving all levels of the planning process, from the master plan to the subdivision plan and zoning (Lörzing 2006). Many authors suggest a possible combination of different approaches (e.g., traditional and innovative, top-down and bottom-up) that can work at different and integrated scales (e.g., the more strategic at the regional and metropolitan levels with the more operational at the very local level).

Classic planning approaches can be critical to apply in peri-urban and not effective in achieving sustainability. One example is the traditional classic land-use zoning that is viewed as acting as a barrier to sustainable development in peri-urban areas because it fails to consider their complex and dynamic features (Haller 2014) and the multifunctional use of spaces that support socially and environmentally sustainable practices, for example, the use of vacant residential lots for new forms of agriculture (Hara et al. 2013). Other planning instruments, such as master plans or local land-use plans, appear unable to consider peri-urban as part of larger metropolitan regions and are hence inadequate to act as effective solutions (Roose et al. 2013).

Some authors also report concerns about the lack of binding norms to protect peri-urban land that is considered valuable and strategic for sustainable development from urban development. This happens not only with farmlands in peri-urban areas but also with unmanaged open spaces and vacant lands in peripheral neighborhoods, where ecological auto-determination and unplanned but socially relevant land uses can flourish (Foster 2014). Additionally, to a certain degree, regulations are seen as a necessary legal frame to ensure more effective integration of planning choices in metropolitan systems (Carruthers and Vias 2005).

A recent work by Moreira et al. (2016) proposed alternative administrative units than traditional municipalities to better target sectorial policies at local scale within peri-urban contexts. For the Metropolitan Area of Lisbon, authors mapped different peri-urban areas and associated dynamics of landscape change through a set of landscape indicators to identify seven different units where to adopt inter-municipal planning policies and regulations adaptable to manage the urban and non-urban land uses, as well as promoting market tools to regulate land-use change initiatives in the desired directions. Such an approach might be able to avoid planning choices about future land-use and urban functions in metropolitan areas that have been traditionally based on the neat separation of spaces, administrative units, and related spatial policies.

The issue of appropriate schemes of governance for peri-urban landscapes relates to the ongoing debate about alternative modes of spatial governance. Governance is acknowledged as a key issue for these areas, which are frequently divided into different jurisdictions but also characterized by administrative overlaps (Korthals Altes and van Rij 2013) or by political marginality (Cash 2014). These uncertainties may lead to informality in urban development. Multilevel governance (MLG) plays a crucial role to effectively supporting the coordination of planning instruments. MLG is defined as the interplay of institutions, mechanisms, and processes through which political and administrative authority is exercised across different levels (Goldthau 2014). MLG is categorized into two types depending on its orientation toward particular administrative areas or particular policy problems (Hooghe and

Marks 2003). In the first type, bundled MLG, jurisdictional boundaries are separated and not intersecting or overlapping, where each level is assigned distinctive functions and clear lines of responsibility (Smith 2007). Here, the authorities and powers are bundled together within a jurisdiction, with those jurisdictions at the lower level "nested" into higher ones. Type I follows a rather traditional hierarchy of different levels of governance documents. However, its deficit is that it does not react properly to spillover effects, for example, while analyzing ecosystem services benefitting and provisioning areas. In the second type, the flexible jurisdictions form a complex pattern of formal and informal institutions and networks that often overlap with each other. They are no longer related to a jurisdiction but focus on specific policy sectors with task-specific institutions (Hooghe and Marks 2003). Implementing the second type of MLG produces a rich pattern of both formal, statutory spaces and "soft spaces" as more functional, fluid, and governance arrangements. Soft spaces involve creating new functional spaces inconsistent with political territorial boundaries (Allmendinger et al. 2015), which may result in "inefficiencies, spatial externalities, and spillovers" (Moss and Newig 2010).

An example of flexible governance for peri-urban contexts is proposed by Hedblom et al. (2017) with reference to Swedish examples: in Stockholm, the system of green wedges, a landscape previously unrecognized as environmental relevant, has become acknowledged and incorporated in multilevel landscape governance among the municipality, regional authorities, and NGOs. These partners established a long-term commitment and finally formalized a local-level governance structure at local level allowing the conservation of multiple functionalities the wedges provided to the peri-urban population.

Transferability of planning approaches to other geographical contexts is a key issue to evaluate their real flexibility and robustness. Geneletti et al. (2017) found a high level of uncertainty about the real transferability of successful planning approaches to contexts, in which physical, environmental, and socioeconomic conditions are different than the ones where these approaches have been developed (Ryan and Throgmorton 2003). One of the most important issues that make approaches difficult to transfer relies on the institutional variability of planning schemes and related legislation. Many papers highlighted that specific contexts call for specific approaches to incorporate sustainability in several respects of peri-urban planning processes (Todes 2004) and to fit the local specificities of spatial legislation (Harman and Choy 2011). For example, this is the case with approaches of performance-based planning, whose implementation represents a major challenge even for administrations with high institutional capacity (Baker et al. 2006): the possibility of its adoption in other contexts with different planning and governance systems should not be taken for granted and requires further investigation.

## 4.3 Challenges and Raised Trade-Offs in Planning Approaches

Several challenges can be identified when evaluating the effectiveness of sustainable planning to peri-urban landscapes. One of the most relevant is the aforementioned possibility to use traditional approaches (land-use Euclidean zoning, master plans, spatial regulations), mainly because these instruments may be not able to address the fast-changing features of peri-urban areas. Furthermore, such standalone instruments could be vulnerable to formal and informal pressures on planning processes (Mason and Nigmatullina 2011).

Another limitation highlighted by current research raised concerns of the real socio-environmental effectiveness of sustainable planning approaches and the measurability of the environmental effects of the sustainable development of peri-urban areas (Zimmerman 2001). Uncertainties about the short-/long-term environmental sustainability and the potential unwanted outcomes generated from the application of (presumed) sustainable planning approaches have been highlighted. Sustainable models for peri-urban areas have been unable to show whether the solution proposed is ecologically sound and even whether it can be considered livable. An important example of socio-environmental effects of planning is the positive correlation between population growth and the close proximity of peri-urban green spaces in the cities of Antwerp and Ghent (Van Herzele and Wiedemann 2003). This implies that, indirectly, development of peri-urban green spaces can generate more requests for urban development for people wishing to live close to greenery and thus can generate more urban sprawl.

A big challenge is related to the economic resources needed to implement any planning decision. This is a crucial issue, in times when many local authorities (e.g., municipalities) are experiencing a continuous decrease of available budget to be used for the acquisition of land needed to develop new public green spaces or other forms of public service. To this end, alternative sources of funding should be sought, such as grants or incentive schemes, by which landowners could be economically encouraged to directly create or manage new green spaces. Such mechanisms can also produce more effective results if linked to engagement of stakeholders who might provide additional economic support. For example, local communities might be willing to pay a limited fee to have access to green spaces that can be planned by local governments in private lands. Through the budget coming by these fees, the management costs could be covered. Other forms of land acquisition for public spaces include Transfer of Development Rights mechanisms. Landowners and developers exchange a right to build on concentrated portions of property with the obligation to transfer to the municipality the remaining area, zoned for public use (e.g., green spaces). This can increase the overall provision of public green spaces at reduced costs for the municipality (Martinico et al. 2014).

A recent study by Geneletti et al. (2017) reviewed approaches of sustainable planning for urban peripheries and peri-urban areas in particular, revealing challenges and trade-offs that emerge from existing planning research on peri-urban systems. An important category of trade-offs concerns the relation between peri-urbanization processes and the landscapes produced by these processes. For example, Haller (2014) argued that, even if the process of urbanization and peri-urbanization cannot be claimed as positive or negative per se but can produce both positive and negative outcomes, these need to be balanced considering the local socioeconomic and environmental characteristics of the context.

In fact, the possibility of generating sustainable and eco-compatible development can clash with socio-environmental and, particularly, equity issues. New peri-urban developments or retrofitting may generate inequalities by providing opportunities for particular social groups to get preferential access to environmental amenities and therefore allowing an unequal access to ecological/environmental benefits at the cost of low-density urban development (Leichenko and Solecki 2008).

Focusing more on planning approaches, some trade-offs may result from the application of particular spatial planning concepts. An example is the concept of the "compact city," where urban densification and consolidation can generate trade-offs with the condition of urban livability (Westerink et al. (2013). In developing countries, the increase of density as a solution to low-density developments located in peri-urban areas poses issues of availability of green spaces for the growing population (Ramos-Santiago et al. 2014). On the contrary, the request of having pleasant peri-urban environments may clash with the need for water conservation and sustainable management (Carruthers and Vias 2005).

## 5 Conclusions and Perspectives for Further Research

The previous sections have revealed how peri-urban landscapes are particular socio-ecological systems where it is challenging to find consolidated, easy-to-replicate planning approaches to enhance their level of sustainability. This is mainly due to their dynamic characters, fast-changing nature, and the many pressures that they have to face, especially from humans that tend to want more land for their different activities.

Different land-use and land-cover compositions and configurations as well as different and quick changing socioeconomic structures produce very diverse types of peri-urban landscapes, which are difficult to reduce and to classify. As a direct consequence, research on planning approaches of these systems is still limited and scattered, and they are more focused on solving context-specific issues than on providing comprehensive frameworks for sustainable planning.

According to the ongoing research, one of the most relevant approaches and topics for the planning of peri-urban landscapes is related to providing equal and facilitated access to green spaces for the different social subjects living nearby. Inclusive planning approaches to peri-urban greenery contexts should maximize the social benefits of woodlands (accessibility and qualities of goods and services, culturally appropriate development and fulfillment, self-reliance, etc.). The consideration of factors of equity and possible disparity within the current peri-urban population and between the present and future generations are crucial issues to be taken into account in making planning decisions (van Herzele et al. 2005).

Ecosystem services-based planning is an emerging field of research but still rarely applied in peri-urban contexts. New scenarios can be planned in order to conserve and/or maximize the overall provision of ES by peri-urban landscapes. The management and protection of ecosystem services by agro-ecosystems located in peri-urban and other peripheral areas is a possible way to fight against sprawl urban developments and reduce their negative impacts.

Nature-based solutions and green infrastructure provide sustainable, multipurpose, and flexible alternatives for various planning objectives. Particularly for peri-urban landscapes, green infrastructure may be able to achieve a multiple set of planning objectives such as environmental protection, the development of greenery with new distributions of public parks and gardens, the enhancement of the accessibility of current public green spaces, and the integration of peri-urban agriculture.

With reference to this last point, the possibility to readdress existing farmlands and—much importantly—abandoned farms to New Forms of Urban Agriculture is a fundamental planning strategy for peri-urban landscapes that fulfills multifunctional objectives including food safety, landscape conservation, and ES provision. Planning scenarios of NFUA have to be designed according to the specific features of geographical contexts and particularly evaluating variables such as accessibility by local residents. NFUA can be part of municipal programs and investments for public greenery and environmental conservation. However, due to the large size of these areas, their planning requires synergies and coordination among different administrative levels (e.g., for the creation of large agricultural parks).

This presence of many different public bodies and administrations raises the crucial issue of the choice of the most effective spatial governance instrument and mechanism that should be used to apply the sustainable planning approaches discussed in this chapter. Peri-urban landscapes have to be included in wide metropolitan systems, presenting complex relations with both the main cities and the rural surroundings. It is therefore important that new types of flexible metropolitan governance and related planning instruments are established and that they can integrate different planning levels (municipalities, provinces, regions) and sectors.

According to these considerations, Table 1 reports the main characteristics of peri-urban landscape together with planning recommendations and possible approaches (with reference to the scale of application).

Some future directions can be envisaged for new research on planning of peri-urban landscapes. First, it is essential to further explore to which extent some approaches that performed well in a particular context could be reused in other contexts with similar characteristics. This is probably the most relevant issue, as many examples from current literature have revealed uncertainties with regard to the transferability of successful case studies to other geographical contexts.

Another important research improvement includes the evaluation of the socio-environmental effects and outcomes of planning approaches that are adopted. In

**Table 1** Synthesis of characteristics, planning recommendations, and planning approaches for peri-urban landscapes

| Characteristic of peri-urban landscapes | Planning recommendations | Suitable planning approaches | Scale |
|---|---|---|---|
| High proximity to urban areas | Ensure equal accessibility to resources/services | Planning and design of peri-urban greenery<br>Nature-based solutions | Local<br>Local |
| Mix of land uses | Avoid rigid zoning<br>Support/allow the multifunctional use of the land and the reuse of vacant/abandoned lots | Planning new forms of urban agriculture<br>Ecosystem-based planning<br>Green infrastructure planning | Regional<br>Regional/metropolitan<br>Local |
| Presence of ecological and agricultural values | Develop binding norms/regulations to protect land from urban development | Planning and design of peri-urban greenery<br>Planning new forms of urban agriculture<br>Nature-based solutions | Regional<br>Local<br>Local |
| High pressure for further urban development | Develop binding norms/regulations to mitigate/avoid urban sprawl | Strategic planning<br>Planning and design of peri-urban greenery<br>Nature-based solutions | Regional<br>Regional/metropolitan<br>Local |
| Part of wider metropolitan contexts | Co-development of metropolitan plans integrated with lower planning levels (municipal/local) by institutional and local stakeholders<br>New planning instruments (strategic plans, landscape metropolitan plan) | Multilevel spatial governance<br>Strategic planning | Regional<br>Regional |

some cases, specific approaches may eventually result in unsustainable outcomes, instead of a higher level of sustainability. This could happen if the effects on different sectors or at different scales are not adequately addressed. For example, urban planning aimed at densification to reduce sprawl can generate problem of green space availability for the growing peri-urban population. Methods and monitoring programs are needed to provide quantitative evidence on the extent to which a proposed solution can be considered sustainable and livable.

Finally, the same characteristics that make peri-urban landscapes challenging contexts for sustainable planning offer, on the other way, interesting and unique opportunities for current planning approaches. In particular, these opportunities are based on the local resources of peri-urban areas, including both environmental resources (e.g., through ecosystem services-based planning) and socioeconomic resources (e.g., through the integration of bottom-up processes into top-down approaches). Examples include the possibility of planning peri-urban landscapes by mixed configuration of new housing and different types of highly accessible green spaces and other spaces for local food production. Abandoned spaces and vacant lands can be turned into positive resources that increase socio-ecological opportunities and offer more sustainable food production for the peri-urban population.

To this aim, a shift in the conceptualization of the peri-urban contexts from the traditional urban-centric approaches (e.g., including zoning and vertical land-use planning) to an environmental and ecosystem-based interpretation is crucial. This will also allow a better understanding—and consequent regulation—of the social and economic consequences of the peri-urbanization processes (e.g., in terms of environmental intra- and intergenerational equity) and increase the overall sustainability level of these complex and dynamic systems.

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# VIII

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# Ecosystem services deficits in cross-boundary landscapes: spatial mismatches between green and grey systems

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**Abstract**

Quantitative analyses of the influence of boundary lines on ecosystem services distributions remain rare. Approaches towards integrative assessments of green and grey landscape systems, particularly in cross-boundaries contexts, remain underdeveloped. This study aims to close that knowledge gap. This study was carried out in the cross-boundary landscape of the cities of Cieszyn (in Poland) and Český Těšín (in the Czech Republic), which form one urban system that is divided by a national boundary. The study proposes a novel quantitative method to (1) assess and analyse the spatial structure of urban green and grey systems and (2) analyse the potential provision of ecosystem services (ES) in cross-boundary landscapes. The methodology could be useful for various types of cross-boundary landscapes. A spatial analysis using technomass (Ψ) and Normalized Difference Vegetation Index (NDVI) indicators was performed and combined with population data. The ratio between technomass and number of inhabitants to NDVI, used as a proxy indicator for the provision of ES, was implemented for the identification of areas of deficits in ecosystem services provision. The study shows significant spatial asymmetries, indicated inter alia by the share of grey and green systems and distribution of ES deficit areas. The spatial asymmetries of the urban cross-boundary landscape indicate the need for environmental governance covering green and grey systems located on both sides of a boundary as a spatial unit. This challenges current planning frameworks based mostly on "static" Euclidean land-use zones.

**Keywords** Urban landscape · Boundary · Spatial indicators · Technomass · NDVI · Green and grey system

## Introduction

Urban landscapes are compounds of grey and green systems. The grey systems corresponding to the built-up infrastructures - i.e., buildings, roads, technical infrastructures and the like - are the most significant signatures of human domination over the landscape (McHarg 1969). On the other hand, green systems play an important role in increasing inhabitants' well-being (e.g., Jim 2004). The morphological and ecological relationships between urban green and urban grey systems are not linear but rather greatly vary through space and time. Urbanization processes directly affect urban green and grey dependence. Urbanization has become the main driving force of landscape changes by influencing the structure, function, and dynamics of ecosystems (Luck and Wu 2002). Indeed, the volume and pace of urbanization, directly and indirectly, affect other ecosystems (Inostroza et al. 2010), thus compromising the generation, provision, and flow of fundamental ecosystem services (ES) to sustain urban life and functions such as rainfall infiltration, carbon sequestration and cooling effect (UHI mitigation) (Inostroza 2014b; Inostroza et al. 2016a; Inostroza 2016a; Zimmermann et al. 2016).

From an ecological point of view, green system patches and fragmentation, loss of natural vegetation and loss of biodiversity of green systems seem to be the most important challenges related to urbanization processes (Kaczorowska et al. 2015). Many landscapes have become urbanized or peri-urbanized and show differences in the amounts, intensities, and rates of human modifications, which are still not fully understood (Inostroza et al. 2016b, 2017). Nevertheless,

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research studies concerning grey and green urban systems continue to consider them separately. Moreover, urban landscapes, including green and grey systems, have often been analysed as two-dimensional spaces created from two-dimensional patches, leaving, for instance, the intensity of grey systems as being not well described or analysed (Inostroza 2014a). Quantitative (indicator-based) and integrative assessments of green and grey systems are not well represented in the scientific literature.

Geographic information systems (GIS) and remote sensing data have been largely used for identifying urban green and grey systems and their changes over space and time. Several radiometric indicators have been applied to measure green land cover and vegetation dynamics, including Normalized Difference Vegetation Index (NDVI) and Normalized Difference Built-up Index (NDBI) (Zhang et al. 2009). Moreover, the NDVI indicator has been used in environmental studies as a biomass proxy indicator (Dahlin et al. 2014; Roces-díaz et al. 2015). Novel spatial GIS-based 3D indicators can facilitate detailed assessments of urban grey systems, overcoming shortcomings of 2D indicators (Inostroza 2014a). Indicators aimed at describing urban ES need to be well suited for use in urban environments to ensure meaningful transferability to other geographical contexts and to spatial planning (La Rosa et al. 2015).

Scientific research on Ecosystem Services (ES) in urban landscapes has gained great attention during recent years. Recent ES research allows assessment and mapping of ES provision and demand, and various studies have attempted such assessments based on spatially explicit data (eg. Burkhard et al. 2012; Fürst et al. 2013). Some of the methods assume that each ES is of "equal importance "regardless of quality, rarity, spatial configuration, size, and proximity to other land uses (Lafortezza and Chen 2016). In general, the locations of green urban systems can indicate ES providing areas, whereas the locations of grey urban systems indicate ES benefitting areas (Syrbe and Walz 2012). Comparing ES demand and ES provision can be the basis of delimiting ES deficit areas, which are characterized by higher ES demand than provision. These areas, which are often associated with low accessibility to green urban systems, indicate a poor quality of life. The provision of ES is a crucial issue for the quality of life of urban inhabitants (Martinico et al. 2014).

Quantitative assessments of landscapes are frequently implemented in the frame of patch – corridor matrix models, where the landscape is defined as a" cluster of interacting ecosystems" (Forman and Gordon 1986). Although political administrative boundaries are among the most significant signatures of the human modification of space, they are not yet incorporated into patch – corridor – matrix models. Administrative boundaries shape the human influence over large landscape areas and are of particular importance in urban and other types of highly modified landscapes. Besides traditional urbanization processes occurring within administrative boundaries (e.g., expansion of urban peripheries), landscapes are exposed to peri-urbanization processes stretching across different administrative boundaries (Inostroza et al. 2013; Inostroza 2016b). Concepts like metropolitan region, conurbation, peri-urban areas (zones), rural-urban interface, which are discussed intensively in the scientific literature from different angles (Geneletti et al. 2017), try to grasp such cross-boundary influence over landscapes. Political administrative boundaries, interacting with patches and corridors in the frame of a certain ecological matrix, must be taken into account during quantitative landscape assessments.

A cross-boundary landscape (CBL) is a cohesive unit from an ecological point of view but is divided into two or more administrative units. This mismatch between the ecological and political structures of a CBL makes its quantitative assessment challenging. A boundary that divides the landscape might introduce particular asymmetries that do not necessarily follow ecological functions (Brüll et al. 2017). The spatial asymmetries of a CBL are the measurable differences in landscape configuration and composition identified on both sides of the boundary line (Spyra 2014a). However, quantitative landscape assessment methods suited for CBLs, despite the isolated efforts of certain institutions such as the European Environment Agency (Frank et al. 2017; Spyra 2014b) remain lacking. Shares of ES located in landscapes stretching across two or more administrative units are still under-researched. This research attempts to contribute to filling that gap to grasp the specificity of CBLs using a method based on GIS and remote sensing to analyse the spatial distribution of grey and green systems within a CBL and to ascertain their effects on the spatial distribution of ES. Therefore, this research has two aims. Firstly, a quantitative assessment of the spatial structure of urban green and grey systems located within the analysed CBL was performed by means of remote sensing and GIS. Secondly, the ES deficit areas in the CBL were analysed.

## Method

In this research, a spatially explicit quantitative analysis of grey and green systems located in the CBL has been undertaken using GIS and remote sensing techniques.

### Study area

The study area comprises the cities of Cieszyn (in Poland: PL) and Český Těšín (in the Czech Republic: CZ) located on the Olza River in the southern part of the Upper Silesia cross-border region (Fig. 1). Cieszyn was administratively one city until the beginning of the twentieth century, when the urban tissue was divided between recently reborn Poland and the Czech Republic (formerly Czechoslovakia). The national


**Fig. 1** Location of Cieszyn in the cross-boundary region of Upper Silesia

border divides the former city of Cieszyn into two separate cities from a political-administrative point of view: Polish Cieszyn (C) and Czech Český Těšín (ČT). The two cities conform today to a CBL.

## Data set and spatial unit

Land cover (LC) data, which were prepared according to INSPIRE regulations (Infrastructure for Spatial Information in the European Community), were collected from both Polish and Czech sources. The LC classes were classified as belonging either to the green system or to the grey system separately for Český Těšín and Cieszyn (Table 1).

The used data sets contained detailed information about single buildings. As the exact height of each building was missing, the building heights were estimated using a parametric rule based on two variables represented in the database: (1) built-up area and (2) number of floors of each building (Table 2).

A grid of hexagonal cells was used to perform this study. The hexagonal cell was calibrated to an area of 20,000 $m^2$ after testing different cell sizes. This cell area is similar to that used in other studies applying cells for spatial analyses (eg. Vimal et al. 2012) and allows a good representation of the matrix, where most of the cells are not dominated by a single land use. Furthermore, larger cell sizes become too rough for describing typical urban scale spatial transitions. Conversely, smaller cell sizes would be dominated by single land uses and would not capture the complex mix of land uses typical of urban landscapes.

## Indicators

To perform the analysis, a set of three indicators was used (Table 3).

Technomass (Inostroza 2014a) and the Normalized Difference Vegetation Index (NDVI) were calculated for each hexagonal cell. Technomass is the accumulated matter possible to observe and measure in a given area considering only materials with anthropogenic origin, for example, asphalt, bricks, cement, and steel, and would not include any organic or living materials such as trees and grass (Inostroza 2014a, b). Thus, the technomass indicator is a proxy of the volume of the urban grey system. The calculation of technomass uses the following equation:

$$\Psi = \frac{\left[\sum_{i=1}^{n}(\mathrm{bh})_i + 1/2\sum_{j=1}^{n}\left(\mathrm{r}_j\right)\right]}{\mathrm{A}}. \quad (1)$$

Ψ is the technomass [$m^3/m^2$], b is the building's surface, h is the building's height, r is the roads and other sealed surfaces, and A is the total sample area.

NDVI was used as a proxy indicator of the urban green system. NDVI was calculated per pixel using the near infrared (NIR) and red bands of a Landsat 7 image and standard remote sensing procedures.

$$\mathrm{NDVI} = \frac{(\mathrm{NIR}-\mathrm{Red})}{(\mathrm{NIR}+\mathrm{Red})} \quad (2)$$

**Table 1** LC classes classified as belonging either to green or gray system

| | CZ | | PL | |
|---|---|---|---|---|
| | Český Těšín (CZ) | | Cieszyn (PL) | |
| | ID | Name of land cover | ID | Name of land cover |
| Green | 2 | arable land | PTTR02 | arable land |
| | 5 | Garden | PTUT01 | garden |
| | 6 | Orchard | PTUT02 | plantation / orchard |
| | | | PTUT03 | orchard |
| | 7 | permanent grassland | PTTR01 | permanent grassland |
| | 10 | Forest | PTLZ | forest & shrubs |
| | | | PTRK | shrubs |
| Grey | 13 | Built-up area (including courtyard) | PTZB | built-up area (including courtyard) |
| | 14 | roads and other sealed surfaces | PTSO | waste landfill |
| | | | PTPL | urban square |
| | | | PTNZ | other artificial surface |
| | | | PTKM | roads, railroads, airfields |
| | | | PTGN03 | sand or gravel area |

The NDVI values were obtained in a raster environment for the study area, transformed into a vector file and then intersected with the hexagonal grid. To obtain the overall NDVI value per hexagon, each NDVI value was weighted and summed. For that purpose, each NDVI value was multiplied by its area within the specific hexagon and then summed to obtain the final NDVI weighted value per hexagon.

The calculations of the number of inhabitants per hexagonal cell were carried out using Eqs. 3 and 4:

$$I_{bm} = \frac{S_{bm} F_{bm}}{A}, \tag{3}$$

and

$$I_m = \sum_{b=1}^{n} I_{bm} \tag{4}$$

where Ibm corresponds to the number of inhabitants per housing object b located fully or partially in hexagonal cell m, Sbm is the full or partial surface/build area of housing object (dwelling) b located fully or partially in hexagonal cell m [$m^2$], Fbm is the number of floors of housing object (dwelling) b located fully or partially in hexagonal cell m, and A is the area in $m^2$ per inhabitant in the housing unit. A is equal to 26.5 $m^2$ for the Polish part of the city (Poławska et al. 2014) and 31.4 $m^2$ for the Czech part of the analysed city (Habartová et al. 2011). The allocation of housing objects within particular hexagonal cells is accurate. Housing object "b" is located either in one particular hexagonal cell (a not very frequent situation, meaning that the full built area of housing object is assigned to one hexagonal cell) or stretches across two or more hexagonal cells, meaning that we have divided its built area between one or few hexagonal cells accordingly. For each hexagonal cell, we have summed all built-up areas coming from one or more buildings.

The ratio between technomass and number of inhabitants to NDVI was used as a proxy indicator for the provision of ES, allowing the identification of deficit areas according to the specific relationship between grey and green systems. The ES deficit factors were therefore calculated using the following equation:

$$C_m = \frac{\Psi_m I_m}{NDVI_m} \tag{5}$$

where Cm is the ES deficit factor in hexagonal cell m, Ψm is the technomass amount in hexagonal cell m [$m^3/m^2$], NDVIm is the NDVI value in hexagonal cell m and Im is the number of inhabitants in hexagonal cell m.

**Table 2** Parametric rule for estimation of building height

| Surface [$m^2$] | Number of floors | Estimated height [m] |
|---|---|---|
| 0–200 | 1 | 4.5 |
| 200–500 | 3 | 9 |
| 500–1000 | 4 | 12 |
| > 1000 | 1.5 | 6 |

**Table 3** Spatially explicit indicators used in the study

| Indicators used in hexagonal cells |
|---|
| • Ψ – technomass [$m^3/m^2$]; |
| • NDVI; |
| • Dci - Shortest distance of the centroid of hex cell i to the borderline [m]; |
| • Im – Number of inhabitants per hex cell; |
| • Cm – ES deficit factor |

## Spatial analysis

The results were analysed in linear buffers set along the Polish–Czech borderline (Fig. 2). We used buffers to describe the spatial gradient in the landscape from the boundary towards both directions (Poland and Czech Republic). The very existence of the boundary introduces a spatial bias, which is indeed the underlying driving force structuring the landscape. To grasp the cross-boundary character, a set of linear buffers located on the PL and CZ site were introduced. To assign the thicknesses of the buffers, we first tested standard buffering sizes of 100 m, 250 m, 500 m, and 1000 m, as normally done in this type of spatial analysis (Shen et al. 2015). The thickness of the buffer was set to 250 m, which allowed the best spatial description of gradients of topological elements from the borderline in the two directions.

To measure the spatial gradient per buffer, the centroids of each hexagonal cell were computed to calculate the shortest distances of each of those centroids to the boundary line. This shortest distance of the centroids to the boundary line was used to classify the hexagons as belonging to a certain buffer.

## Results

### Technomass and NDVI as indicators for green and grey urban systems

The general trends of technomass and NDVI values in different buffers are displayed in Figs. 3 and 4. The analysed CBL is characterized by higher amounts of technomass in the central areas. The spatial distribution of cells with high values of technomass describes the polycentric character of the CBL, where technomass hotspots are defined by conglomerations of hexagons with higher amounts of technomass than the average technomass value (0.52 $m^3/m^2$). Technomass hotspots with high technomass values (over 3.5 $m^3/m^2$) correspond to (1) the locations of the two city centres and (2) other densely built-up areas that correspond to the industrialized (northern) part of the CBL and residential areas (Figs. 3 and 5b). The cells with technomass values over 1 $m^3/m^2$ indicate the central areas. Using that estimation, we found that on the Czech side, the urban centre area covers 496 ha and has 17,500 inhabitants, whereas the Polish side has 388 ha of surface and has 19,000 inhabitants. There is a significant spatial asymmetry in the central part of the CBL, meaning that grey systems on the Polish part are characterized by smaller volumes than those of the Czech grey systems but are associated with higher numbers of potential users (inhabitants).

Regarding NDVI, opposite trends in the spatial distribution were found. In the Polish part of the CBL (Cieszyn), the NDVI values decreased as the distance from the border increased, indicating a diminishing volume of green systems. The trend is opposite in the Czech part of the CBL (Fig. 4).

The spatial distribution of cells with low values of NDVI is more balanced on the Polish side of the CBL (Fig. 5c). On the Czech side, 10.9% of cells have very low and low NDVI values, whereas on the Polish side, 12.5% have very low and low NDVI values. The very highest values of NDVI are

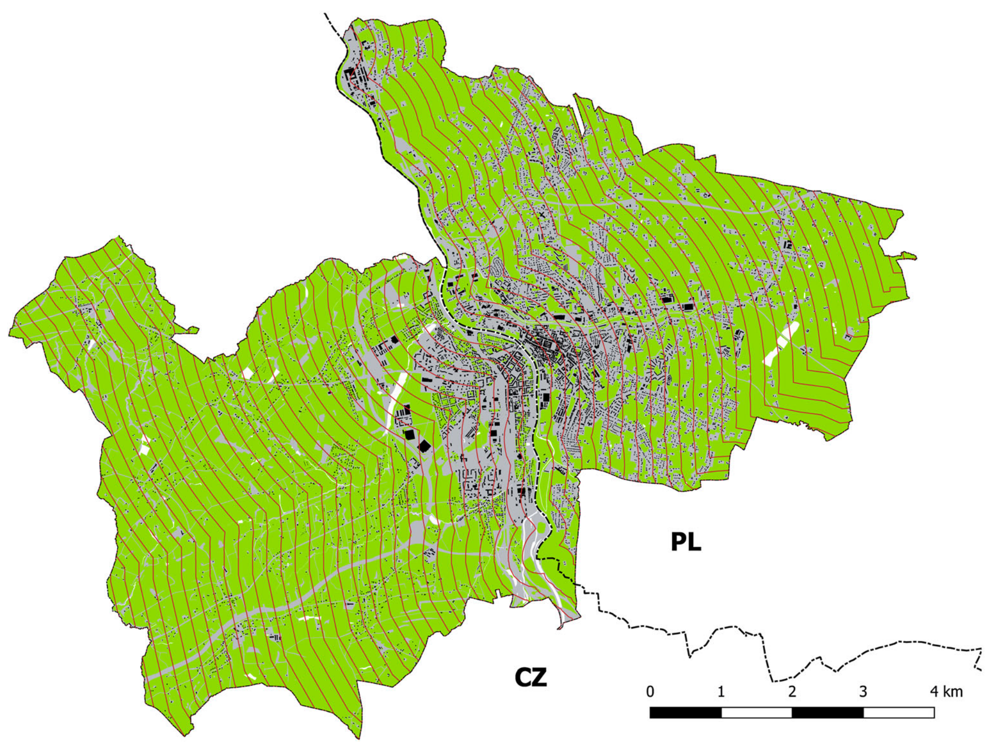
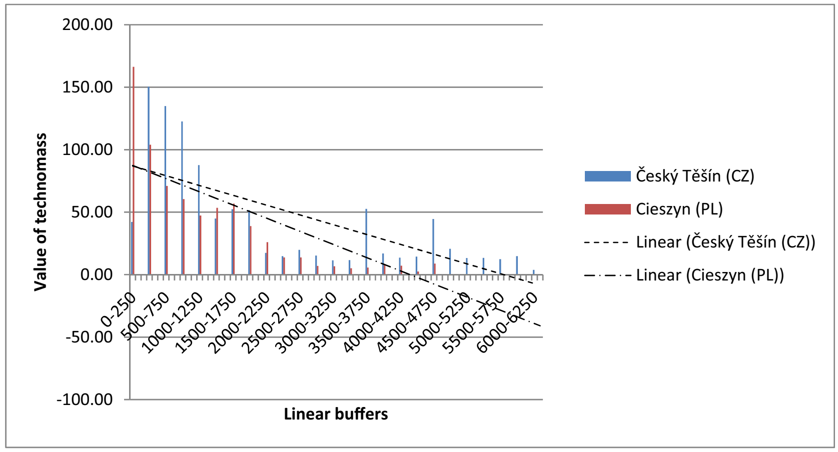



**Fig. 2** The linear buffers (250 m) set along the Polish – Czech borderline

**Fig. 3** Values of technomass (ψ) calculated in buffers in Český Těšín and Cieszyn




Value of technomass (ψ) in buffers in Český Těšín and Cieszyn

characterized by 14.7% of cells on the Czech side and 7.3% on the Polish side. That finding indicates spatial asymmetries among the distribution of green systems within the CBL and their potential existing biomass. Based on that, we estimate that the green systems located on the Czech side are characterized with higher volumes of biomass.

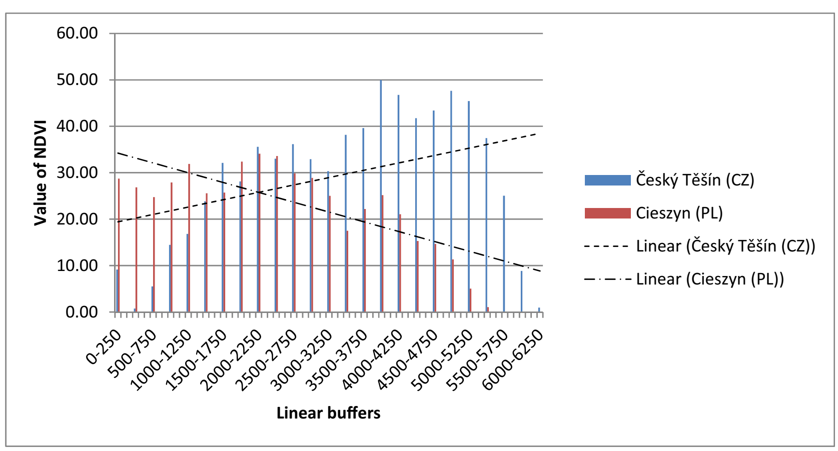
## Ecosystem services deficit areas

The particular relationship between the value of technomass and number of inhabitants versus the amount of green (NDVI) is neither constant nor linear. We posit that ES deficit factor (Cm) serves as a proxy of the locations of the ES deficit areas. To spatially analyse those results, Cm was organized into five sets of values (Table 4).

The highest disproportions between technomass and NDVI can be understood as mismatches between ES provision and demand. These can be observed when Cm is classified as very high. If Cm is classified as very low, it shows a balance between ES provision and demand and good potential accessibility to green systems (Fig. 5d). The results showed that 31.5% of the hexagonal cells characterized with very low values of Cm are located in Český Těšín and 21.2% are in Cieszyn and that 10.3% of the hexagonal cells characterized with very high values of Cm are located in Český Těšín and 16.2% are in Cieszyn. The higher presence of ES deficit areas is located on the Polish side of the CBL, and the better balance between ES provision and demand is on the Czech side. That indicates a significant spatial asymmetry of this landscape (Fig. 5d).

An analysis of the average values of Cm in the buffers to the borderline shows relevant asymmetries between the Czech and Polish sides of the CBL (Fig. 6). The most significant asymmetries are in buffers 750–1000, where on the site of Český Těšín, the Cm values are far below zero, showing a significant ES deficit. In the same buffer on the Polish side of the CBL, the Cm values are greater than zero, showing that a balance between provision and demand for ES exists in this area. Moreover, most of the asymmetries between both sides of the CBL are identified in buffers from 0 to 250 to 1750–2000, corresponding to the central area of the analysed CBL.

**Fig. 4** Values of NDVI calculated in buffers in Český Těšín and Cieszyn




Value of NDVI in buffers in Český Těšín and Cieszyn

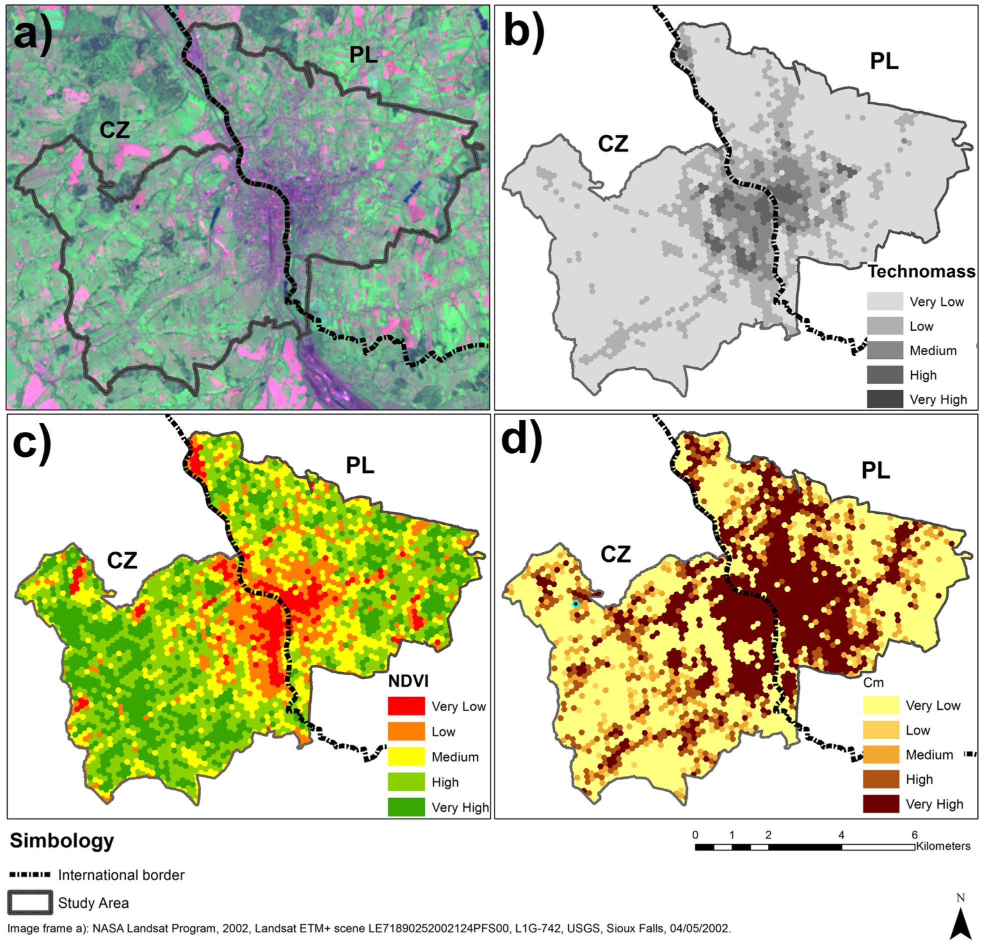



**Fig. 5** Technomass (**b**), NDVI (**c**) and ES deficit factor (**d**) values calculated in hexagonal cells

This indicates potential mismatches between ES provision and demand on both sides of the border (Fig. 6).

## Singularities of the analysed cross-boundary landscape

This study has explored the interactions between urban green and grey systems and provided an assessment of ES deficit areas in the urban cross-boundary context. The results, analysed in linear buffers, provide relevant outcomes, particularly for the historic centre of Cieszyn (buffers from 250 to 500 to 1000–1250).

To summarize the results, the most significant singularities of the analysed CBL are as follows:

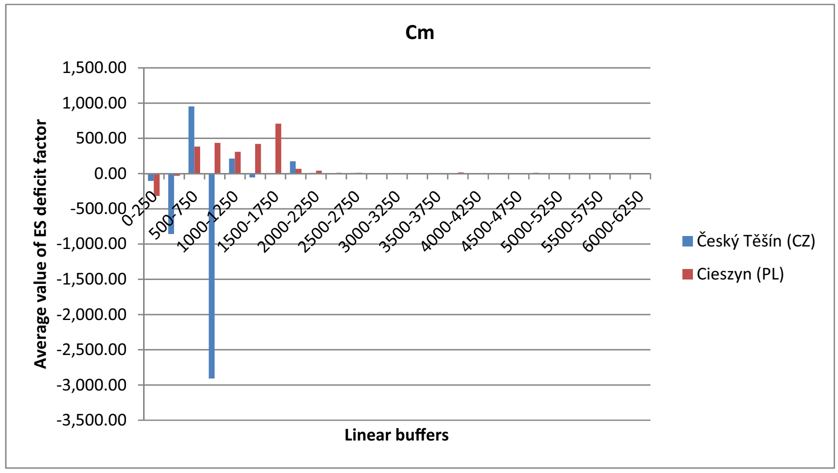
**Table 4** Five sets of the ecosystem services deficit factor values

| | Cm value |
|---|---|
| Very low | $C_m \in (-0,5; 0,5)$ |
| Low | $C_m \in (-1; -0,5) \cup (0,5; 1)$ |
| Medium | $C_m \in (-3; -1) \cup (1; 3)$ |
| High | $C_m \in (-10; -3) \cup (3; 10)$ |
| Very high | $C_m \in (-\infty; -10) \cup (10; \infty)$. |

(1) The most polycentric structure was observed on the Czech side (Český Těšín), and the polycentrism of that structure was indicated by technomass hotspots, indicating areas characterized by high concentrations of anthropogenic matter accumulated in the landscape matter (Fig. 5b).
(2) A decrease in green systems vegetation dynamics is observed on the outskirts of the Polish part (Cieszyn), but an increase in vegetation dynamics is observed on the outskirts of the Czech part (Český Těšín) (Figs. 4 and 5c).
(3) The uneven spatial distribution of green systems is characterized by high NDVI values (Fig. 5c). The Czech part (Český Těšín) is characterized by higher NDVI values than the Polish part (Cieszyn), which is characterized by a more equal distribution of areas with low NDVI (Fig. 4 and 5c).
(4) More ES deficit areas are located in the Polish part (Cieszyn) (Figs. 5d and 6).

## Discussion

The ES concept integrates socio-cultural and ecological perspectives over landscapes (Faehnle et al. 2014; Termeer et al.




The average values of ES deficit factor (Cm) calculated for each linear buffer to the border line

**Fig. 6** Analysis of the average ES deficit factors (Cm) calculated for each linear buffer to the borderline

2010), whereas CBL provides a strong study case to assess ES deficit areas located in different administrative units. The proposed method is useful for performing spatial assessments of a broad set of different CBLs. Not all ES are positively correlated (Nelson et al. 2008); thus our study offers a simplified view of ES provision and does not consider the issue of trade-offs in ES provision (Lafortezza and Chen 2016).

Spatial analyses of landscapes based on buffers are often present in environmental studies. Circular buffers are more frequently used than linear buffers to perform landscape spatial analyses (Ning et al. 2015). Circular buffers have been used to study different aspects of urban landscapes (e.g., dispersion zones, urban happiness, and urban vitality), and buffer radii vary, depending on the context of the case study, from 50 m to 100 m (Baoyan and Xue-fei 2015) and up to 500 m (Kyttä, Broberg, Haybatollahi, & Schmidt-Thomé, 2015; Sung & Lee, 2015). Linear buffers in landscape studies have been used to analyse aspects of infrastructure development (Liu et al. 2015) or to monitor characteristics of urban temperature (Shen et al. 2015). In the second case, the buffers were sized from 100 m to 2000 m.

## Strengths and opportunities of the methodology used in the study

Landscape assessments performed using the patch – corridor – matrix model do not consider the presence of interacting administrative boundary lines, which are strong signatures of human domination over the landscape. Boundaries, as non-physical elements, and their interactions with CBLs require specific quantitative assessment methods. CBLs are the subject of qualitative assessments often implemented in the frame of human geography (e.g., the notion of cultural landscapes) or political geography (e.g., the notion of "border phenomenon") (Newman and Paasi 1998; Scott and van Houtum 2009). The method presented here and implemented in the Polish – Czech case study provides a way forward to close this knowledge gap. It helps provide empirical evidence for connecting cities with their environments, acknowledging that standard decision-making processes that stick to political-administrative units might negatively affect the sustainability of urban development (Chan 2015).

The method used in this study is valuable for the assessment of spatial structures of various types of landscapes, including but not restricted to those located in cross-boundary contexts, crossing two or more national or international administrative units. Analyses in linear buffers provide robust quantitative assessments to describe particular cross-boundary landscape configurations. Furthermore, the applied indicators have mathematical simplicity and require relatively modest data to be calculated. These are two strong features for their applicability in landscape assessments (Jaeger et al. 2010), also taking into account that obtaining detailed and comparable good quality spatial data remains challenging in many landscapes, especially in cross-boundary contexts (Frank et al. 2017; Inostroza et al. 2016b).

The NDVI indicator used in our study is popular in landscape assessments (Turner et al. 2001). The novel technomass indicator can be both an indicator of landscape patterns and processes (Inostroza 2014a). Each hexagonal cell was used to represent a matrix characterized by different configurations of green and grey systems. Hexagonal cells have been used here because they provide a spatial representation capable of capturing the continuity and contiguity of single elements across space in a stronger way than standard squared cells, as they are not captured by the corner paradox. Hexagons have identical contiguity in 6 directions, ensuring that continuous spatial elements are better represented than when using squared cells, which have 2 different levels of differential contiguity—four from the sides and four from the angles. The stronger spatial performance of hexagons makes them especially suitable for landscape monitoring and for exploring future scenarios.

Hexagonal cells are not often used to assess urban landscapes, but several studies have indicated their better usability for landscape assessments rather than rectangular cells (e.g., Birch et al. 2007).

Our methodology proposes using GIS and remote sensing based indicators instead of standard landscape metrics, which are normally applied, for example, to green landscape elements as vegetation assemblages to assess ecological connectivity (Li and Wu 2004). The reason behind that is to have a better proxy of ES across the analysed CBL. Moreover, in this research, we conducted an integrative assessment of green and grey systems to ascertain specific configurations of both as an entangled unity and in relation to population density. That offers us the possibility of employing a proxy of spatial variability of ES provision and demand across CBLs.

## Uncertainties of the research methods

The use of NDVI as a proxy of ES provision is a generalization subject to shortcomings, including its unit of representation, which cannot be directly related to a biophysically understandable measure. However, it offers the possibility of large-scale assessments. The strength of using NDVI in our case is related to its direct and simple combination with technomass as a proxy of grey systems.

At the same time, estimating the amount of population within a cell is subject to uncertainty due to particular spatial assumptions such as homogeneous (isotropic) population density within the cell. On the other hand, estimations of technomass and NDVI are as accurate as the data set used. In this case, for a cell size of 20,000 $m^2$, the spatial resolution of our spatial data set, 1:2000, is very high. Regarding the calculation of NDVI, the satellite imagery used in the calculation had a cloud coverage of less than 3%, for which the accuracies in the NDVI calculation are as high as 97%.

## Informing environmental governance in cross-boundaries contexts

Different types of landscapes are either included within administrative boundaries or located across them. In CBLs, the presence of a boundary dividing several administrative units influences the landscape's composition and configuration. This creates uneven conditions for anthropogenic changes in the landscape and different conditions for the development of landscape systems, affecting their green and grey components. Similar "asymmetrical" processes of shaping landscape can be observed for landscapes located within one country but divided for a longer period by an administrative boundary (e.g., metropolises and districts) or boundaries between cultural regions (Allen and Cochrane 2007). As a result, the particular morphology of a CBL is influenced by the presence of boundary lines, which influence the spatial distribution of land uses and ecological processes. In our approach, landscape morphology was assessed by quantifying the specific configurations of green and grey systems, taking into account the presence of the boundary line with the help of linear buffers. This study allows us to make a step towards understanding the interface between the socio-political system and the landscape. The socio-political system and its spatial effects are represented in our case by the specific delimitation of the borderline, whereas the landscapes represent a highly interwoven assemblage of biotopes and technotopes, with interactions stretching across administrative boundaries. Our ambition behind the proposed research method is to go a step beyond traditional spatial planning based on "end state design" (Steiner 2014) and fixed by planners in "static" Euclidean land-use zones, delineated at certain spatial scales and within particular administrative boundaries. As noted by Sayre (2008), discussions about scale in landscape studies should be concentrated on the spatial and temporal processes shaping the landscape rather than on scale per se. Thus "there is no single correct scale, but a process may have one or several appropriate/best scales for research or planning" because "scales are produced by human-social, geophysical or biological processes" (Sayre, 2008, p.105). Our method captures the complexity of dynamic interrelating processes between green and grey systems and transfers that knowledge into delimitations of ES deficit zones. This can be of a great use for spatial planning and environmental governance in cross-boundary contexts, where traditional land use plans often fail to grasp the transitional character of CBLs.

Asymmetries in ES deficit areas may have important ecological implications, particularly in cross-boundary contexts. Provision of different ES do not "stop" at national borders following political determinations but flow across in both directions. In general, administrative and functional boundaries rarely coincide with the natural boundaries that are relevant to wildlife (Wilson and Piper 2008) or ecological connectivity (Garmendia et al. 2016). The proposed methodology could be useful for identifying ES providing areas, ES benefitting areas and ES connecting areas (Syrbe and Walz 2012), thus filling an important gap in current ES research (Inostroza et al. 2017). Quantitative assessments of cross-border urban landscapes can aid in setting common ES-based planning goals by the integration of spatial plans through the adoption of common planning objectives and review of planning time horizons and boundaries (Wilson and Piper 2008). The use of simple indicators for landscape monitoring can be of great help in exploring future scenarios to ascertain how landscape changes affect the provision of ES (Mukul et al. 2017).

## Outlook

Particular relationships between amounts of technomass and NDVI are neither constant nor linear but vary across space and possibly across time, affecting the provision and demand of ES. Further investigations are needed to understand these relationships under a spatially explicit perspective, as they might be crucial for sustainable urban development and environmental governance. A suitable further step would be to explore particular fluxes of ES using a detailed calculation of biomass. This would make possible estimations of relevant ES such as carbon sequestration and cooling. A complete understanding of the CBL could result after the inclusion of blue infrastructure in further steps of this study.

To provide more precise and usable results, especially in environmental governance contexts, a quantitative delineation of the urban system of Český Těšín and Cieszyn would be needed. The extent of the delineated urban system is supposed to be different from the official administrative boundaries and thus might interfere with more boundaries (encompassing more boundaries within). The proposed methodology could then be applied to analyse those boundaries, with the aim of informing environmental governance in a cross-boundary context.

The presented research is an important step in understanding boundary effects in landscape studies. Future studies should consider other relevant landscape characteristics, such as soil type, slope, barren soils, flooding and bioretention areas, as fundamental determinants of the land use pattern. These landscape physical aspects are influencing the spatial distribution of land use with a greater impact than that of the administrative boundary ones, and they should be considered in further boundary effect assessments.

## Conclusions

A spatially explicit quantitative approach using ad-hoc indicators was used to assess and analyse the spatial structure of urban green and grey systems and to delineate ES deficit areas in a CBL. Quantitative assessments of green and grey systems located in CBLs are helpful for analysing the positive and negative impacts of political-administrative delineations over landscapes. Environmental effects such as pollution, social exclusion and lack of recreational areas do not follow national borders. The study provides empirical proof of cross-boundary landscape spatial asymmetries and delivers a suitable method for assessing different types of landscapes. The results indicate the need for more effective landscape planning, environmental governance and monitoring in cross-boundary contexts to cope with asymmetries that might introduce social and environmental instabilities and thus affect, for example, the aims of European cohesion policies. The presented research method provides scholars and planners the possibility of assessing urban green and grey systems and to determine ES deficit areas located on cross-boundaries and other types of landscapes.

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# IX

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RESEARCH ARTICLE

# The ecosystem services concept: a new Esperanto to facilitate participatory planning processes?

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**Abstract**
*Context* Several case studies investigated the role of ecosystem services in participatory planning processes. However, no systematic study exists that cuts across a large number of empirical cases to identify the implications of using ecosystem services in participatory planning.
*Objectives* This study explores the potential of the ecosystem services concept to act as a boundary concept ("new Esperanto") to facilitate the integration of actors' perceptions and objectives into planning goals.
*Methods* We analyzed eleven case studies to explore how the ecosystem services concept has been operationalized to support participatory planning processes, and to identify lessons from successful applications. We characterized the case studies according to contextual and methodological criteria. Each case study was assessed through a codified score card method in order to detect success or failure criteria in using the ecosystem services concept in participatory planning. We compared the case study criteria with the results of the balanced score card method.

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*Results* We identified several positive effects of applying the ecosystem services concept in participatory planning, including the facilitation of knowledge sharing and consideration of local experiences, the support towards a shared vision, and the increased awareness among local actors concerning their role as ecosystem services suppliers or beneficiaries. Among the drawbacks, we identified the risk of overemphasizing specific ecosystem goods or services during the process.
*Conclusions* We conclude by providing some recommendations to enhance future practice related to issues such as communication, use of local knowledge and integration of ecosystem services in existing legal instruments.

**Keywords** Case studies · Comparative analysis · Ecosystem services · Landscape planning · Participatory planning · Stakeholders

## Introduction

The ecosystem services (ES) concept, which emerged from ecological economics in 1990s, allows the explicit consideration of ecological processes and human activities in planning (Wilkinson et al. 2013). The general contributions by the ES concept to planning are, for example, better communicating the ways in which ecosystems contribute to human well-being (TEEB 2010), finding new arguments for nature conservation and management (Fisher and Brown 2014), raising environmental awareness (Palomo et al. 2012, 2014; García-Llorente et al. 2016), facilitating innovative landscape assessments (Burkhard et al. 2012), and enabling better links to economic valuation (Hubacek and Kronenberg 2013). To this end, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) demands examples of ecosystem assessments that would facilitate national planning processes to become more effective in mainstreaming biodiversity and ecosystem services.

One of the most important contributions that the ES concept could provide is the support in planning processes. In the context of spatial and ecosystem management, specifically participatory planning processes are gaining momentum and thus receiving more attention from researchers and practitioners (e.g. Reed 2008; Turnhout et al. 2010; Potschin and Haines-Young 2013; Arler and Mellqvist 2015; Mascarenhas et al. 2016; Mukul et al. 2017). Several studies investigate the ES concept's role in participatory planning processes (Partidario and Gomes 2013; Saarikoski et al. 2017), showing its potential in this field (Opdam et al. 2015).

*If the ES concept is well introduced*, it can help to overcome obstacles in a participatory planning process by finding a common language among planning actors - comparable to Esperanto (e.g. Cowling et al.

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2008; Palacios-Agundez et al. 2013; Adem Esmail et al. 2017). The ES concept can be then understood as a transdisciplinary boundary concept that helps to achieve a cohesive understanding, from a range of planning actors, of environmental issues (Reyers et al. 2010; Schröter et al. 2014). Thus, the ES concept can contribute to develop a common ground among actors taking part in the participatory planning related to important environmentally oriented planning issues, i.e. planning priorities, aims, and obstacles (Woodruff and Bendor 2016; Dick et al. 2017; Rozas-Vásquez et al. 2017) or conservation policies (García-Llorente et al. 2016).

On the other hand, a *potential challenge to utilize the ES concept* in participatory planning processes is that the concept might be too complex, that it does not meet the requirements for planning applications, and might be misinterpreted in practice (Balmford et al. 2011; von Haaren et al. 2014; Hansen et al. 2015; Sander et al. 2016). A potentially critical factor in using the ES concept in cooperation with diverse planning actors is the tendency towards biased attention to visible and directly usable ES, which are mainly provisional and cultural ES (Rodríguez et al. 2006). This could undermine the value of regulating and maintenance ES, as well as the ES which are located far away from benefiting areas (Liu et al. 2016; Tammi et al. 2016). Furthermore, there is the need to limit ES complexity to specific scales in order to avoid confusion, especially if non-scientific planning actors are involved (Jacobs et al. 2016).

### Problem statement/research gap

Despite an increasing number of papers on ES in participatory planning, most of the studies so far have been conceptual (e.g. Opdam et al. 2015) or individual cases (e.g. Mascarenhas et al. 2016). There is a lack of a systematic integration of the ES concept into participatory planning (De Groot et al. 2010; Albert et al. 2014; Kabisch 2015). No systematic study exists that cuts across a larger number of empirical cases to identify more general implications of applying ES concept in participatory planning.

In our study, we explore how the ES concept can potentially contribute to finding a common language, similar to *Esperanto,* among planning actors. We hypothesize that the concept of ES can well facilitate communication processes in planning and contribute thereby to participatory planning. Our intention in this research is to look in detail into practical experiences in the ES concept implementation in the different participatory planning contexts.

Consequently, the aim of this paper is to enhance the understanding of options and implications of applying the ES concept in participatory planning based on evidence from several practical case studies. More specifically, our research objectives are:

1. to characterize the participatory planning context, where the ES concept has been applied;
2. to analyze common advantages and risks of using the ES concept in different participatory planning contexts;
3. to show how the ES concept can be operationalized to successfully support participatory planning processes.

In order to provide insights in using the ES concept in participatory planning, we performed a comparative analysis of several case studies with the help of two analytical tools–a balanced score card (Fürst et al. 2014) and comparative criteria table (inspired by La Rosa et al. 2015).

## Methods and case studies

The selection of the case studies was based on several steps. Firstly, to gain a general overview of available case studies addressing ES applications in participatory planning, a comprehensive literature analysis of using the ES concept in participatory planning was conducted. In a second step, we presented the results of the literature review during the EcoSummit conference 2016 in Montpellier, where the authors organized a workshop titled "Generating practical outputs from ES studies–an interdisciplinary exchange". This workshop was open to all conference participants and we used this opportunity to increase the pool of case studies. The final set was based on eleven case studies with diverse spatial and planning contexts, covering ten countries and four continents: Europe (6 studies from Czech Republic/Poland, Finland, two case studies from Germany, The Netherlands, and Spain), Asia (1 study from Turkey), Africa (2 studies, both from Ghana), North America (1 study from Mexico) and South America (1 study from Chile) (Fig. 1). The criteria for final case study selection were both relevance to the research question as well as the availability of in-depth knowledge of the design and impact of participatory processes as gained from personal involvement in those cases. For all case studies identified, the respective key persons involved were invited to contribute to the case study analysis and manuscript preparation as co-authors to allow for first-hand reflections on experiences. The method used in this regard is similar to other publications reflecting on the impacts of participatory planning processes (e.g. Nassauer and Opdam 2008).

The diverse characteristics of the case studies gave us the possibility to compare the different experiences in order to present common advantages and risk of using the ES concept in participatory planning and to show how ES concept can be operationalized to successfully support participatory planning processes.

Two analytical tools were used in the comparative analysis of case studies. The first one is the *comparative criteria table (CCT)* which helped to gather, characterize and compare information from the case studies. We followed the comparative criteria approach represented by La Rosa et al. (2015). The CCT contains case study characteristics, the planning context, the planning scale, the ES framework, methodologies used, and deliverables (Table 1).

The second analytic tool is the *Balanced Score Card (BSC)* described by Fürst et al. (2014). The BSC is a matrix with questions related to the risks and advantages of using the ES concept in the participatory planning process, e.g. with regard to knowledge sharing, social networking, shared vision, actor inequality, supply–demand relationships, and the involvement of social, ecological and economic system components into planning. We divided the questions into two general groups (Table 2): (1) the advantages of implementing the ES concept in participatory planning and (2) the risks of implementing the ES concept in participatory planning. Additionally, we separated questions according to short- and long-term

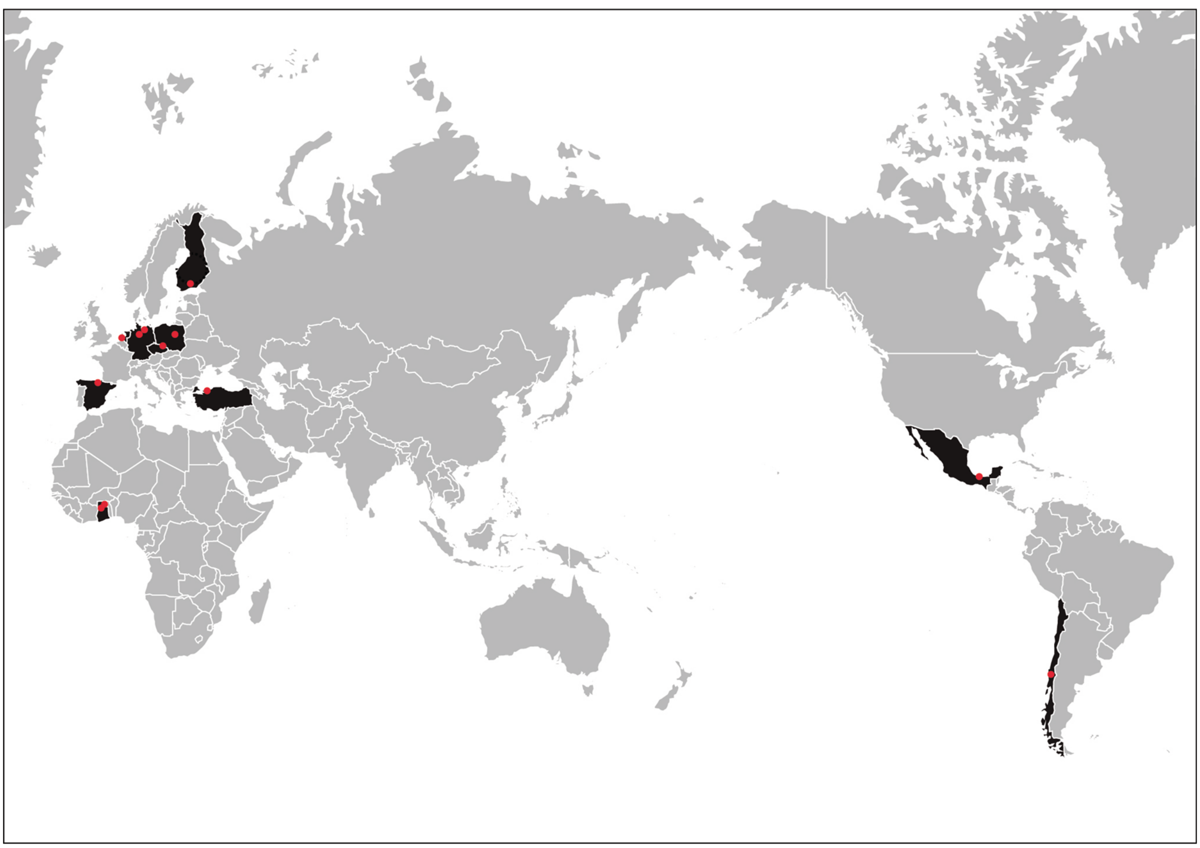


**Fig. 1** A global map with the location of the case studies. Source: Open Street Map and ArcGIS version 10.0

**Table 1** Comparative criteria table (CCT) used in the study

| Criteria of comparison | Description |
|---|---|
| Case study characteristics | (1) Geographical location (country) |
| | (2)Types of the case study: (a) *theoretical* where the ES concept is discussed only at the theoretical bases; the research was not (or not yet) implemented in planning and no practical outcomes were delivered and (b) *practical* where the ES concept was used in the planning process and practical planning outcomes were delivered; |
| | (3) Area and geographical location [ha]; |
| | (4) Amount of inhabitants in the year of performing the study; |
| | (5) Duration of the project; |
| | (6) Land use classification |
| Planning context | (1) Priority planning objectives; |
| | (2) Actors involved: (a) *experts/scientists* defined as objective knowledge holders; (b) *stakeholders* defined as having a particular interest as they represent a community or group interest (stake); and (c) *citizens/laymen* as the group being affected, but not organized to represent a shared interest |
| | (3) Governance system (top down, bottom up); |
| | (4) Additional regional priorities involved (e.g. job security, economic development, green growth, etc.); |
| | (5) Obstacles in the planning process (e.g. lack of resources, low willingness to participate, NIMBY, etc.) |
| Planning scale | (1) Type of planning: (a) *policy planning*, (b) *spatial planning*, (c) *management planning*; |
| | (2) Spatial scale of the case study: (a) *macro–national*, (b) *meso–regional/landscape*, (c) *micro–local/urban*; |
| | (3) Temporal scale: (a) *strategic (long term)* ∼ 50–100 years; (b) *tactical (mid term)* ∼ 10–30 years; (c) *operational (short term)* ∼ 1–5 years |
| ES framework | (1) Classification system utilized (e.g. MEA, CICES or others); |
| | (2) Types of ES considered |
| Methodology | (1) Assessment methods and data base: (a) *qualitative* (e.g. expert based); (b) *quantitative* (e.g. indicator/model based) |
| | (2) Participatory methods used in order to operationalize the ES concept (e.g. open access conference, focus group discussions, online participation and surveys like one-time/Delphi, planning cell, etc.) |
| Deliverables | (1) Type of document prepared (e.g. land use plan, masterplan, strategy, report, written–oral agreement, etc.) |
| | (2) Type of financial resources (mechanisms) proposed to implement the planning outcomes |

Comparative criteria table (CCT) used in the study. *ES* ecosystem services, *MEA* millennium ecosystem assessment, *CICES* common international classification of ecosystem services

(temporal scale) as well as to local and regional scale (spatial scale). Each question was assessed by the survey participant with scores ranging from "0" (no advantage) to "5" (great advantage) scores for the advantages of using the ES concept in participatory planning and from "0" (no risk) to "-5" (high risk) scores for risks concerning implementation of the ES concept in participatory planning for their particular case study.

For each case study, one principal researcher (the survey participant) who was responsible for conducting the study was identified and asked to participate in our survey. The total amount of principal researchers is equivalent to the amount of analyzed case studies (eleven). Both BSC and CCT were filled by the principal researcher, but consulted with the whole research team working with the particular case study. Explanations of the questions in the BSC were presented in Fürst et al. (2014). In addition, further clarifications in terminologies used in the BSC and CCT were provided by the main authors. The total score of the advantages and risk levels was calculated as the average value for each matrix cell. The final score of the overall balance is represented by the sum of the positive and negative values.

Finally, the BSC was combined with the CCT to show how the ES concept can be operationalized to successfully support participatory planning processes. The CCT provided background information to justify particular risk and advantages scores displayed in the

**Table 2** The Balanced Score Card (BSC) for assessing how efficient the use of the ecosystem services (ES) concept was in facilitating the planning process by supporting consensus building and enhancing collective action (based on Fürst et al. 2014)

| | | **Name of the case study** | |
|---|---|---|---|
| | | **Advantages** | **Risks** |
| | | **Description** | **Description** |
| | | **Did the ES concept...** | |
| **Temporal scale** | **Short term** | ...facilitate knowledge sharing? | ...provoke actor inequalities due to knowledge access / background? |
| | | ...support working on a shared vision? | ...overemphasized specific goods / services? |
| | | ...contribute to social networking and exchange? | ... hide economic motivations? |
| | **Long term** | ...help building a common pool of knowledge? | ...exclude actors from the planning process due to knowledge access / background |
| | | ...help to build a common understanding / value system? | ... provoke outsourcing the feeding of demands to other areas? |
| | | ...help to develop shared interests and end up in concrete actions? | ...hide trade-offs due to unclear system boundaries for assessment and evaluation? |
| **Spatial scale** | **Local scale** | ...contribute to include local experiences? | ...disfavor the participation of locally concerned actors (land users)? |
| | | ...add to an increasing awareness on local potentials? | ...lead to more pressure on the supply side or to areas with high provision potential? |
| | | ...help local actors to identify as supplier or demander of services? | ...disfavor economic concerns of local actors? |
| | **Regional scale** | ...help to strengthen local-regional collaboration? | ...provoke imbalance in who is defining prior regional targets? |
| | | ...put a vision into action? | ...aggravate globalization effects? |
| | | ...strengthen the role of local actors in regional perception? | ... complicate road-mapping for regional sustainable development? |

The Balanced Score Card (BSC) for assessing how efficient the use of the ecosystem services (ES) concept was in facilitating the planning process by supporting consensus building and enhancing collective action (based on Fürst et al., 2014)

BSC. As a final step, we analyzed the results from the BSC of particular categories of case studies described in the CCT. Particularly, we explored how the type of the case study or the number of assessed ES and actors might affect the perception of risks and advantages. We analyzed comparable criteria from the CCT by using descriptive statistics, visualized in box plots (in STATA version 13.1) and checked how it reflected the advantages and risks in implementing the ES concept in participatory planning as described by the BSC. We understand by "comparable criteria" the characteristics of the case studies, which were represented in more than two case studies.

## Results

### Comparative criteria table (CCT)

#### *Characterization of the participatory planning context where the ecosystem services concept has been applied*

The results from the comparative criteria table (CCT) are presented in the Table 3 and in the annex (Table A1). Different ES classifications were used in the case studies. In order to allow a clear comparisons between ES types, the ES were translated into one common ES classification system. Here, the classification of the Millennium Ecosystem Assessment (MEA) was chosen because it was most often used among analyzed case studies (Table A2 and Fig. A1). All case studies, except La Araucania Region and Schaalsee Biosphere Reserve, contained continuous or discontinuous urban fabric including different kinds of settlements. The average size of the case study was 545,400 ha, although the sizes vary a lot. The smallest case study was located in northern Ghana (119 ha). The largest case study, and also having the lowest population density (0.30 inhabitants per ha), was La Araucania Region, in Chile (3,184,200 ha). The most densely populated case study was the Fuhrberg Watershed (21.67 inhabitants per ha). The largest amount of inhabitants was provided in the Basque Region (2,171,886 people), while the smallest amount of inhabitants was in UNESCO Biosphere Reserve Schaalsee (about 14,000 people). The project duration of 60 months in the Fuhrberg Watershed represented the longest among the analyzed case studies. The shortest duration was 8 months in La Araucania Region. The average duration of the project was 30 months. All case studies also contained forest and semi-natural areas, as well as land uses/covers related to agriculture. With regard to the use of the *ES concept in planning,* about 36% of the case studies used the ES concept in a theoretical approach (Tabasco Region, Northern Ghana I and II, and Omerli Watershed), while the remaining case studies presented a "practical" implementation of the ES concept.

During the survey executed for this paper in 2016 and 2017, we discovered that the ES concept was often used together with other concepts in the participatory planning process. *Priority planning objectives* of our case studies were strongly oriented towards sustainable development. Furthermore, planning objectives in all case studies included the ES assessment and prioritization for supporting development objectives and moving towards the integration of the ES concept into spatial planning. We have defined three main groups of actors involved in participatory planning:

– Stakeholders—are actors with a well defined interest (a stake) or important connection to the area related to the participatory process (e.g. a private company who invested money, a public administration).
– Researchers/experts – are the objective knowledge/expertise holders, who do not have a direct interest (connection) in the area related to the participatory process.
– Citizens—are people who live in the area related to the participatory process, but have no well defined stake in it.

About 64% of case studies worked with three actor groups (Tab. 3), namely experts/scientists, stakeholders and citizens, while 36% of case studies did not involve citizens. The biggest number of actors (562 people) was involved in the Omerli Watershed, while the smallest number of actors was in the Schaalsee Biosphere Reserve with 12 actors. On average, 130 people were involved in our case studies. With regard to the governance systems (Table 3), 36% of case studies implemented a top-down approach, one case study implemented a bottom-up approach, and 55% of the case studies implemented a mixture of both top-down and bottom-up approaches.

The identified *obstacles in the planning process* (Table 3) show general problems, site-specific technical obstacles as well as methodological challenges related to the understanding of used scientific concepts. The most frequent *site-specific technical obstacle* identified in the case studies was the poor access to reliable data (36% of the case studies) and economic issues (55% of the case studies). The economic issues were mainly related to high political pressure on different investments, resulting in high pressure on ecosystems to increase economic benefits. Land pressure was often the result of the dominating role of powerful public or private planning actors (Omerli Watershed and Schouwen-Duiveland Island). This imbalance in power relations resulted in the situation where nature conservation goals were dominated by pure economic development goals during the planning process (Schaalsee Biosphere Reserve). Another obstacle relates to *organizational inconsistencies* that complicated the required transversality in the planning legislature (Omerli Watershed and Basque Region). These inconsistencies also occur in the cross-border context where planning legislature is not complementary across the border and was prepared without efficient cooperation between national actors (Czech-Polish borderland). Such inconsistencies were also related to the following: fragmentation and compartmentalization in the administrative structures (Basque Region), inconsistency of macro and local level

**Table 3** Comparative criteria of the case studies

| | | Järvenpää City | Tabasco Region | Northern Ghana I | Omerli Watershed | Basque County | Czech-Polish borderland | Schouwen-Duiveland Island | Northern Ghana II | Fuhrberg Watershed | La Araucania Region | Schaalsee Reserves |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Actors involved in the planning process | Stakeholder(s) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Researcher(s)/ Expert(s) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Citizens | ✓ | ✓ | | ✓ | | ✓ | ✓ | | ✓ | | ✓ |
| | Total number of actors [(1)] | 333 | 210 | 31 | 562 | 37 | 78 | 33 | 95 | 30 | 14 | 12 |
| Governance system | Top-down | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | |
| | Bottom-up | ✓ | | ✓ | | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Obstacles in the planning process | Economic related issues | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | ✓ | ✓ |
| | Data | | ✓ | ✓ | ✓ | | | | ✓ | | | |
| | Organizational inconsistencies | | | ✓ | ✓ | ✓ | ✓ | | ✓ | | | |
| | Motivation of actors | | | | | | ✓ | | ✓ | | ✓ | |
| | Understanding of scientific concept | | | ✓ | ✓ | | | | ✓ | ✓ | | |
| | Others | | | | | | | | ✓ | | ✓ | |
| Planning scale of the analyzed case studies | ***Type of planning scales*** | | | | | | | | | | | |
| | Policy planning | | ✓ | | ✓ | ✓ | ✓ | | ✓ | | | ✓ |
| | Spatial planning | ✓ | | ✓ | ✓ | ✓ | | ✓ | | | ✓ | |
| | Management planning | | | ✓ | | | | | ✓ | ✓ | | ✓ |
| | ***Spatial scales*** | | | | | | | | | | | |
| | Macro scale | | | | | | | | | | | ✓ |
| | Meso scale | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| | Micro scale | ✓ | | | | | | | | | | |
| | ***Temporal scales*** | | | | | | | | | | | |
| | Strategic (long-term ~50-100 years) | | | | | | ✓ | | | | | ✓ |
| | Tactical (mid-term ~10-30 years) | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Operational (short-term ~1-5 years) | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | | |
| Methodology applied to put the ES concept into practice | ***Assessment methods*** | | | | | | | | | | | |
| | Qualitative | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | ✓ | ✓ |
| | Quantitative | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | ***Participatory methods used*** | | | | | | | | | | | |
| | Focus group discussions, workshops | | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Surveys | | | ✓ | ✓ | | | | ✓ | | | |
| | Participatory mapping | ✓ | | | | | | ✓ | | | | |
| | Training | | ✓ | | | ✓ | | | | | | |
| | Others | ✓ | ✓ | | | | | | ✓ | | | |
| Case study deliverables | ***Documents and/or acts prepared as process outcomes*** | | | | | | | | | | | |
| | Report | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | | ✓ | ✓ |
| | Data oriented outcomes[(2)] | | ✓ | | | | | | | | | |
| | Capacity building acts[(3)] | | ✓ | | | | | | | | | |
| | Inputs for spatial plans[(4)] | | | | ✓ | ✓ | ✓ | ✓ | | | | |
| | ES models[(5)] | | | | | | | | | ✓ | | |
| | ***Financial mechanisms proposed to implement*** | | | | | | | | | | | |
| | International funds / EU funds | | | | | | ✓ | | ✓ | | | |
| | National funds | | | | | | | | ✓ | | | |
| | Local public funds | ✓ | ✓ | ✓ | | ✓ | ✓ | | | ✓ | ✓ | ✓ |

[(1)] This number shows the total amount of actors that were involved in implementation of particular case study [(2)]Data oriented outcomes contains metadata, databases etc. [(3)] Capacity building acts contains training courses, academic exchange etc. [(4)] Inputs for spatial plans contains scenario workshop, maps of protection zones, regional planning guidelines, development strategies, landscape design strategies. [(5)] ES models contains assessment models as standalone tools.

spatial plans (Omerli Watershed) and non-availability of important actors for the planning process (Northern Ghana II). A frequent problem for participatory planning processes is to motivate actors to actively participate. Another specific kind of obstacle named here was the "not in my backyard" (NIMBY) phenomenon, which was clearly recognizable in the cross-border context because of the will of national actors who preferred to protect the interests of their own country (Czech-Polish borderland).

Most frequent *methodological challenges* relate to the low understanding of the used planning concepts in general, and the ES concept in particular, leading to a lack of willingness to implement the ES concept (Northern Ghana I and II, Fuhrberg Watershed). This problem seems to be caused by a lack of general knowledge and the belief in the empowerment of the planning process among stakeholders (Omerli Watershed). The lack of a cohesive understanding between actors of some specific approaches was disturbing the planning process. A specific methodological challenge, which appeared within the public–private partnership model, is related to the dominance of one particular actor over the planning process. The dominating actor, characterized by the financial strength, hindered the input of parties who provided less or no funding (Schouwen-Duiveland Island).

The characterization of the *planning scale* showed that 55% of the case studies focus on one type of planning, while the rest focus on two types of planning (Table 3). The dominant types of planning were policy planning and spatial planning. Management planning was the focus of 36% of the case studies. The dominant *spatial scale* among the case studies was meso-scale (82%). Concerning the *temporal scale*, 18% of the case studies reflected to the strategic scale (long-term) and 82% referred to the tactical scale (mid-term).

The ES which were considered in the case studies (Fig. A1) varied between 2 and 19 ES based on the MEA classification. Three case studies (Northern Ghana I, Northern Ghana II and Fuhrberg Watershed) did not include cultural ES, whereas others mostly dealt with recreation, aesthetics and knowledge & educational values as cultural services. On the other hand, food and fresh water provision were assessed in all case studies, which means that provisioning services were the primary concerned ES.

A diversity of *assessment methods* and databases were used to put the ES concept into practice (Table 3). About 27% of the case studies used only qualitative assessment methods and databases. Among the *participatory methods*, 55% of the case studies used two participatory methods, while 36% of the case studies used one participatory method. The most widely used participatory method was regular group discussion (45%). In 36% of the case studies, different kinds of stakeholder workshops (Omerli Watershed, Basque Region, Czech-Polish borderland and Schouwen-Duiveland Island), including the design workshop (Czech-Polish borderland) were implemented. The surveys used in our case studies were always backboned with personal meetings of the involved actors, thus those surveys avoid "anonymity" aspect.

Written reports were the most frequent deliverables of the participatory planning processes, which were implemented in the frame of analyzed case studies (in 73% of the case studies, see Table 3). Two cases prepared strategies: development strategies in the Czech-Polish borderland and landscape design strategies in Schouwen-Duiveland Island. Moreover, regional planning guidelines (Basque Region), a map of protection zones (Omerli Watershed), and ES models as stand-alone tools with a strong visualization component (Fuhrberg Watershed) were prepared. Usually, the type of practical outcome was limited to one outcome (in 73% of the case studies) or two outcomes (in 18% of the case studies). Exceptionally in the Tabasco Region, a rich selection of deliverables was prepared including, besides written reports, metadata, training course, scenario workshop and academic exchange. In this context, a scenario workshop was the method which allowed actors to visualize the future impacts for conserving or not conserving the ES of their main surrounding ecosystem by developing and writing a story of such future states. Here, two main outcomes were identified: (1) identifying and understanding people's awareness about interactions between them and ES; (2) potential use of this method to plan actions from this future vision. Main financial resources to implement the planning outcomes (73%) were local public funds.

## Balanced score card (BSC)

### *Common advantages of using the ecosystem services concept in different participatory planning contexts*

The advantages across different temporal and spatial scales for each of the case study are presented in Fig. 2. The highest advantages were reported in

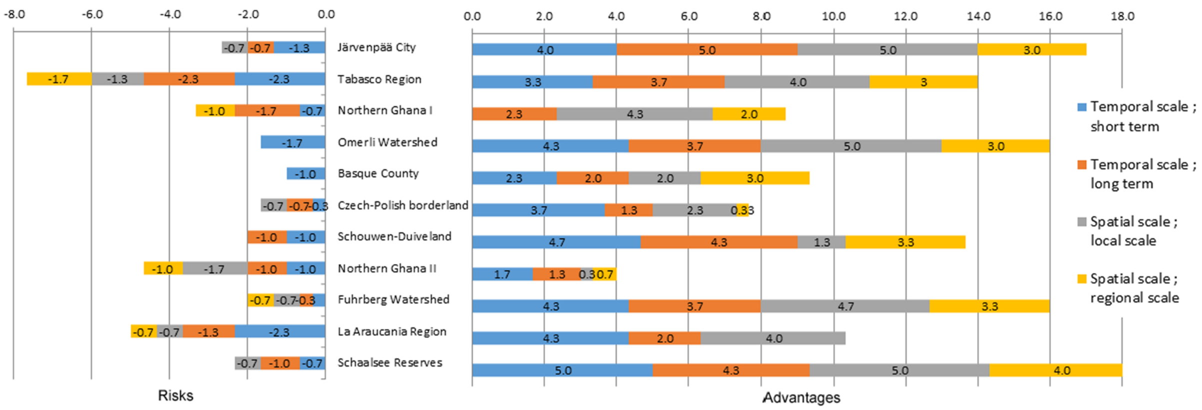



**Fig. 2** Bar chart presenting the summarized scores for the respective case study of advantages and risks in using the ES concept. Bars are separated according to temporal and spatial scales. Average scores inside the bars are based on subsequent questions from the Balanced Score Card

Järvenpää City, Omerli Watershed, Fuhrberg Watershed and Schaalsee Biosphere Reserve, where the total positive score is higher than 15. A low level of advantages was identified in Northern Ghana I and II, Basque Region and Czech-Polish borderland with a score below 10. The lowest score was provided for Northern Ghana II. The complete BSC with detailed answers from participants is presented in the annex (Annex Table A3).

Different kinds of advantages in using the ES concept in participatory planning as identified in our case studies are illustrated in Fig. 3. *The greatest advantages* were that the ES concept: facilitates knowledge sharing, supports the work on a shared vision, contributes to include local experiences, increases the awareness of on local potentials, and helps local actors to identify as supplier or demander of services. In all but one case study, the ES concept was perceived as supportive for knowledge sharing and establishing a common vision. Authors reported, however, that a careful explanation of the ES concept would be needed, as the concept is still perceived as rather new (Northern Ghana I). Through applying the ES concept in planning, many datasets including reports and maps were compiled for and considered in planning for the first time (Järvenpää City). Considering a broader spectrum of services in planning was perceived as another benefit of applying the ES concept. In the Schaalsee Reserve case, the ES concept further helped structuring the participatory assessment and planning processes using a balanced set of economic, social and ecological sustainability criteria. Moreover, the ES concept seemed to facilitate the integration of different perspectives and to develop a common understanding among stakeholders (Tabasco Region), even in interdisciplinary teams (Schouwen-Duiveland Island) and complicated, cross-border contexts (Czech-Polish borderland). Finally, the ES concept supported fulfilling future regional objectives for development in a later stage of the participatory planning process (La Araucania Region).

*A minor advantage* from using the ES concept in participatory planning, characterized by a high variance of the assigned scores, was in regard to putting a vision into action. The *time factor must be considered while implementing the ES concept* in order to put a planning vision into action in participatory planning processes. We have identified a trade-off between the complexity of ES and the need for a holistic approach and the long period that is required for planning.

Further minor advantages come from the aspect of strengthening the role of local actors in regional perception. The ES concept helped to bring the knowledge of local stakeholders into the participatory planning process at the regional level (Schouwen-Duiveland Island, Schaalsee Biosphere Reserve). However, the influence of the local actors on the regional perception would depend on the practical implementation of the strategies discussed and prepared during the planning process and implementation success of those strategies (Northern Ghana I).

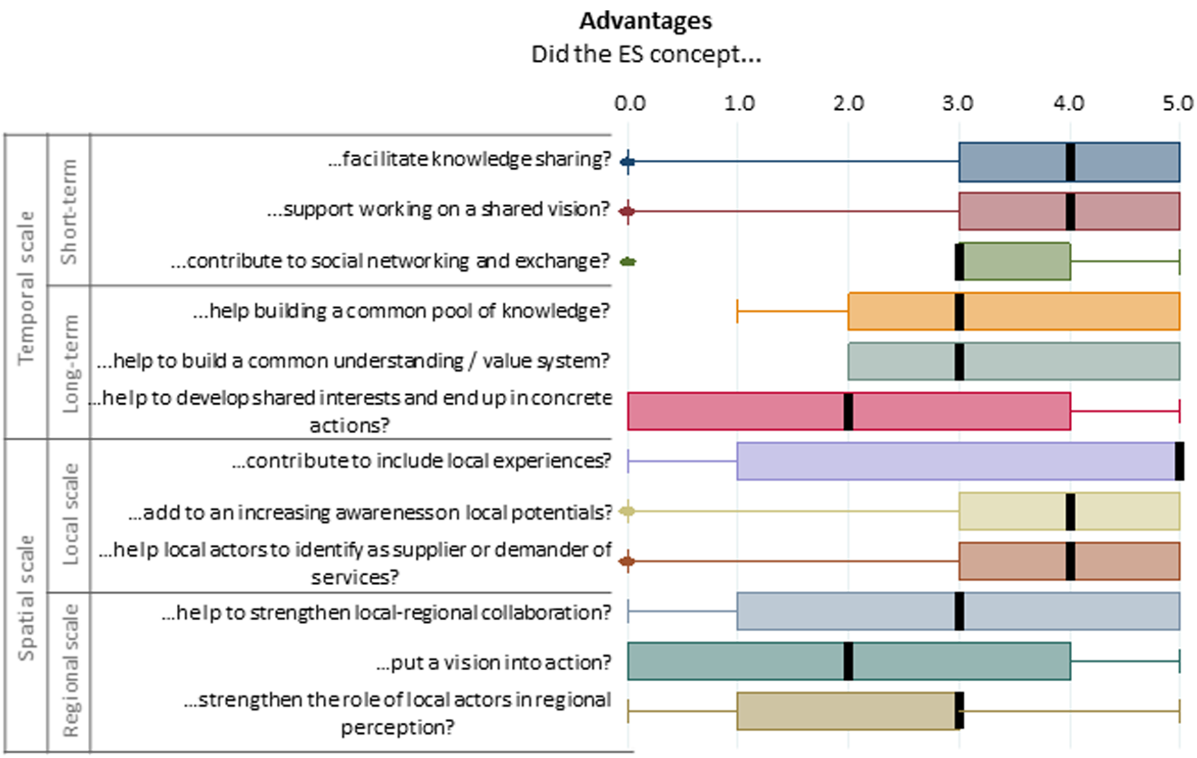



**Fig. 3** Advantages identified for all case studies sorted by questions. Black bars show the median of all case studies

*Common risks of using the ecosystem services concept in different participatory planning contexts*

The risks of different temporal and spatial scales for the respective case study in using the ES concept in participatory planning are presented in Fig. 4. Highest risk is presented for the Tabasco Region case study. Lowest risk levels are identified for Omerli Watershed and Basque Region, which are, in addition, only related to short term-risks. In total, highest average risk scores are given for short-term risks (Fig. 4). Furthermore, our research shows that average advantage scores are in general higher than average risk scores (Fig. A2).

Overemphasized specific goods or services was *one of the major risks* of implementing the ES concept identified across the case studies (Fig. 4). All cases reported that some specific ES were overemphasized. The highest risk was reported in Järvenpää City, Tabasco Region, Omerli Watershed, Basque Region, Schouwen-Duiveland Island and La Araucania Region (scores > − 3.0). Usually, the reason for this was the stakeholder perception of *"my ES"* (Tabasco Region, La Araucania Region), technical difficulties for specific ES assessments or valuation (Northern Ghana I, Fuhrberg Watershed), and ex-cathedra decisions taken by stakeholders to analyze only specific ES (Omerli Watershed). Some case studies proposed a roadmap to avoid this risk (Tabasco Region). While working with the ES concept in participatory planning, it happened that planning actors concentrate specifically at "their ES". The connotation of "my ES" is related to particular interests of some planning actors in the specific territory or emotional relations to particular ES offered by ecosystems being under their supervision or well-known to them. The challenge to overcome this bias as a kind of "not in my backyard" phenomenon seems to be an important issue to foster implementation of the ES concept (as mentioned in the Tabasco Region case study).

*Exclusion of actors due to limited knowledge access or missing scientific background* seems to be problematic in contexts where planning actors do not share a similar educational level. In most of the analyzed case studies, actors had similar educational and professional backgrounds. The case study with high

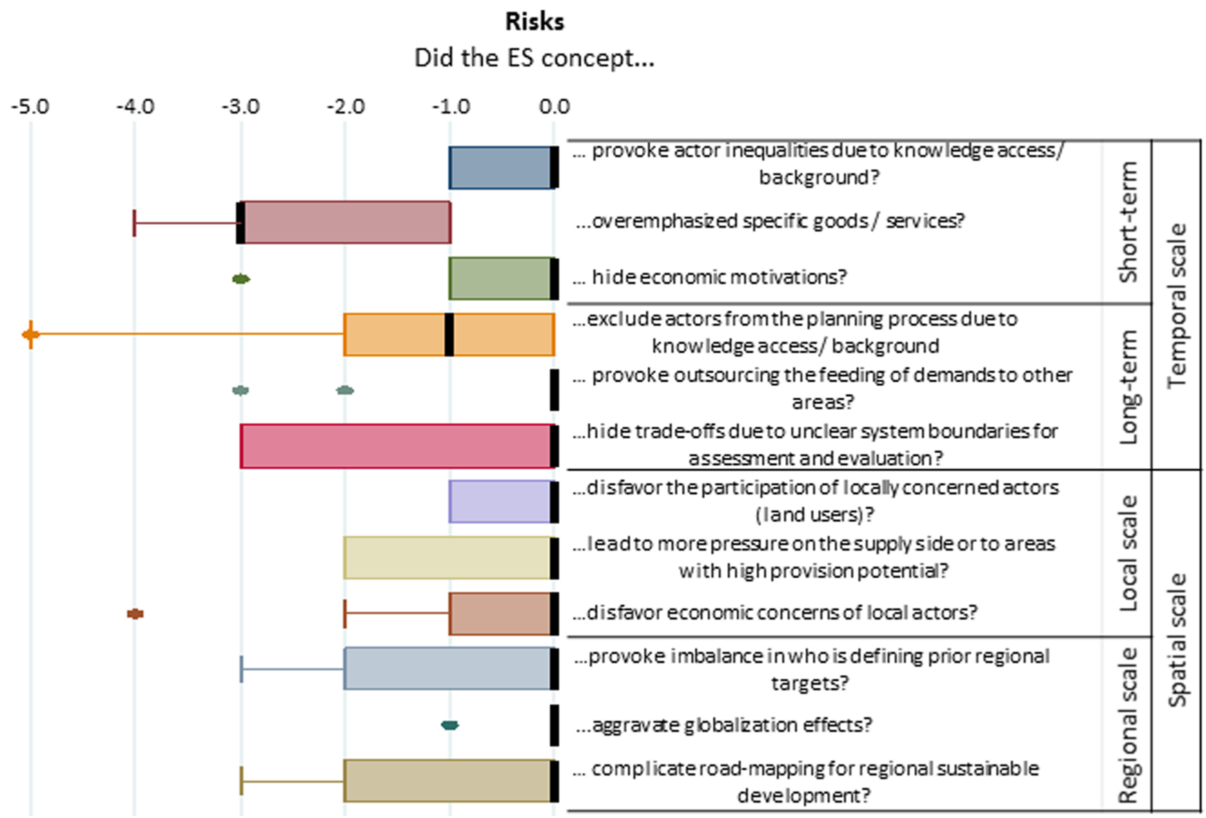



**Fig. 4** Risks identified for all studies sorted by questions. Black bars show the median of all case studies

disparities in the educational level faced this issue as significant risk (Northern Ghana I). Conversely, although stakeholders had different backgrounds in the Omerli Watershed, the careful management of the participatory planning process and the well-established explanation of the ES concept encouraged the sharing of knowledge and experience between stakeholders which increased dissemination of information for future collaborations in the planning process of other study areas. The careful management of the planning process included also effective measures to encourage actors to participate (Järvenpää City). Some minor issues concerning the overall understanding of the ES concept appeared in La Araucania Region, basically due to the multiple definitions of the concept and its perception mostly associated to a pure economic valuation. This experience indicates also that the ES concept is accessible for different stakeholders.

*Little or no risks* associated with the application of the ES concept in participatory planning were seen in the potential outsourcing of demands to other areas and the aggravation of globalization effects. This is also because some of the case studies did not consider globalization and outsourcing effects (as in Järvenpää City, Northern Ghana I, Omerli Watershed, and Czech-Polish borderland). On the contrary, some studies reported positive effects by “improving the globalization orientation” in the frame of the well-known saying “think globally, act locally” (Tabasco Region), by enhancing the energy transition of a local community (Schouwen-Duiveland Island) or helping to ease pressure on the global nutrient cycle (Fuhrberg Watershed).

### Operationalization of the ecosystem services concept towards successful implementation in participatory planning

About half of the case studies (Järvenpää City, Omerli Watershed, Schouwen-Duiveland Island, Fuhrberg Watershed and Schaalsee Biosphere Reserve) suggest a general benefit in using the ES concept in participatory planning. Only for one case study (Northern

Ghana II), the integration of the ES concept was not perceived to be beneficial. As a next step, we compared the criteria from the CCT with the BSC for all case studies. On average, the ES concept is more frequently perceived as an advantage in practice-oriented case studies than in those with a theoretical approach (Annex Fig. A3). Especially the enabling of knowledge sharing and working on a joint vision had low advantage levels for the case studies with a theoretical approach. Similarly, regarding advantages, case studies with practical use of the ES concept showed lower risk levels in implementing the ES concept in participatory planning than those with theoretical use (Fig. 5).

Lower risk levels are also presented by using equal or less than seven types of ES in the participatory planning process (Fig. 6). Especially, using many ES types could lead to higher pressure on the supply side or to areas with high provisional potential. In addition, economic motivations could be hidden if many ES are considered.

Based on the results from the case study analysis, it seems to be advantageous to involve citizens (including farmers) in the participatory planning process (Fig. 7), for example to work on a shared vision, to facilitate knowledge sharing and social networking, to build a common understanding, to develop shared interests, to strengthen local–regional collaboration, and to include local experience. A clear trend could not be identified by analyzing many actors versus a low amount of actors. The involvement of many actors led to more pressure on the supply side or to areas with high provision potential. Furthermore, the consideration of many participatory methods (e.g. surveys, participatory mapping, group discussions, and training) versus only group discussion did not show a trend for advantages or risk levels.

## Discussion and conclusions

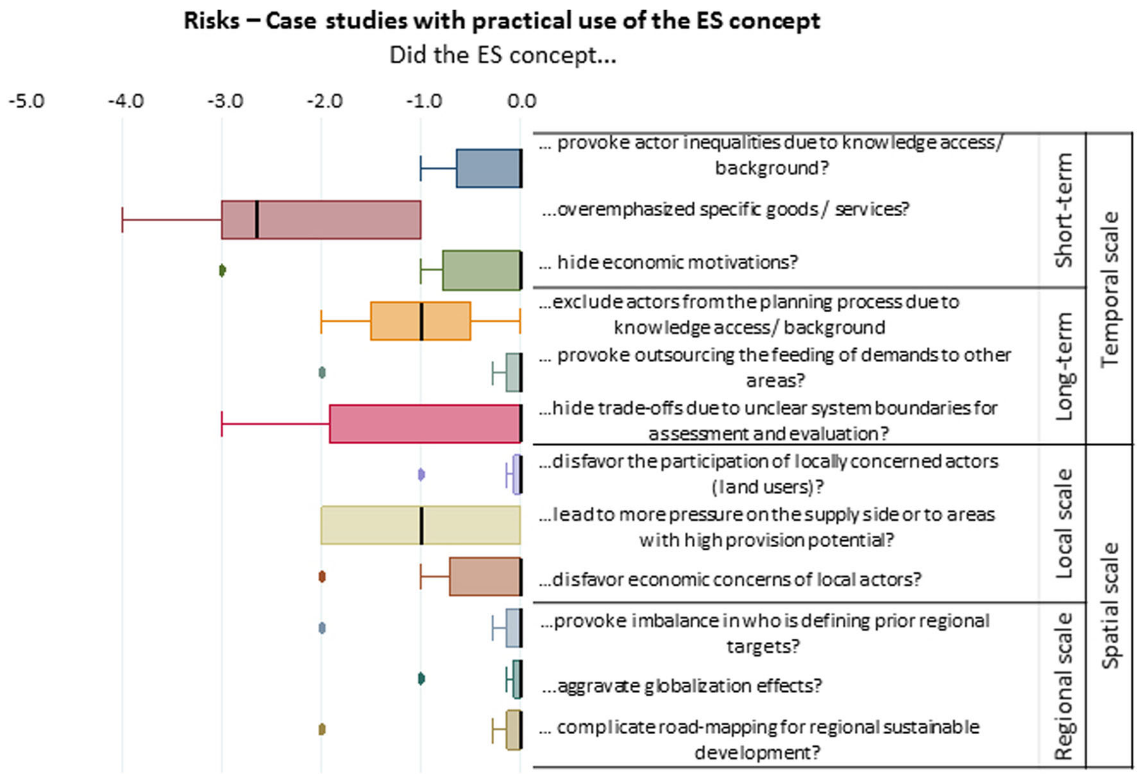
Our case study analysis has shown that the ES concept has the capacity to become an *Esperanto* among different actors in the participatory planning processes under specific, strongly context-related preconditions. Complexity in the participatory planning processes and the high diversity of contexts, where the ES concept is being used or is planned to be used in participatory planning, makes subsequent generalizations difficult. However, we highlighted and discussed general trends concerning the advantages and risks involved in using the ES concept as an Esperanto in participatory planning.

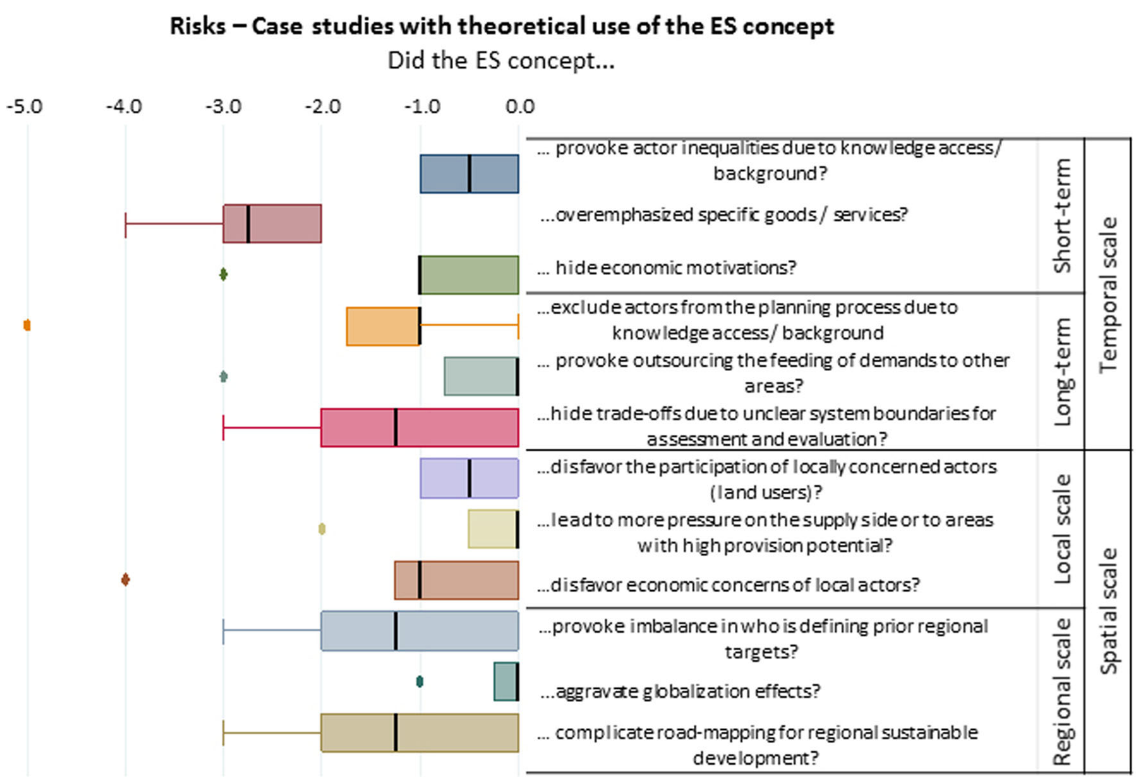
### General assessment of the proposed research method

The self-selected and voluntarily contributed selection of case studies in this study provided insights into experiences with the ES concept rarely described in peer-reviewed literature. However, the self-selection has some limitations, since the breadth of cases clearly influences the results. For example, our sample of case studies represents mainly the global north context, and the limited number of cases does not allow for statistically robust analyses. Replies to the BSC and CCT are reporting the views and considerations of the researchers and planners who worked on the planning process, but do not reflect the views of all other actors who took part in the planning process. We are aware of the risk of subjective answers obtained from BSC and misunderstandings involving questions coming from BSC. We reduced those risks by means of a careful discussions among the co-authors, concerning to the research methodology and to the content of the two analytical tools (CCT and BSC).

Due to the specificity of the case studies, it was not possible to present the results by each actor group. Each of the case studies have worked with diverse actors, but without discussing the specific advantages and risks of the ES concept with representatives of all actor group. Nevertheless, in most of the case studies, representatives of 3 actors groups were involved, except Northern Ghana I and II, Basque County, La Araucania Region where citizens were not included.

On the other hand, the small sample of case studies represents detailed and highly diverse planning contexts and different ways in which the ES concept was implemented in participatory planning. In this study, it was the intention to illustrate a more differentiated picture of the current state in the implementation of the ES approach, rather than to propose a representative sample for statistical analysis. Similar works have been implemented under the same sample conditions (e.g. Partidario and Gomes 2013; Mascarenhas et al. 2015; Rozas-Vásquez et al. 2017). They have provided significant insights into a potential integration of the ES approach in decision-making. Our bottom-up


Risks – Case studies with practical use of the ES concept
Did the ES concept...
-5.0
-4.0
-3.0
-2.0
-1.0
0.0
... provoke actor inequalities due to knowledge access/ background?
...overemphasized specific goods / services?
... hide economic motivations?
...exclude actors from the planning process due to knowledge access/ background
... provoke outsourcing the feeding of demands to other areas?
...hide trade-offs due to unclear system boundaries for assessment and evaluation?
...disfavor the participation of locally concerned actors (land users)?
...lead to more pressure on the supply side or to areas with high provision potential?
...disfavor economic concerns of local actors?
...provoke imbalance in who is defining prior regional targets?
...aggravate globalization effects?
... complicate road-mapping for regional sustainable development?
Short-term
Long-term
Temporal scale
Local scale
Regional scale
Spatial scale


Risks – Case studies with theoretical use of the ES concept
Did the ES concept...
-5.0
-4.0
-3.0
-2.0
-1.0
0.0
... provoke actor inequalities due to knowledge access/ background?
...overemphasized specific goods / services?
... hide economic motivations?
...exclude actors from the planning process due to knowledge access/ background
... provoke outsourcing the feeding of demands to other areas?
...hide trade-offs due to unclear system boundaries for assessment and evaluation?
...disfavor the participation of locally concerned actors (land users)?
...lead to more pressure on the supply side or to areas with high provision potential?
...disfavor economic concerns of local actors?
...provoke imbalance in who is defining prior regional targets?
...aggravate globalization effects?
... complicate road-mapping for regional sustainable development?
Short-term
Long-term
Temporal scale
Local scale
Regional scale
Spatial scale

◀ **Fig. 5** Risks for practical use versus theoretical use of the ecosystem services (ES) concept in participatory planning

approach allowed us to analyze also practical and on-going case studies that have not described yet in scientific literature and that are not reachable through scientific databases. Thus, we deliver first-hand experiences and lessons learned. A main advantage of this approach is the collection of a high diversity of participatory planning contexts.

A promising next step in this research could be the development of an online user guidance tool as a platform for exchange by different actors (planners, scientists, citizen) using the ES concept in participatory planning. The tool should be dynamic and flexible and, at the same time, allow users to add more results within the framework of the CCT and BSC. The tool could help new-comers in the application of the ES concept in planning to detect most suitable (similar) case studies for their field of interest in order to experience training by example.

## The ecosystem service concept in participatory planning processes

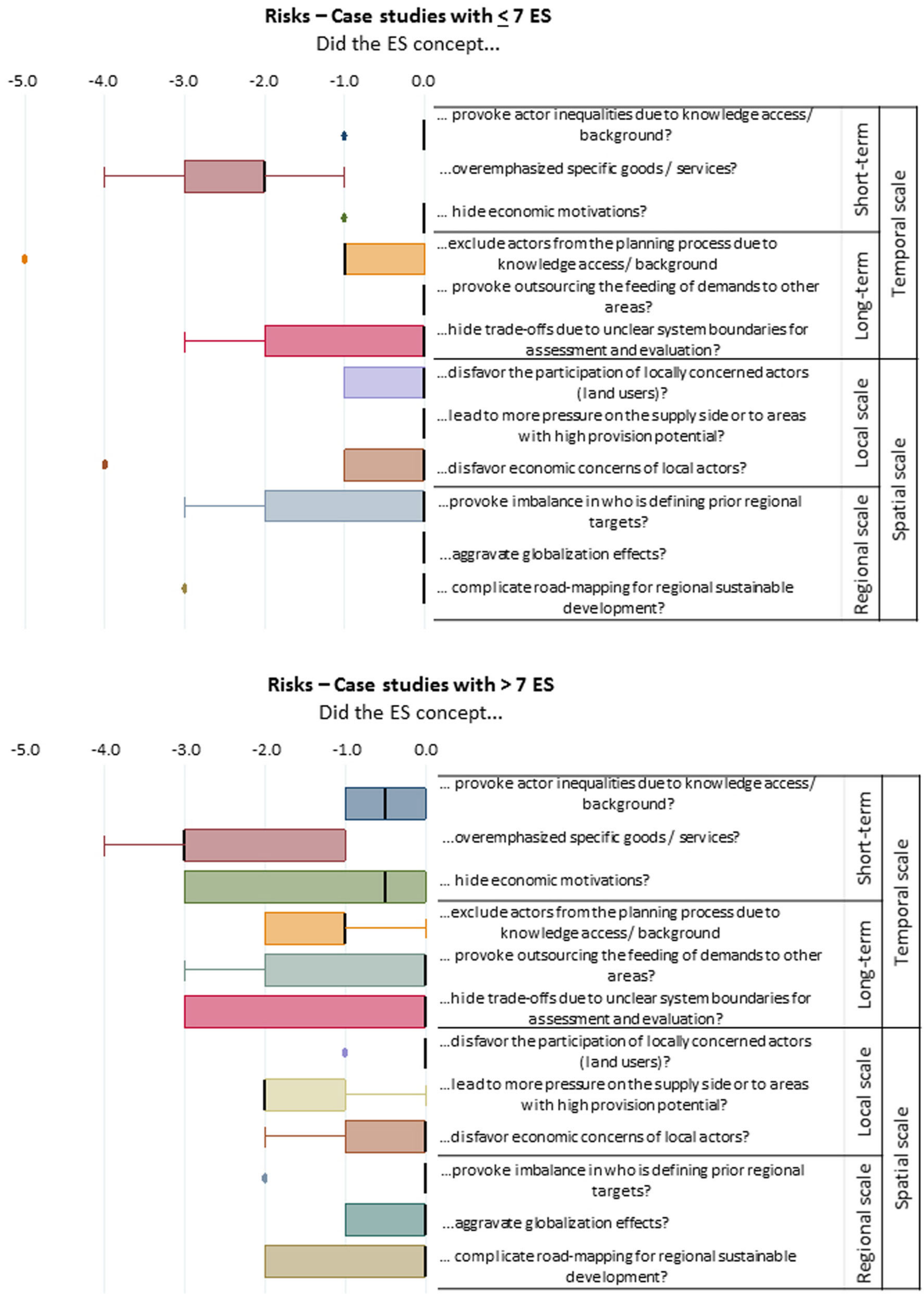
Our study confirms the prior finding that participatory planning processes are complex and context-dependent (Arler and Mellqvist 2015). Participatory tools, often strongly recommended for a successful implementation of the ES concept (e.g. De Groot et al. 2010; Fagerholm et al. 2012), need to be carefully selected and adapted to the local context. Different governance regimes would require different participatory tools to successfully apply and implement the ES concept.

In order to reduce risk in using the ES concept in participatory planning, the concept should be integrated from the beginning of the planning process together with the planning aims. This should be supported with institutionalization of the participatory planning process and the time spent during the process to build trust among planning actors. Additionally, the process of participatory planning needs to have clearly defined objectives, preferably involving connotations to the ES concept that are understandable for all involved actors (Reed 2008). Our study confirms that properly explaining the importance of ES is an important precondition for the success of participatory planning.

Using the ES concept in participatory planning processes *has to consider different spatial and temporal scales*. While analyzing the spatial scales and stakeholder types involved in the participatory planning process we discover the complexity of interrelations that are different between stakeholders acting in different spatial scales and their sizes (meaning capacities, operation abilities, range of influence over the landscape). Also Hein et al. (2006) emphasized the differences in stakeholder interests and valuation of ES dependent on the spatial scale.

Before and during the participatory planning processes, the use of the *ES concept has to be considered in relation to the bundle of other mechanisms,* such as education and competence development, to strengthen the role of local actors in regional perception and to amplify the vision of local actors. Our study shows that attempts to build the ES culture could be implemented by two main types of actions as provided in the case studies Tabasco Region and Czech-Polish borderland. The first general type focused on the micro scale (local–urban scale) and the implemented actions aimed to assist stakeholders to understand what, how, where and when ES help to improve their well-being. This can be done through (i) education: this is the integration of the ES concept in the primary and secondary education system (investing for the future), and (ii) competence development: to encourage economic units (e.g. stretching from local stakeholders through public agencies to big private stakeholders) to include the ES concept in their acquired environmental awareness and thinking. The second main group of actions should concentrate on issues related to policy design and should intend to build a bridge between providers and beneficiaries of ES. Such actions need a legal framework, resources and ES awareness of respective actors. Actors need to deal with more than one ES in order to incorporate a holistic approach of different landscape systems into participatory planning. Therefore, we recommend to assess and manage ES in a set (ES bundle)—possibly from the beginning of the participatory planning process. However, planning actors have to be aware of the higher risk of failure related to the high complexity of this process.

Different ecosystems (e.g. natural, agricultural or urban) offer different services. Interactions of those ES with society exemplified by urban development, agricultural development, or protected areas, are very


Risks – Case studies with ≤ 7 ES
Did the ES concept...
-5.0
-4.0
-3.0
-2.0
-1.0
0.0
... provoke actor inequalities due to knowledge access/ background?
...overemphasized specific goods / services?
... hide economic motivations?
...exclude actors from the planning process due to knowledge access/ background
... provoke outsourcing the feeding of demands to other areas?
...hide trade-offs due to unclear system boundaries for assessment and evaluation?
...disfavor the participation of locally concerned actors (land users)?
...lead to more pressure on the supply side or to areas with high provision potential?
...disfavor economic concerns of local actors?
...provoke imbalance in who is defining prior regional targets?
...aggravate globalization effects?
... complicate road-mapping for regional sustainable development?
Short-term
Long-term
Temporal scale
Local scale
Regional scale
Spatial scale
Risks – Case studies with > 7 ES
Did the ES concept...
-5.0
-4.0
-3.0
-2.0
-1.0
0.0
... provoke actor inequalities due to knowledge access/ background?
...overemphasized specific goods / services?
... hide economic motivations?
...exclude actors from the planning process due to knowledge access/ background
... provoke outsourcing the feeding of demands to other areas?
...hide trade-offs due to unclear system boundaries for assessment and evaluation?
...disfavor the participation of locally concerned actors (land users)?
...lead to more pressure on the supply side or to areas with high provision potential?
...disfavor economic concerns of local actors?
...provoke imbalance in who is defining prior regional targets?
...aggravate globalization effects?
... complicate road-mapping for regional sustainable development?
Short-term
Long-term
Temporal scale
Local scale
Regional scale
Spatial scale

◀**Fig. 6** Risks for many (> 7 ES) versus few ecosystem services (ES) types considered in the participatory planning process

special. Therefore, during the participatory planning process, the time-consuming and challenging part is to learn how to integrate these services into a set of complementary planning actions. Obviously, the development of holistic actions would require a lot of resources, a good understanding and sufficient amount of time, which has to be considered during the participatory planning process.

Our research also exemplifies that a clear analytical differentiation between advantages and risks specifically related to the usage of ES concept in participatory planning is challenging. This is due to the fact that participatory planning approaches are often used to implement landscape or land use planning (e.g. in the frame of national planning legislature).

### "My" ecosystem services

The "My ES" phenomenon reflects the situation in which one or a few ES are overemphasized due to particular interests of influential planning actors. "My ES" practices lead to exclusion of diverse actors from the benefits of the construction of a bridge between providers and consumers of ES (van Wensem and Maltby 2013; Galler et al. 2016). Such a situation often results in a misdirected implementation of the ES concept in participatory planning, where just a single or only a few ES are considered in planning and, therefore, overemphasized. We have experienced such a phenomenon in separate case studies but have not identified a straightforward solution to deal with it. However, other studies suggest using a step-by-step approach to tackle this problem (Levrel et al. 2017; Olander et al. 2017). In these approaches, subsequent steps taken in the participatory planning process should firstly help to build the necessary knowledge basis among the planning actors and the ES concept. As the next step, measures should be taken to carefully discuss the ES concept oriented towards planning goals (Plant and Ryan 2013). Such steps are not linear and could be placed according to individual requirements. Nevertheless, planners and other planning actors have to be aware about the issue of intentional exclusion of selected ES.

### The operationalization of the ecosystem services concept in participatory planning with regard to policy frameworks

Existing policy frameworks and planning systems can play a fundamental role in fostering or hampering an effective operationalization of ES in participatory planning processes. One relevant aspect is the lack of institutional guidelines at different planning and administrative levels to incorporate ES in a spatial planning process (Rozas-Vásquez et al. 2017). For example, some recent reviews highlighted a big gap in the explicit use of ES in spatial planning processes to clearly inform planning and to derive decisions on land use (Cortinovis and Geneletti 2018; La Rosa 2018; Rozas-Vásquez et al. 2018). This could be partly due to the absence of a mandatory inclusion of ES in planning processes by planning systems (i.e. national/regional planning laws). For spatial planning, this aspect reflects the historical relation between planning and national/regional norms and planning systems that shape scopes and contents of each plan. This issue therefore highlights the opportunity to normatively and mandatorily embed ES in new forms of policy planning frameworks, regulations and standards. Our study confirms that the ES concept provides an opportunity to improve landscape planning by recognizing and explicitly placing the relationship between ecosystems and well-being. However, to achieve this potential, new standards for high-quality ES plans should be set (Woodruff and Bendor 2016). To this end, Pelorosso et al. (2016) advocate new standards for spatial planning based on ecological processes and relative functions of areas and ecosystems delivering the ES, which should be grounded in new measurements able to quantify these services at different scales (from the municipal to the district scale).

### Can the ecosystem services concept become a new Esperanto to facilitate participatory planning processes?

Using the ES concept as a new Esperanto or boundary concept to facilitate participatory spatial planning processes often represents a challenging and ambitious endeavor. At the same time, using the ES concept offers opportunities to improve collaboration between diverse actors and to reduce disparities between them. Our study shows that the ES concept has the capacity

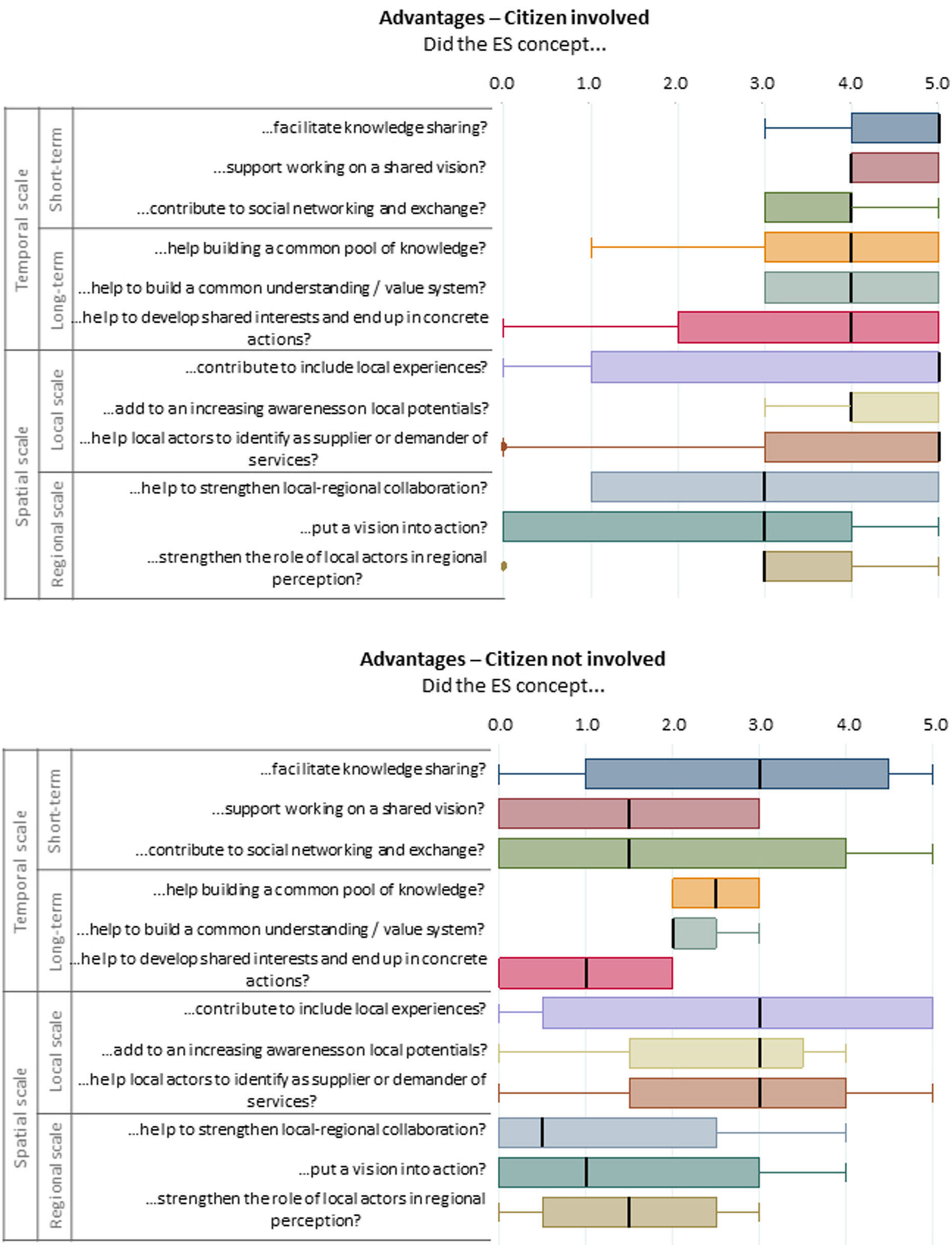



**Fig. 7** Advantages of involving local actors in the ecosystem services (ES) concept

to facilitate the communication and interaction among planning actors as well as to build a sustainable relationship between ecosystems and society. From the analyzed case studies, the following recommendations can be outlined to better exploit the opportunities of using the potential of the ES concept to support participatory planning:

- A clear understanding and a case-specific definition of the ES concept is needed by the different stakeholders or actors involved in the planning process, since it is still seen as a new concept and open to different and sometimes conflicting interpretations.
- The expected added value must be clearly described, and transparently communicated in participatory planning process to justify extra efforts needed for understanding and translation.
- Using the ES concept in participatory planning could be fostered if its application is embedded in legal instruments such as laws, regulations and planning standards at respective planning levels. However, the change of such planning contexts and instruments is often unlikely in the short term, and the high diversity of planning contexts, legal situations, case-specific objectives and politics, hinder a standard interpretation and application of ES concept definitions, methods, and procedures across different geographical contexts and decision-making levels.
- Local and indigenous knowledge should be actively identified and used to support stakeholders involved in the planning processes through the establishment of on-going learning mechanisms. Those mechanisms could then be able to facilitate a kind of planning and decision-making which would be closer to local needs and more likely to gain public support.

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# Governance of ecosystem services trade-offs in peri-urban landscapes

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ABSTRACT

Peri-urban landscapes (PULs) are specific transitional forms of urban landscapes undergoing dynamic land-use changes. PULs' transformations are driven by close and significant influence of an urban core, cross-administrative boundary character, and diversity of governance actors. PULs have significant potential to provide ES and respond to the urban and peri-urban demand for ES, but they are also particular contexts where significant and different ES trade-offs can occur. Majority of existing forms of governance are not able to deal and address such trade-offs, which thus call for more innovative and effective governance approaches and mechanisms, aimed at achieving ES synergies and reducing ES conflicts.

This paper discusses the characteristics of PULs in the context of governance questions related to the management of ES trade-offs in the urban peripheries. The drivers of ES trade-offs are presented and different trade-off relationships between and within the main ES types are analyzed. The paper drafts a way forward from the current state-of-the-art related to governance of peri-urban ES trade-offs by providing recommendations for more effective governance that would address these trade-offs. Due to the very dynamic character of PULs, it is difficult to manage land-use changes and ES trade-offs. Hence, the governance approaches need to be adaptive and integrative at multiple levels, while engaging diverse actors to balance ES trade-offs that have mixed urban and rural character.

## 1. Ecosystem services in peri-urban landscapes (PULs)

The continuing and rapid peri-urbanization (PU) processes account for large-scale environmental impacts and transformation at the global level (Seto et al., 2011). The oftentimes uncontrolled development of settlements and infrastructure takes place at the expense of productive farmland (Bren d'Amour et al., 2017; Solecka et al., 2017) and natural areas (Inostroza et al., 2016), degrade the capacity of landscapes to provide Ecosystem Services (ES). This process fosters biodiversity loss (Piorr et al., 2011) and leads to increased and concentrated demand for ES and natural resource consumption (Elmqvist et al., 2013). Peri-urban landscapes (PULs) connect cities with their rural surroundings (La Rosa et al., 2018) in a continuous spatiotemporal manner (Inostroza et al., 2019) and are increasingly recognized as a significant type of cultural landscape (Ives and Kendal, 2013; Sylla and Solecka, 2019) affecting the quality of life in the metropolitan region (Piorr et al., 2011).

Therefore, the competition, conflict and trade-offs related to ES within the urban-rural continuum are becoming more prevalent (Hedblom et al., 2017; Von Der Dunk et al., 2011) establishing PULs as a new and important arena for governance and management of ES (Boyle et al., 2001; Westerink et al., 2013).

### 1.1. Peri-urban landscapes

PULs are characterized by low population density and a mixture of diverse land-uses in a continuum spatio-temporal urbanization gradient from urban cores to (semi)-natural areas. PULs remain under preponderant and increasing urban economic and spatial influence, which is represented by the presence of typical urban forms (e.g. continuous or discontinuous urban fabric) and lifestyles (e.g. teleconnected urban jobs), changing the socio-ecological structure of cities' hinterlands (Piorr et al., 2011). Very often PULs play a significant role in the global

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competition to attract highly skilled workers (Nefs et al., 2016) and subsequently in the economic development of regions, being a specific arena for the interplay between global and local economic interests and investments (Maneepong and Webster, 2008). Moreover, PULs are characterized by a mixture of old and new residents (Ravetz et al., 2013) who are often urban commuters, coexisting with a mix of urban functions and services, i.e. shopping malls, industrial sites, logistic centers, low-density housing, dump sites, or cemeteries (Gallent et al., 2006; Shkaruba et al., 2017).

Such dynamic situation foster land-use changes and generate the PULs transition systems (Pinto-Correia et al., 2018, p.28f). This transitional character of PULs is indicated by dynamic processes of urban expansion with increasing populations and new forms of lifestyles, which require significant consumption of goods and services and require particular mobility demands (Ravetz et al., 2013). Due to their spatial interconnectedness with the urban centers and residential communities, PULs represent the interface between urban and non-urban ecosystems, bridging the socio-ecological connectivity of the urban systems at large (Zhu et al., 2017). PULs are being transformed at a faster rate than other landscapes (e.g. agricultural or forest) due to the high availability of investment land to be transformed, significant socio-economic drivers related to cities, as well as respective high capacity to provide ES in the immediate proximity to urban cores (Barrera De et al., 2018).

These transformations are regulated by a different range governance or planning instruments, including municipal land-use planning at different scales and spatial extents regulating the use of the land within administrative border of the municipality. PULs are under the spatial jurisdiction of Metropolitan, Regional or Landscape authorities that make use of diverse planning levels and related spatial plans under different governance schemes where all the different levels therefore require an appropriate coordination (La Rosa et al., 2018).

Processes of urban developments in PULS usually produce a diversification of land-use, a densification of infrastructure network and a general increase of built up areas and sealed soils and these processes leads to a fragmentation of the agricultural and forest landscapes (Mitchell et al., 2015). This can have strong consequences on ES provision but, on the other hand, ES can benefit by a higher accessibility to these landscape from specific residents of peri-urban areas and also from more central part of bigger cities (Zlender and Thomson, 2017).

### 1.2. Ecosystem services trade-offs

PULs include different types of ecosystems able to deliver a diverse set of ES. From a cultural ES perspective, PULs represent important areas for outdoor recreation for the urban population (Fan et al., 2017; Žlender and Ward Thompson, 2017). Different types of greenery in the PULs (i.e. woodlands, fringe forests, country/agricultural parks, and peri-urban open spaces) are appreciated by users for their multifunctional recreation possibilities and because they offer a diverse kind of 'nature' (La Rosa et al., 2018).

PULs also provide different water and climate related regulating services, such as air filtration, cooling and ventilation condition services to the urban core (Pedrazzini, 2017; Zasada et al., 2011). In this sense, PULs are essential elements for urban resilience and adaptation to climate change (Pedrazzini, 2017). Additionally, PULs are part of larger ecological networks for biodiversity and green infrastructure across and beyond urban areas (Balzan et al., 2018; La Rosa et al., 2014a; Piorr et al., 2018). Finally, the provision of food remains a major ES (Rolf et al., 2018), as agriculture represents often the most prevalent land use in PULs. The growing concerns about increasingly globalised, fragile and resource inefficient food systems add relevance to the issue of provisioning ES delivered by PULs (Deakin et al., 2015; Puma et al., 2015; Sonnino, 2016). One of the possible approaches to tackle PU food systems could be short food supply chains, represented by e.g. Km0 food concept (Dansero and Puttilli, 2014). Maintaining such provision is particularly critical as (intensive) land use systems could limit the PULs' capacity to provide other ES (e.g. biodiversity, carbon sequestration, cultural ES), or even consume them as natural resources (groundwater, soil fertility, soil erosion, reduced pollination).

Different values like the availability of green spaces, fresh air, as well as strong forces in urban land markets are driving housing preferences out of the urban cores (Fleischer and Tsur, 2008; Solecka et al., 2017). This increases urban development pressure on the PULs, compromises their capacity to provide the aforementioned ES and leads to an increase in the concentration of societal demands over remaining ecosystems and their services. These process and related land use changes are the main drivers behind the loss of ES and emerging ES trade-offs (Martínez-sastre et al., 2017; Zorrilla-miras et al., 2014). The general notion of "trade-off" refers to the existence of opposing and inverse effects and – subsequently – a situation in which someone needs to balance two opposing situations or qualities (Jon Paul Rodríguez et al., 2006). Such "need for balance" occurs very often in governance, particularly when related to transitional landscapes like PULs. From an economic perspective, trade-off is related to the basic economic fact that limitation of the total resources capable of producing different commodities necessitates a choice between relatively scarce commodities (Samuelson, 1954); so to put it simply, some things are gained while at the same time some others are lost (McShane et al., 2011). In the context of ES, the trade-off occurs when one service increases and fosters the reduction of the other service (Haase et al., 2012). Such a situation is opposed to "synergy", where services interact in a positive way, without loss of one service in favor of the other (Lee and Lautenbach, 2016) – in other words, when there is a so-called win-win situation (Howe et al., 2014). The cross-cutting themes related to ES synergies and trade-offs include the clear distinction between potential and actual supply and demand for ES, the temporal and spatial scales of ES analyses, the winner-loser relationships between stakeholders, as well as the reversibility of the trade-offs (Cord et al., 2017; Xiangzheng et al., 2016).

The concept of ES trade-offs is to some extend similar to concepts of ES rivalry, where consumption of one service reduces the available amount of this service. There are some similarities between the notion of ES trade-offs and ES excludability, which means that a specific ES is available only to those consumers, who pay for it. (Villamor et al., 2007). But the notion of ES excludability does not include the gaining and loosing aspect, which is pertinent for the concept of ES trade-offs (McShane et al., 2011).

In the manuscript we refer to ES trade-offs (i.e. the trade-offs between services) and discuss them in the context of governance. However, it is important to distinguish between ES trade-offs, which are discussed further in this manuscript and governance trade-offs, which refer to the discussion "who of the governance actors wins and who loses".

### 1.3. Drivers of transformation in PULs

ES trade-offs are dependent to the land-use planning and management choices that can enhance the output of one ES at the cost of other service(s) (Haase et al., 2012; Xiangzheng et al., 2016). The most prominent drivers in PULs are related to peri-urban development processes, which are regulated by local and regional policies. ES trade-offs are observed particularly in contexts where participation of diverse governance actors, who are affiliated with different governance levels/scales, is indispensable (Gonzalez-redin et al., 2016). Regional decision makers often prefer certain ES, which are related to their specific interests ("my ES" phenomenon) (Galler et al., 2016; Spyra et al., 2018a), over the public interest. Therefore, ES trade-offs occur when short-term economic benefits are preferred over long-term biological conservation goals (McShane et al., 2011). Policy makers affiliated with different governance levels often prefer the short term benefits related to establishing new investment areas which could stimulate economic

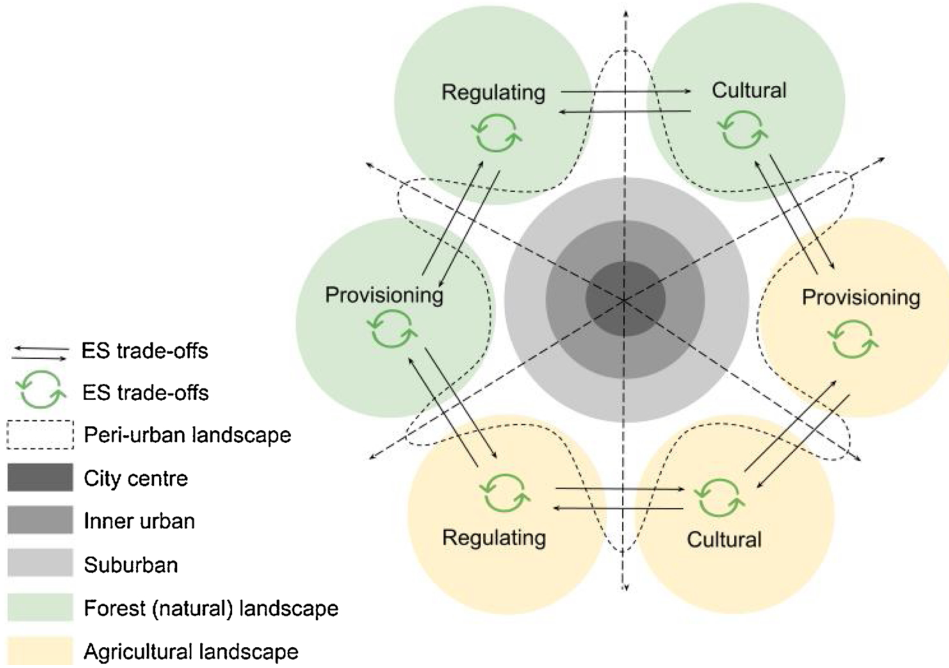


**Fig. 1.** A conceptual framework for analyzing ES trade-offs in PULs. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article).

development, rather than long term oriented nature protection (Nabielek et al., 2013; J P Rodríguez et al., 2006).

Transformations of PULs, especially new urban development's and related infrastructure, are often directly produced by public and private investments like buildings, technical, or transportation infrastructures. Here the pressure over PULs is very often related to the need to provide new dwelling areas, or new industrial/commercial areas. Investors call for "open new lands for investments", which fosters new investments at the fringe of the cities to the extent of PULs (Solecka et al., 2017). Some of the investments to the extent of PULs are driven by the desire of urban inhabitants to own a second or holiday home closer to nature, on the assumption of a personal increase in the quality of life. This phenomenon is typical of many European areas and is represented by so-called "dachas phenomenon" (also often referred to as "collective gardens") in Central and Eastern Europe (Roose et al., 2013), or "second home phenomenon" recognized in other contexts (Cuadrado-Ciuraneta et al., 2017; Li et al., 2018). Such processes require an increase in accessibility to cultural ES (i.e. nature reserve or peri-urban greenery) (Shoemaker et al., 2019; Sylla and Solecka, 2019). To provide enhanced access, new transportation infrastructures are developed that might have a negative effect on the way PULs ecosystems function, mainly by fostering their fragmentation (Haddad et al., 2015).

PULs are extremely diverse in terms of agricultural land use and intensity. Land consumption fostered by intensified agricultural production often characterizes PULs (Döös, 2002; Gardner, 1996; Hooke et al., 2012). Together with agricultural land abandonment these are examples of processes affecting PULs (Renwick et al., 2013). In this context, trade-offs are driven by land use planning and land speculation, two aspects well connected to the way PUL are governed. These transformations not only modify the number, type, and quality of provided ES, but also tend to generate context-specific trade-off among different categories of ES. Here we acknowledge a lack of research on transformative processes, transition and regime shift of agricultural lands, which are affecting ES (Rau et al., 2019).

Such specific situation related to ES trade-offs in PULs require new governance approaches in order to address existing conflicts and support the sustainable development of such dynamic landscapes by protecting and, if possible, increasing the supply of ES. With this research we aim to draft a way forward from the current state-of-the-art related to governance of peri-urban ES trade-offs by providing recommendations for more effective governance that would address these trade-offs. This article is based on the outcomes of an immersive scientific conference and workshop titled "Governing the trade-offs of peri-urban ecosystem services" at Ecosystem Services Partnership (ESP) Europe conference in San Sebastian (Spain), October 2018, where an interdisciplinary group of scientists presented different perspectives and research on this topic. Before the session we performed a survey related to ES trade-offs in PULs with the session speakers. Results of this survey were presented during the session and discussed with all participants with the help of interactive tool (Mentimeter). After the session, to strengthen our arguments provided in this essay, we implemented several literature searches. In the pertinent for our essay manuscripts, ES trade-offs and governance aspects were very often discussed together with other topics related to PU. Due to the context of our immersive workshop and the availability of scientific literature, further considerations in our manuscript have a specific focus on European context. The paper initially describes the types and characteristics of ES trade-offs in PULs (section 2). Building on this, we discuss existing challenges to govern ES trade-offs in PULs (section 3) and outline a way forward from the described state-of-the-art towards better governance of PU ES trade-offs (section 4). Finally, we discuss future research perspectives and provide some conclusions.

## 2. Types and characteristics of ES trade-offs in PULs

Many approaches are available to identify and analyze ES trade-offs. We divided ES trade-offs in relation to the provisioning, regulating and cultural ES according to the Common International Classification of Ecosystem Services (CICES). We started from the general pairs of trade-offs identified by (Lee and Lautenbach, 2016) Lee and Lautenbach (2016) as representative of the most recurring types of trade-offs and we contextualize them for the particular cases of PUL in light of case studies presented at our session and other relevant literature.

Fig. 1 presents the conceptual framework that constitutes the graphical representation of different possible trade-offs occurring between ES that should be taken into consideration while analyzing ES relations in PULs. The yellow and green circles represent different types of ecosystems that deliver three main sorts of ecosystem services. The peri-urban landscape is delimitated irregularly to depict very often chaotic distribution of peri-urban areas. The dotted arrows represent the pressures on the peri-urban landscapes coming from the city. They are located in all directions showing that all types of ecosystems and their services are affected, and trade-offs may be present there. The trade-offs may occur between different ES types, but also within one type. Trade-offs within a single ES type represent a very typical situation that has not been investigated much in recent literature on ES trade-offs. Such trade-offs occur when, for example, the establishment of a new single-family housing area generates demand for cultural services (i.e. private gardens), which might be created from areas that have delivered different cultural ES before. However, we have not identified, neither in the literature nor in the session discussion, sound examples of PU ES trade-offs within regulating services. Pressures for urban development are the main drivers of land use change causing ES trade-offs at the PULs. Fig. 1 includes only a systemic representation of the ecosystems in PULs and does not reflect the multifunctionality of such landscapes.

### 2.1. Cultural and provisioning ES trade-offs

A trade-off between cultural and provisioning ES is often identified in scientific literature due to the conflicting land uses and local governance actors advocating specific ES. This ES trade-off pair is particularly relevant in PULs, where the intensification of agricultural activities might reduce the provision of recreational, aesthetic and spiritual potential of semi-natural landscapes. An agricultural landscape hosting intensive production which lacks heterogeneity and structural elements has a low visual attractiveness (Häfner et al., 2018; Van Zanten et al., 2014). Additionally, high emission levels, e.g., noise and odors from intensive livestock holdings, also reduce the amenity value of the PULs. An opposite trade-off occurs when the transformation of productive farmlands to public green spaces can reduce the productivity of farmlands (Sil et al., 2016). Other trade-offs occur as conflicts arising from intense recreational use of the farmland and agricultural infrastructure, unwanted trespassing, littering, etc. (Busck et al., 2008). Rodriguez-Morales et al. (2018) presents a case study of a peri-urban agricultural area near the city of A Coruña (Spain) and explores ES trade-offs between perceived values of the ecosystem by the owners and the users of the land. The results of Public Participatory GIS analysis indicate that while users demand more accessible and better equipped infrastructure areas, landowners ask for stricter rules for the use of the land.

To support decision makers with the prioritization of landscape management strategies, (Peña et al., 2018) identified existing ES trade-offs within in Bilbao which were mostly occurring in the peri-urban part of the metropolitan area. The prevailing ES trade-off was observed mainly between aesthetic value and timber production and was mainly dependent on the low acceptability and perception of homogenous forest plantations (i.e. coniferous or eucalyptus) by Basque population.

Trade-offs between cultural and provisioning ES are very typical for the “dacha phenomenon” in Eastern Europe. Private grounds traditionally used for growing vegetables have been replaced with lawns and playgrounds, except some particular socioeconomic situations in households or regions (e.g., poor road access or unexciting scenery) (Roose et al., 2013; Shkaruba et al., 2017).

### 2.2. Cultural and regulating ES trade-offs

The increasing demands of land for activities in PULs related to cultural ES (e.g. horse riding, biking, agro-tourism) can generate trade-offs with the regulating capacity of these ecosystems (e.g. climate regulation). The need to provide better accessibility to cultural ES can increase the provision of cultural ES, but subsequently decrease those of regulating ES. Spyra et al. (2018c) developed a method to identify areas with a deficit of accessibility to high quality public green areas. The accessibility to green amenities is also an important driver identified in the study of Sylla et al. (2019) where the importance of different environmental amenities in the PULs was assessed using the hedonic pricing method. The cultural ES of protected areas seem to be most appreciated by new single-family housing inhabitants at the PULs, but at the same time, new housing and infrastructure developments seal the surfaces and decrease the water retention potential (Szewrański et al., 2018). Therefore, the request for having pleasant peri-urban environment may clash with the need for conservation and sustainable management of water resources (Carruthers and Vias, 2005). The process of designing a masterplan for a peri-urban agro-natural park in north Italy Allocco et al. (2018) revealed that the most relevant trade-offs in the park management scenarios were the ones between the possibilities for enjoyment and interaction with nature and the need for stricter protection of ecosystems.

### 2.3. Regulating and provisioning ES trade-offs

Biomass and fiber production versus climate regulation represent one of the most typical and common trade-offs (Lee and Lautenbach, 2016). Forests represent crucial ecosystems for carbon sequestration and storage but are also exploited for timber production. A trade-off is generated when deciding how long forests should be maintained to sink carbon, or when trees should be cut (Olschewski et al., 2010) but also on the decision on which species to grow (Onaindia et al., 2013). In contrast to the trade-off perspective, specific agricultural and landscape systems, such as urban food forest aiming at co-provision of ES in a multifunctional way are gaining momentum. The specific integrative and multifunctional nature of (urban and peri-urban) food (Morgan, 2009) is also highlighted, which can serve as a “vehicle” to encourage urban-rural-interaction and regional governance processes, offering new solutions aimed at closing the resource circle, implementing Green and Edible Infrastructure at metropolitan scale and encouraging new business models.

On the other hand, the transformations of productive farmlands into public areas related to new urban development, or re-development, of PULs represent a typical, if not exclusive trade-off of PULs. The clash between the loss of farmland and the need of new public areas (especially green areas) can be solved by the planning and designing of new forms of urban agriculture (La Rosa et al., 2014b) where traditional productive use of the land is re-activated or complements other ES in a new vision of farmland multifunctionality (Rolf et al., 2018).

### 2.4. Different types of cultural ES trade-offs

Another significant trade-off in PULs can be observed between different types of cultural ES. Transformations in PULs can be perceived differently by old and new inhabitants of peri-urban areas: while new dwellers ask for additional services, infrastructure and public areas (especially green space) in the peri-urban contexts, traditional inhabitants express resistance to these changes as having negative impacts on the original cultural landscape (Ko and Son, 2018).

Analyzing the heterogeneity of people’s preferences for green spaces in Nancy (France), (Tu et al., 2016) Tu et al. (2016) showed that private green areas can work as substitutes of public greenery and that the relative Willingness-To-Pay for having peri-urban forests in the vicinity of their home is lower.

With reference to the “dacha phenomenon” (Shkaruba et al., 2018), cultural vs cultural trade-offs can be manifested e.g. by the different preferences of residents between, for example, new recreational grounds (playgrounds, swimming pools) and green lawns, flower beds or old orchards (with no serious food production value) that may have aesthetic or sentimental value (Shkaruba et al., 2018).

Another well-known cultural ES trade-off occurs when the recreational value of an area increases, fostering the tourism and therefore affecting other cultural ES such as sense of place, aesthetic and spiritual value (Stålhammar and Pedersen, 2017).

### 2.5. Different types of provisioning ES trade-offs

The specific drivers of this trade-off are related to the need to provide food for a growing urban core and the need to reduce the cost of food production by limiting the distance between food production and consumption spaces. In this case, the increase in food production provisioning ES causes a reduction in other ES that are typical for PU contexts such as forest production (Onaindia et al., 2018). Other studies show that presence of provisioning ES is often a key condition for the generation of ES trade-offs when one or more subjects are benefitting by a provisioning service (Howe et al., 2014), which seems to be relevant also for PU contexts: examples include conflicts for the use of land to provide different crops or timber (Montoya et al., 2019,) or trade-offs that can be generated by using different forms of agriculture (Zhang et al., 2012). Another example of conflicting provisioning ES is the use of arable land for food or energy purposes. Even though PULs are located in close proximity to urban centers and agricultural lands that could provide food supply areas for cities (Zasada et al., 2011), the arable lands are also used for planting biofuel-related plants. This provides an important trade-off between two provisioning services available at the PULs, exerting at the same time impact on cultural- as well as regulating ES provided by the same agroecosystem.

During preparations and implementation for our immersive session, held at Ecosystem Services Partnership (ESP) Europe conference in San Sebastian (Spain), October 2018, we found no solid examples of PU ES trade-offs within regulating services. Also, the discussion among interdisciplinary group of session attendees brought no pertinent examples of PU ES trade-offs within regulating services. As well as, literature searches brought no solid examples of PU ES trade-offs within regulating services.

## 3. Challenges for the governance of PULs

Many definitions of governance can be retrieved by different academic fields focusing on urban systems. (UN Habitat, 2002) UN-Habitat (2002) defines governance as "the sum of the many ways individuals and institutions, public and private, plan and manage the common affairs of the city. It is a continuing process through which conflicting or diverse interests may be accommodated and cooperative action can be taken." Similarly, for (Fukuyama, 2013) Fukuyama (2013) the concept of governance is related to the "government's ability to make and enforce rules (…) and the performance of agents in carrying out the wishes of principals." While governments are responsible for ensuring a certain set of services, the provision of these services is a task that should be distributed among government, private sector and civil society who benefit from the same services. In our paper we adopt the perspective of environmental governance, as defined by Lemos and Agrawal (2006, p. 298), where environmental governance refers "to the set of regulatory processes, mechanisms and organizations through which political actors influence environmental actions and outcomes."

In the upcoming sub-sections, specific characters of governances approaches and mechanisms required for PULs are discussed, highlighting weaknesses and limitations. However, the specific characteristics of PULs offer specific positive –and somehow unique- chances of forms of governance toward an overall increasing of sustainability (Geneletti et al., 2017b). These opportunities rely on the local resources of PULs, including both environmental resources (e.g. through ecosystem services-based planning) and socio-economic resources (e.g. through the integration of bottom-up processes into top-down approaches). Examples include the possibility of planning PULs with mixed configuration of new low-density housing and highly accessible green areas and other spaces for local food production (Provè et al., 2016). To this end, interesting opportunities are given also by abandoned or unused spaces and vacant lands that can be transformed into positive drivers to increase social-ecological opportunities of public greenery (La Rosa et al. 2014) and offer more sustainable food production for the peri-urban residents (Yang et al., 2016).

### 3.1. Different actors, different interests

The three main groups of actors involved in governance processes are (1) experts/scientists defined as objective knowledge holders; (2) stakeholders defined as having a particular interest as they represent a community or group interest (stake); and (3) citizens/laymen as the group being affected, but not organized to represent a shared interest (Spyra et al., 2018a, 2018b). In general, governance approaches are institutionalized by different formal (e.g. policy instruments) and informal (e.g. agreements, networks, which are not envisaged by formal rules) ways, which are characteristic of decentralized, democratic states and are "compatible" with democracy (Lauth, 2012). Governance approaches are leading towards guiding, steering, controlling or managing the public goods (Kjaer, 2004). Informal governance approaches include non-binding documents such as strategies and agreements between different actors or active networks comprising different actors (Follesdal et al., 2011).

Governance in PULs should try to accommodate the diverse and conflicting interests. Such conflicts which are characteristic of the diversity actors acting in PULs over a territory in space and time (Narain, 2009) can also be related to emerging neoliberal pressures of private interest over public ones (Swyngedouw et al., 2002). The main difficulties in addressing the diversity of PULs governance actors are caused by three main factors: (1) blurred and overlapping jurisdictional boundaries; (2) conflicting interests of actors and different sectors; and (3) geographical origin of actors involved.

PULs cannot be reduced to single jurisdictional or administrative boundaries, as they often include several municipalities or other administrative entities (Piorr et al., 2011). The inclusion of different administrations and public bodies could lead to a fragmentation of decision making in terms of spatial governances, therefore disabling a concrete effectiveness of policy making for PULs (Pagliarin, 2018). PULs can be even located outside the legal jurisdiction of municipal boundaries (Narain, 2009). Thus, the specificity of PULs is that jurisdictional boundaries are blurred, causing a governance complexity, overlapping competencies in the governing bodies. This eventually fosters conflicts in responsibilities of such governing bodies and therefore requires an institutional collaboration that is difficult to be reached (Patti, 2017).

The different origin of actors involved in governance processes, coming from urban or rural areas, is reflected in the trade-offs generated by conflicting interests and expectations (Hedblom et al., 2017; Spry et al., 2016). For instance, engagement of land owners offers opportunities for natural resource management, but this can be challenging for PULs in particular because of competing government priorities and a high diversity of land owners (Spry et al., 2016).

Addressing trade-offs in PULs requires the inclusion of many sectors like agriculture, urban, forest and also regional and (cross-) national development goals such as air pollution reduction, integrated watershed-management, transport-management, economy and employment, the provision and accessibility to ES. Thus, PU governance needs to find a challenging consensus among very different needs coming from diverse sectors and scales (Hudalah et al., 2007). Governance approaches to ES trade-offs require better cross-sectoral coordination able to address different levels of development goals (Dupont, 2007).

### 3.2. Current blind spots and limitations

Shortcomings of current examples of governance approaches adopted in PU contexts are related also to the urban-rural dichotomy and independently address either urban, or rural issues. Thus, such approaches do not address the transitional and hybrid character of PULs (Allen et al., 2006).

The most widely used governance approaches to tackle PU ES trade-offs are formal and implemented in a top-down manner: (1) land use planning, zoning, landscape conservation; (2) environmental norms and regulation; (3) planning and policy making at the regional level. Such approaches are often not tailored to the specificity of PULs and, therefore, do not address their trade-offs (Maneepong and Webster, 2008; Zhao, 2013). Often ES are addressed independently and inter-relations among them are lacking. Traditional approaches suffer from administrative and sectoral fragmentation and NIMBYism (Frank et al., 2017; Spyra, 2014), where governance actors prefer their own interests (e.g. related to commune) over the joint interests of entire PULs. Therefore, urban governance approaches based on the hierarchical administrative structures fail when the responsibilities of several governing bodies overlap, and the jurisdictional boundaries are blurred (Termeer et al., 2010).

Furthermore, top-down governance approaches suffer from weak dialogue among different stakeholders (Faysse et al., 2014) especially in societies with current or historically established top-down governance. Among the many actors in the governance process of PULs, policy makers show no significant involvement is solving ES trade-offs, mainly because they have little awareness of their ecological significance (Faysse et al., 2014). An example is related to unsuccessful compensation measures implemented on agricultural lands where trees are being planted in random locations, fostering a loss of agricultural lands (Strohbach et al., 2018).

On the other hand, other limitations in traditional governance of PU ES trade-offs are related to missing coordination at the higher (i.e. regional) administrative levels (Maneepong and Webster, 2008). Liberalization of central land use policies may have a similar effect, as is the case with loosening framework conditions in the Netherlands triggering uncontrolled PU in some regions (Nabielek et al., 2013), or mass deforestation of PUL in the former USSR shortly following its collapse (Boentje and Blinnikov, 2007).

The importance of site-specific contexts is demonstrated in Eastern Europe, for the previously introduced "dachas phenomenon", in Belarus, Russia and Ukraine. This case demonstrates that slow top-down bureaucracy (as in Belarus) in the longer term can be a more effective way of addressing ES trade-offs in PULs, than bottom-up initiatives often fueling PU (as in Ukraine), thus fostering different ES trade-offs in PULs (Shkaruba et al., 2018). Nevertheless, slow top-down bureaucracy does not follow the dynamic and transitional character of PU ES trade-offs (Shkaruba et al., 2017), which confirms that each PU ES trade-off needs balanced and tailored governance approaches.

Finally, the governance processes are simply struggling with financial problems, due to NIMBYism and the complexity of PULs, represented by blurred administrative and financial responsibilities for PULs and related ES.

Governance actors are often not motivated to cover expenses related to implementing governance to the extent of entire PUL, thus having expanses going beyond their administrative boundaries, or beyond their areas of interests (Watson, 2009).

## 4. Governance of ecosystem services trade-offs and synergies in PULs

The overall goal for the governance of PU ES should be to minimize trade-offs and stimulate possible synergies between various ES. Recent research suggests that focusing on ES trade-offs in the governance processes can actually lead to better synergies among ES, so as to generate win-win solutions (Howe et al., 2014; McShane et al., 2011; Peña et al., 2018) and pave the way towards objective assessments of governance outcomes (Hirsch et al., 2010). Also, recent literature discusses the bundle of green infrastructure and low entropy city concepts to increase urban sustainability (Pelorosso et al., 2017). This could be also adopted to reduce ES trade-offs in PULs.

In the next sub-sections we present some proposals to move forward to more innovative and effective forms of governance that could be able to manage and address trade-of PU ES, based on specific examples and trends. To do this, we have used four major lines of discussions (Mc Shane et al. 2011), representing relevant dimensions where existing governance for ES trade-off can be reformed and innovated: (1) Scale, because PU ES trade-offs occur between different spatial and temporal dimensions; (2) Context, because PU ES trade-offs governance should be tailored for cultural, political, economic and sociological contexts and "one-fit-all" approaches need to be avoided; (3) Pluralism, because PU ES trade-offs need to be understood from different points of view related to diversity of PU governance actors; (4) Complexity, because the PULs are evident examples of inextricably linked ecological and social systems.

Our ambition in this section is to provide recommendation, which can be useful for researchers, policy makers and practitioners. Due to the novelty of the aspect of ES trade-offs governance in PULs, it is difficult to fully distinguish between future research agenda related to this topic and recommendations for practice. It is also because the fact that researchers are representing experts' group of governance actors (Spyra et al., 2018b), often included in governance processes related to PULs.

### 4.1. Scale

PU ES trade-offs are the epigenetic manifestation of the underlying process of fast change in PULs, observed in different spatio-temporal scales, covering the urban-rural continuum and reflecting the involvement of social, ecological, political sectors. This specific feature of PU landscape requires that governance to address ES trade-offs needs to work across different spatio-temporal scales to integrate local, regional and national planning documents and to overcome decisions promoting either urban or rural areas.

For example, governance should shift away from traditional and rigid land-use design and act as a flexible platform where trade-offs between different uses of the land can be negotiated between public policies and private initiatives (Moreira et al., 2016). This does not mean that traditional governance schemes cannot be effective or useful. For example, when looking at spatial planning, links and integration among different planning levels should be revised and strengthened to correctly include the urban-rural continuum and involve all levels of the planning process, from the master plan to zoning (Lörzing, 2006). In multi-level governance, sub-national, regional or local institutions are important for such approaches, as they are competent in specific domains (Happaerts, 2012) such as agriculture, forestry, environment and landscape planning.

### 4.2. Context

Governance to address ES trade-offs needs to acknowledge local specificity reflected by historical, social and political contexts (Robinson, 2011; Sarkar and Montoya, 2011) with particular attention to context specific legislation and needs of local governance actors. Thus, it is recommended to combine official legislation frameworks with stakeholders' bottom-up initiatives, building upon the emergent citizen science and context specific local knowledge of local actors (Stosch et al., 2019). To this end, context specific networks of governance actors (e.g. local associations) are helpful to implement actions towards reduction of ES trade-offs in PULs (Jones et al., 2017). These approaches need to incorporate social and environmental justice objectives, which is advocated as a way towards more equitable governance of ES (Dawson et al., 2018, 2017).

To reduce the possibility of trade-offs and promote synergies, it is important to better "fine tune" ES with the use of scenario based planning (Allocco et al., 2018) and to link these scenarios to market oriented mechanisms (e.g. payment for ES model) (Daly-Hassen et al., 2010; Newton et al., 2012).

Transfer or import of successful governance models from one context to another is not always possible and often problematic because of the local specificity and different regulations, heritage, cultural values, governance and planning systems (Geneletti et al., 2017a).

Moreover, abandonment of traditional, context specific, local governance approaches underpins supply of some ES and fosters ES trade-offs. For example, as explained by García-llorente et al. (2015), traditional governance approaches related to irrigation channels and local water governance systems can maintain supply of regulating ES in PULs and, while being positively acknowledged by local governance actors, can support the reduction of trade-offs.

### 4.3. Pluralism

The governance of ES trade-offs in PULs needs to include three groups of actors representing the views of different sectors: citizens / users, stakeholders and experts (Spyra et al., 2018b). Focusing on the trade-offs offers an opportunity to raise general awareness about the role of ES among these groups, prepare the ground for discussion and generate more shared choices on the governances of complex systems such as landscapes (McShane et al., 2011), thus avoiding the risks of misunderstandings and black box processes (Kaim et al., 2017). As displayed by Patsy Healey (Healey, 1997) and applied by Primdahl and Kristensen (2016), governance needs to be based on communicative action and consensus-oriented decision-making, so that these decisions are "owned" by a broader set of PUL actors with their specific interests (i.e. represented by the different demands for ES).

Participatory governance approaches help to reflect on functions and benefits from different perspectives and to reconnect different objectives, to find synergies and interlinks between different functions and scales, instead of accumulating multiple ES with the idea of “the more the better”. Thus, the participatory process helps to better contextualize functions with benefits (Luederitz et al., 2015). Furthermore, actors’ involvement is a crucial prerequisite for better landscape stewardship (Bieling and Plieninger, 2013). Successful governance approaches for ES trade-offs need to be not only participatory, but also consensus oriented. Nevertheless, pluralistic governance concerning PULs need to be implemented under established regulatory and normative frameworks, as poorly regulated governance could have a negative impact on the reduction of ES trade-offs (Albert et al., 2016).

Governance approaches also need to offer the possibility to move from regulatory approaches and provide flexible solutions to complex PU ES trade-offs problems. Desired flexibility of those approaches is related to the fact that they should not be specifically focused on the final (static) effect of the governance process (e.g. fixed land use plans), but consider more the transitional process of change as the fundamental aspect to be governed (Spyra, 2014; Steiner, 2011). This is similar to performance-based planning approaches, implemented since early 1950s, which promote flexibility, are based on less regulations, are faster in implementation and foster dialogue among governance actors (Baker et al., 2006; Jaffe, 1993). In such governance approaches impacts can be assessed against expected outcomes. This flexibility of selected governance approaches fits into the transitional character of PULs and helps to reflect in a meaningful way on the dynamic processes of PU, rather than focusing on a desired "end form" (e.g. common in the frame of land use zoning approaches). Thus, we argue that the desired governance approaches need to be oriented towards a long-term perspective and drafted in a visionary manner. For example, multi-functional peri-urban agriculture in PUL has good potential to provide food and other types of ES (Onaindia et al., 2018; Zasada et al., 2011), but is lacking in comprehensive implementation.

### 4.4. Complexity

Governance actors need to be continuously aware of the high complexity of PULs, which consist of social and ecological systems. Thus, governance processes on the one hand side need to consider high unpredictability of such systems (Holling, 2001) and on the other need to be based on dissemination of knowledge related to complexity of ES trade-offs, which helps to minimize conflicts (Stosch et al., 2019). This could be followed by incentives for local governance actors (e.g. farmers) to encourage them to manage their land in the way that trade-offs are reduced or even transformed into synergies (Djanibekov and Khamzina, 2016).

In order to support the decision makers with evidence-based inputs, scientists explore a wide range of different methods and approaches to identify, quantify and assess different trade-offs at the PULs. The ES trade-offs are investigated with the use of biophysical, socio-cultural and economic methods. The biophysical methods include spatial modelling (Verhagen and Whitley, 2018), foodshed methodologies (Zasada et al., 2019), conceptual models, which are also supported with geostatistical computations (Shoemaker et al., 2019). Socio-cultural methods include participatory GIS (Rodriguez-Morales et al., 2018) and participatory scenario planning (Rolf et al., 2018). Economic methods include contingent valuation methods with the willingness to pay approach (Tu et al., 2016) as well as hedonic pricing method (Sylla et al., 2019).

On the other side, the complex and dynamic nature of PULs cause specific challenges for investigation and analysis of ES related to lack of spatially explicit data, small scale developments, which are difficult to map, dynamic transition processes, multitude of governance actors, lack of definition and delimitation of peri-urban landscapes (Dupont, 2007; Geneletti et al., 2017; Goncalves et al. 2017). The development and use of generally applicable indicators and thresholds related to topological and morphological properties of the urban peripheries, functional relationships, distances or (population) densities are often neither possible nor useful, due to the importance of the regional contexts and their tremendous differences. European-scale spatial analysis make an attempt in this direction (Zasada et al., 2013) but are often limited in their regional significance.

## 5. Conclusions

This paper starts with an acknowledgment of the limited research on the governance of ES trade-offs in PULs in terms of: (1) detailed assessment of case studies in PUL, where governance approaches were implemented to limit trade-offs and foster synergies among ES; (2) review of scientific literature concerning ES trade-offs in PULs. Building from the research on trade-offs of ES in PULs presented in a scientific workshop and analyzing the limited literature on the topic, this contribution identified and described several shortcomings related to governance of ES trade-offs in PULs:

In many cases governance has so far failed to address the high diversity of actors related to PULs. This is even more complicated by the low awareness among decision makers and other governance actors of the socio-ecological significance of ES trade-offs.

Governance in PULs need to be applied in complex metropolitan systems, where jurisdictional boundaries are blurred, diverse governance actors represent conflicting interests and are located in different sectors (e.g. urban, agricultural, forestry).

Governance of PU ES trade-offs is often focused on the urban – rural dichotomy, by addressing either urban, or rural issues and therefore fails to recognize the more complex spatio-temporal continuum characterizing PULs.

Top-down governance approaches are still dominating in PULs but, at the same time, bottom-up initiatives are not well integrated in the general existing governance schemes.

Innovative governance of ES trade-offs could be based on, firstly, increasing general awareness about ES trade-offs and, secondly, on identification of the context specific networks of governance actors. Such a governance approach needs to be implemented by joint efforts of actors situated at different levels (from regional to municipality or neighborhood) and working under a consensus-oriented leadership.

As actors and stakeholders belong or are connected to organizations acting at different levels, a robust and multilevel governance represents the basic precondition for sustainably governed ES trade-offs in PULs. Such a framework can be delivered by means of governance by the state, private governance, self-organizations etc, but it should be context specific and institutionalized through well described arrangements. As PULs are part of wide and complex metropolitan systems, new types of flexible metropolitan governance can be established to integrate different planning levels (municipalities, provinces, regions) and sectors. ES should therefore be included in strategic and/or metropolitan spatial planning at regional or metropolitan level.

## CRediT authorship contribution statement

**Marcin Spyra:** Conceptualization, Writing - original draft, Writing - review & editing, Visualization, Supervision, Project administration, Funding acquisition. **Daniele La Rosa:** Conceptualization, Writing - original draft, Writing - review & editing. **Ingo Zasada:** Conceptualization, Writing - original draft. **Marta Sylla:** Writing - original draft, Writing - review & editing, Visualization. **Anton Shkaruba:** Writing - original draft, Funding acquisition.

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# XI

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# Protection of peri-urban open spaces at the level of regional policy-making: Examples from six European regions

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ABSTRACT

Peri-urbanisation is a dynamic process consisting primarily of the expansion of artificial areas into natural, semi-natural, and agricultural areas. This process reduces peri-urban open spaces, thus it is threatening peri-urban biodiversity and hampers the provision of ecosystem services. In this manuscript, we introduced the concept of peri-urban open spaces and exemplified it on the level of regional policy-making in the following six European case study regions: Basque Country (Spain), Flanders (Belgium), Gorenjska (Slovenia), Hajdú-Bihar (Hungary), Mazovia (Poland), and Saxony-Anhalt (Germany). Our study aimed (1) to analyse land cover changes related to peri-urban open spaces in the case study regions, (2) to identify and classify policy improvements that are useful to protect peri-urban open spaces, and (3) to provide recommendations for regional policy instruments to improve the protection of peri-urban open spaces. We designed a mixed-method approach combining Geographical Information Systems, an explorative questionnaire, and a semi-quantitative survey to fulfil our research aims. Our results showed that peri-urban open spaces are decreasing in all case study regions but with different scale and dynamics over time. Mostly (non-irrigated) arable land was transformed into non-peri-urban open space. Moreover, we identify 15 policy improvements that are suitable to support the protection of peri-urban open spaces at the level of regional policy-making. Our results indicated a potential for improving the regulatory instruments and showed the usefulness of multi-level governance that better address the protection of peri-urban open spaces at regional level. Using our research results, we provided recommendations for regional policy-makers who are willing to pay more attention to the protection of peri-urban open spaces.

## 1. Introduction

Urbanisation is globally increasing due to population growth and demographic change (Grimm et al., 2008). Along with urbanisation, also peri-urbanisation (PU) is taking place that affects even a greater extent of landscapes and creates different challenges of policy-making. PU continuously increases urban and other artificial land cover in Europe (EEA, 2019). Between 2000 and 2006, more than 1000 km$^2$ of land in the European Union (EU28) was used for urban expansion indicated by new housing, industry, roads, or recreational purposes. Between the years 2012 and 2018, 539 km$^2$ of land was taken for these purposes. In a projection until 2030 (baseline 2010–2030) by the European Observation Network for Territorial Development and Cohesion (ESPON), an increase in urban areas is especially foreseen for Poland, Netherlands, United Kingdom, Spain, southern France, and central Italy (EEA, 2016). Currently, highest rates of sealed land with more than 5% of the national terrestrial surface are the Netherlands, Belgium, Germany, and Luxembourg (EC, 2013). Sealing the soil limits the exchange of energy, water and gases, which can have a negative impact on the ecological functions of the soil (Glæsner et al., 2014).

In our manuscript, we are referring to PU as a process of establishing peri-urban landscapes (PULs) – transitional territories that are not yet urban and not fully rural, combining rural with urban pecularities (Spyra et al., 2020), that cannot be addressed from the perspective of the classic urban-rural dichotomy (Simon, 2008). Similarly to the definition of landscape in European Landscape Convention (ELCs), PULs are resulting from “the action and interaction of natural and /or human factors” (Article 1, point a, Council of Europe, 2000). Even if in this

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manuscript, the process of PU has been investigated in the context of European countries, this process is also observed in other geographical zones, such as the Global South (Butsch and Heinkel, 2020).

PU is a process of expansion of artificial areas into untilled (open) areas, accompanied with diverse socio-economic transformations, taking place beyond urban fringes (Zasada et al., 2011). According to the European Environmental Agency (EEA) the most significant drivers of PU are related to the development of (1) construction sites, (2) industrial and commercial sites, (3) mines, quarries and dump sites, (4) housing, services and recreation, and (5) transport infrastructures (EEA, 2019). Many of these developments are fostered by the migration of urban dwellers from cities to peri-urban areas (Zasada et al., 2011) and the intention of people to increase their quality of life by moving into or using amenities of peri-urban areas (Simon, 2008). For example, people assume that peri-urban areas have better air quality, higher personal safety and lower prices of land (Nilsson et al., 2014; Woltjer, 2014). Nevertheless, this constituent of PU is also pertinent for the development of sub-urban, outlying, and peripheral areas at the fringe and outskirt of cities. Overlaps among those processes are the topic of an on-going scientific debate (Žlender, 2020). Furthermore, changing social patterns of cities foster PU (Butt and Fish, 2016). Other important drivers are related to direct or indirect incentives that encourage PU (Nilsson et al., 2014) like foreign investments along with “pro-investment” public policies (Zhao, 2012). These are only a few examples of global socio-economic drivers of PU, which includes as well limited access to dwellings in metropolitan areas (Butt, 2013). Recent research underlines that PU is multifaceted and related to a combination of different driver types like socio-economic, political, or even technological drivers (Plieninger et al., 2016; Shaw et al., 2020).

Using the land cover perspective, PU is indicated by dynamic land cover changes (LCC) mainly from forests, semi-natural areas, and agricultural areas to artificial land (Siedentop and Fina, 2010). Those processes foster the emergence of PULs. Current debates on the delimitation of PULs go beyond classical variables related to land use / land cover and population size or density. For example, Gonçalves et al. (2017) pointed out that delimitations of PULs need to be based on a transdisciplinary process that is linking physical, social, economic and personal aspects (different views of PU governance actors). A similar approach was developed by Žlender (2020) who characterised governance actors in PULs.

We refer in our manuscript to regional policy-making as the governance level addressing the whole extent of PULs. The regional level has the best potential to cover the complexity of PUL, as it includes several properties particular to a regional community in their administrative boundaries. Moreover, strong regional policy-making and planning have the capacity to prevent uncontrolled PU (Nilsson et al., 2014) and stimulate a balanced relationship between social needs, economic activities and the environment as requested in the ELC (Council of Europe, 2000).

The main aim of the study is to analyse peri-urban open spaces (PUOS) that are often neglected in policy-making on regional level. Policy-makers on regional level often focus either on rural or urban oriented actions and ignore or undervalue open spaces (PURPLE, 2017). The transitional character of PULs, related for instance to intensive LCC, hampers the effectiveness of policies addressing pressures on open spaces (Spyra et al., 2020). Therefore, investments in PULs tend to be unsustainable over time, and do not properly take into consideration the real capacities of these spaces to contribute to biodiversity conservation and ecosystem services (ES) provision. Knowledge related to LCC of PUOS and regional policies addressing PUOS comes from diverse research fields and describes diverse examples of PULs. Experiences related to regional policy instruments applicable to PUOS are also not yet well described. Such experiences are “owned” by the regional policy-makers who are directly responsible for the design, implementation, review, and agenda setting of regional policies.

With our paper, we intend contributing to close this knowledge gap with the following research objectives:

(1) to analyse LCC related to PUOS, exemplified in six European regions,
(2) to identify and classify policy improvements that are useful to protect PUOS at the level of regional policy-making,
(3) to provide recommendations for regional policy instruments to better tackle the protection of PUOS based on our results.

### 1.1. *Peri-urban open spaces*

New developments in PULs that are taking place at the urban fringe at the edge of build-up areas (Wandl and Magoni, 2017) encourage a more in-depth analysis of non-artificial parts of these areas to understand their dynamics towards transformation and contribution to biodiversity and ecosystem services of PULs. Particularly, PUOS are of high interest as they form places of highest land-use conflicts and pressures. Krasnowiecki and Paul (1961) and Bryant et al. (1982) were probably the pioneers in conceptualising PUOS. Bryant et al. (1982) have introduced the term of city’s countryside looking at it as a complex environmental system comprising natural, economic, cultural, social, and political dimensions. Those authors provided considerations related to the need for management, use, and functions of open spaces located in city’s countryside. Moreover, several concepts equivalent to the PUOS concept have been described that are related to the conceptualisation of open spaces in the extent of "rural-urban fringes" (e.g. Friedberger, 2000) or acknowledging the urgent need to protect open spaces in metropolitan areas (Krasnowiecki and Paul, 1961).

The term of PUOS is used in the scientific literature in different ways. For example, recent studies like Žlender and Gemin (2020) discussed peri-urban green spaces from the perspective of people’s sense of place. Sun and Shao (2020) talked about quantification of visitor satisfaction toward peri-urban green and open spaces, and discussed the challenges related to policy-making of peri-urban green and open spaces. Hersperger et al. (2020) addressed the issue of growth management and its effect on diminishing open spaces in the peri-urban context.

PUOS from a philosophic perspective can be considered as areas of open space and the concept of “open” or “non-open” space seems to be interlinked with how humans perceive landscapes (Lindenmayer, 2009). Humans may think that something that tends to be “open” has the capacity to be “filled”. Filling of open spaces is often related to converting them into artificial surfaces like urban fabric, or transportation units. Thus an “open space” is a non-build-up area (e.g. recreational area, forest, farmland), where the “natural” environment is dominant (both biotic and abiotic elements of it) and where the level of anthropogenic intervention still allows ecosystems to function and landscape values to be present (Maruani and Amit-Cohen, 2007).

However, in our research we decided to focus on the understanding of PUOS which can be more useful and practical for policy-makers and allows a delimitation and spatial analysis of PUOS on regional scale. In this respect, we prepared the delimitation of PUOS based on land cover classes, as described in the Method section of this manuscript. Similar approaches were implemented to, e.g., delineate patterns of urban built-up and open spaces (Pauleit and Duhme, 2000).

### 1.2. *Negative effects of peri-urban open spaces diminishment and degradation of ecosystem services and biodiversity*

PUOS provide many important services for citizens, for example,

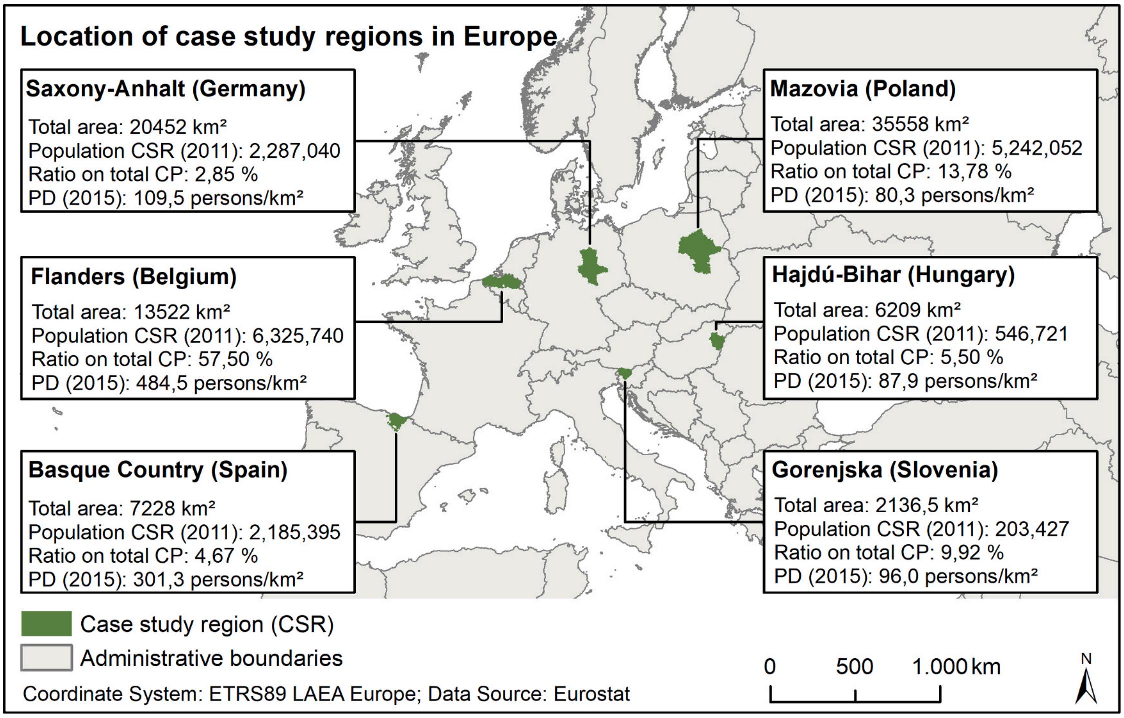


**Fig. 1.** Location of the case study regions in Europe and characterisation of the case study regions (CSR); explanation of abbreviations: CP = Country Population, PD = Population Density.

fulfilling recreational demands and providing space for leisure activities (Maruani and Amit-Cohen, 2007). Those services contribute to social, environmental, economic, and human health aspects of landscape sustainability (Jennings et al., 2012; Nutsford et al., 2013; Wandl and Magoni, 2017). PU and the associated LCC, land take, and land degradation are significantly affecting biodiversity and causing habitat loss and fragmentation of peri-urban ecosystems, therefore affecting the capacity of PUOS to provide different services and endanger landscape sustainability. For example, in 2015, 30% of the EU's land was highly fragmented due to urban sprawl and land use intensification, which had negative effects on different services provided by PUOS (EEA, 2019).

At the same time, the demand for PUOS services is growing with increasing human population and consumption (Carpenter et al., 2009; Yachi et al., 1999). People are stressed by the noise, heat, and hustle of cities. The reduction in peoples stress levels is often associated with the accessibility to urban green spaces (Maller et al., 2005; White et al., 2013; van den Berg et al., 2010). In order to comply with such needs, policies related to PUOS need to ensure the provision of ecosystem services (Vejre et al., 2010). PUOS provide many urban ecosystem services (ES), e.g. air pollution control, noise reduction, above-ground carbon storage, water and temperature regulation (regulating ES), food (provisioning ES), leisure activities (cultural ES) (Bolund and Hunhammar, 1999; Haase et al., 2012; Maller et al., 2005), and can provide even food in the form of urban gardening (provisioning ES) (Bendt et al., 2013; Spilková and Vágner, 2017). ES contribute with economic and non-monetary values to human benefits, and therefore to human well-being (Haines-Young and Potschin, 2010). Consequently, LCC and soil sealing are affecting key aspects of human life (MEA, 2005), and the way in which global earth systems function, e.g. global climate regulation (Lambin et al., 2001). PU provokes environmental and health risks which are reflected in increasing societal costs (Scalenghe and Marsan, 2009). For example, a study performed by the Flemish government shows that societal costs increase if buildings are more dispersed in the landscape (Department Omgeving, 2019). A study by Dutta (2012) shows that PU increases the costs of permanent crops and pastures due to fragmentation of landscapes, which is problematic for PULs inhabitants. This confirms that PU has negative effects on farming activities. However, there is no conflicts between the protection or management of PUOS and farming.

Landscape fragmentation is mentioned in the literature as being the most serious ecological threat to biodiversity (Brückmann et al., 2010; Forman, 2008; Selva et al., 2011; Qviström, 2017). Many species cannot maintain viable populations in small patches, thus fragmentation leads to local extinction (Krebs, 2008; Piqueray et al., 2011). In addition, loss of habitat decreases species richness and diversity (Bogyó et al., 2015). The reduction of open spaces in PULs or fragmentation of such spaces fosters the development of new edges in PULs. It has significant consequences for landscape functioning, particularly for the protection of natural heritage of PULs (Lindenmayer, 2009). For example, many researchers observe a weed invasion as a direct effect of new edges introduced in the heavily disturbed landscape (Krebs, 2008). Actions, incentives, and regulations are required to protect PUOS in order to halt the loss of biodiversity and to maintain ES.

### 1.3. Policy instruments

A policy instrument (PI) represents a specific measure, available for different governments, which is used to implement specific policy objectives (Howlett, 1991). In the context of the European Union and according to the definition provided by the manual of the INTERREG Europe Programme (INTERREG Europe, 2019; p. 38) "a policy instrument is a means for public intervention. It refers to any policy, strategy, or law developed by public authorities and applied on the ground in order to improve a specific territorial situation. In most cases, financial resources are associated with a policy instrument. However, an instrument can also sometimes refer to a strategy or legislative framework with no specific funding".

Scientific literature has described various ways of classifying PI. A popular classification of PI is related to three basic types: (1) sticks, which are highly choice constraining, (2) carrots that are moderately choice constraining, and (3) sermons that consider and facilitate free choices (Bemelmans-Videc et al., 1998; Jordan et al., 2003). Three

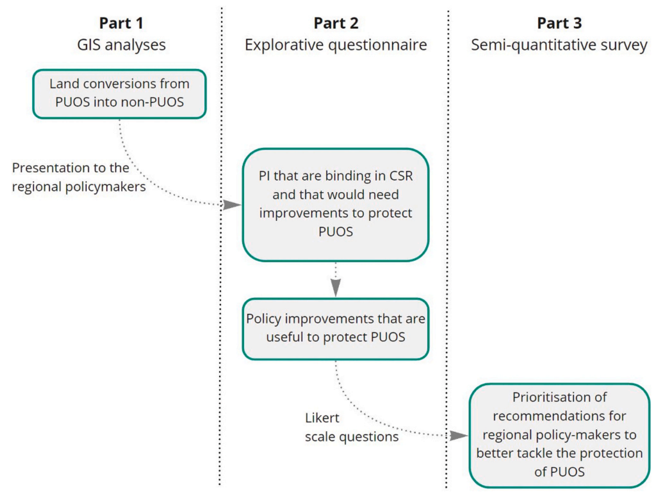


**Fig. 2.** Methodological framework of the study. PI = Policy Instrument; PUOS = Peri-Urban Open Space; GIS = Geographical Information Systems; CSR = Case Study Region.

general groups of policy instruments, which are often discussed in the literature (Jordan et al., 2011; Ring and Schröter-Schlaack, 2011; Sterner, 2003), are: (1) regulatory instruments that aim to directly control specific aspects related to particular space (e.g., land use zoning), (2) economic instruments, including market-based instruments that are related to economically oriented approaches (e.g., taxes, charges or fees, emission trading schemes), and (3) informational and motivational instruments aiming at raising awareness and educating social actors in order to give them a free choice related to specific issues. This group of instruments is leaning to non-regulatory instruments that is the contrast to traditional command-and-control regulations, and towards voluntary agreements, where governance actors commit themselves to specific actions on a voluntary basis (Zito et al., 2011). Such PI are characteristic for "new modes of governance" (Jordan et al., 2011). Recently, the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) provided a classification of PI that expands the above mentioned three types into four types: (1) Legal and Regulatory Instruments, (2) Rights-Based Instruments and Customary Norms, (3) Economic and Financial Instruments, and (4) Social and Cultural Instruments (IPBES, 2020a).

A combination of different policy instruments is required to foster effective governance and decision-making of PUOS. As stated by the White Paper on European Governance, this could be a combination of various forms of legislation, programmes, guidelines, and use of structural funds (COM, 2001). Such a combination is called a "policy mix" and defined by Ring and Schröter-Schlaack (2011; p. 15) as a "combination of policy instruments which has evolved to influence the quantity and quality of biodiversity conservation and ecosystem service provision in public and private sectors".

## 2. Case study regions and methods of the study

### 2.1. Case study regions

The selection of case study regions (CSR) was dependent on the availability of representatives of policy-makers at the stage of preparing an INTERREG Europe project application. The policy-makers had an interest in the protection of PUOS and have been affiliated to specific regions in the European Union (hereafter, "the regional policy-maker"). This approach gave us the opportunity to collect first-hand knowledge and policy experiences related to PUOS in those regions, obtained from local policy-maker and experts. Moreover, the CSR are located in different parts of the European Union, differ in size and population (Fig. 1), as well as vary in the dynamics of PU. That gave us the possibility to cover and analyse different characteristics of European PULs. However, it was not our aim to directly compare the selected regions among them. Regional policy-makers were affiliated to the following regional institutions that are located in our CSR (in brackets): University of the Basque Country (Basque Country, Spain), Flemish Land Agency (Flanders, Belgium), BSC, Business Support Centre, Ltd., Kranj (Gorjenska, Slovenia), Hajdú-Bihar County Government (Hajdú-Bihar, Hungary), Agencja Rozwoju Mazowsza s.a. (Mazovia, Poland), and the Ministry for Regional Development and Transport of Saxony-Anhalt (Saxony-Anhalt, Germany). Each institution was either directly responsible for the PI (Belgium, Hungary and Germany) or was endorsed by those institutions that are responsible for the PI (Poland, Slovenia and Spain).

During implementation of this research, representatives of the CSR became partners in the INTERREG Europe project RENATUR that gave us additional opportunities to further explore aspects of policy-making in those CSR.

### 2.2. Methods

#### 2.2.1. Methodological framework of the study

Our research was implemented in three parts and was based on a mixed-method approach using in sequence (1) Geographical Information Systems (GIS), (2) an explorative questionnaire, and (3) a semi-quantitative survey (Fig. 2). We performed a GIS-based analysis to show the dynamics of PU and to analyse the need for the protection of PUOS (Part 1 in Fig. 2). Before starting the explorative questionnaire (Part 2 in Fig. 2), the initial results of GIS analyses were shown to the regional policy-makers to better visualise the spatial configuration of PUOS and the reduction of PUOS in their region over time. Later, the semi-quantitative survey was conducted between September 2018 and November 2019 (Part 3 in Fig. 2). The survey contained 15 policy improvements to better protect PUOS at the level of regional policy-making that were mentioned by the regional policy-maker in Part 2.

#### 2.2.2. Delimitation method of peri-urban open spaces

Our delimitation method of PUOS was based on CORINE Land Cover classes (CLC). According to it, PUOS are non-built-up, mainly non-sealed, terrestrial areas located in PUL, while land use is not related to the following land cover classes based on CORINE Level 2: urban fabric (1.1); industrial, commercial and transportation units (1.2); mine, dump and construction sites (1.3) (CLC, 2018). We refer to non-PUOS for the remaining land cover classes.

#### 2.2.3. Part 1: GIS analyses

The LCC in the six CSR were illustrated for the time periods 1990–2000, 2000–2006, 2006–2012 as well as for 2012–2018 and were analysed afterwards. The administrative boundaries were provided by Eurostat (2016 version). CORINE land cover (CLC) and land cover change data (CHA), produced by the European Environmental Agency (EEA), are used together with the respective nomenclature to determine the LCC in each region (for details, see https://land.copernicus.eu/pan-european/corine-land-cover). The five major groups of level 1 are: (1) artificial surfaces, (2) agricultural areas, (3) forests and semi-natural areas, (4) wetlands, and (5) water bodies. Land cover data for the separate time periods were clipped with the administrative boundaries of the respective CSR.

For the visualisation of the changed land cover types, we have created a transition matrix using the tool *intersect* in ArcMap 10.7.1. The tool calculated a geometric intersection of the input features, which in this case were the land cover types detected for the year 1990 and 2018, respectively. Which means that the matrix only includes land cover data from 1990 and 2018, but does not contain data from 2000, 2006 or 2012. The output feature class contains all features or parts of features that overlap in the given feature classes.

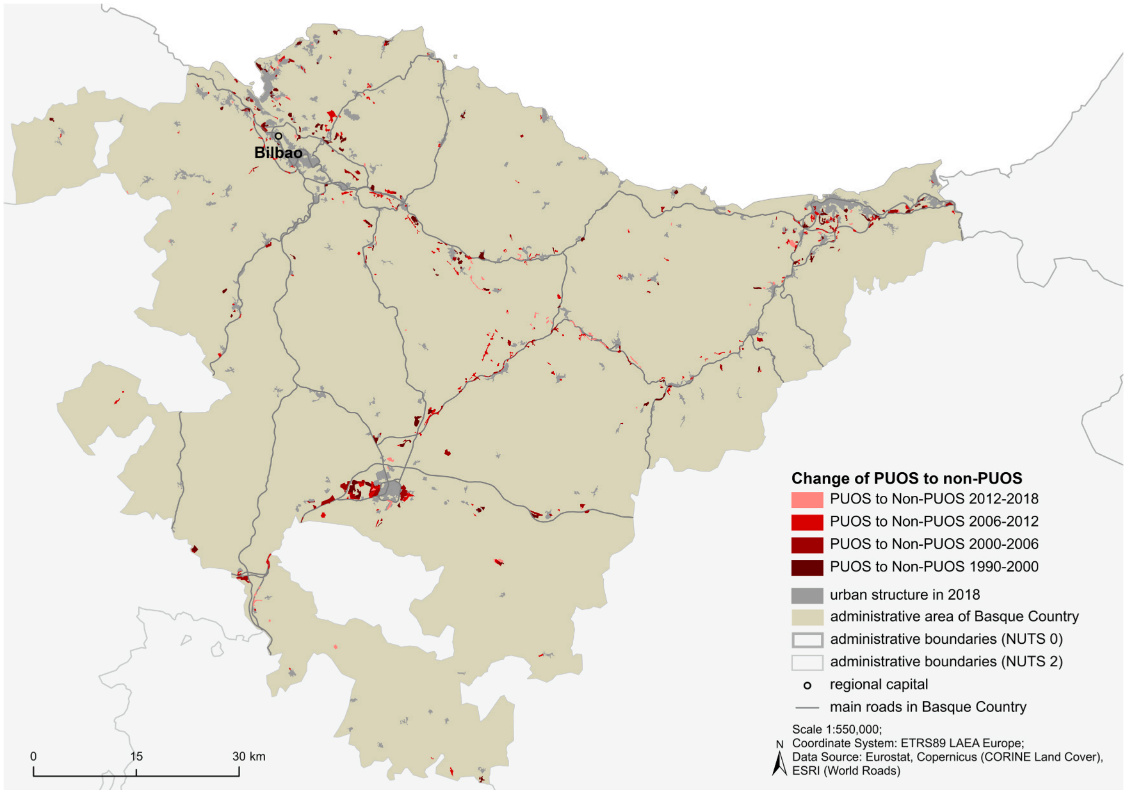


**Fig. 3.** Land cover changes of peri-urban open spaces to non-peri-urban open spaces in Basque Country (Spain) between 1990 and 2018.

*2.2.4. Part 2: explorative questionnaire*

This part covers the explorative questionnaire with regional policy-makers affiliated to the respective CSR. They were contacted online between April and May 2018. The regional policy-makers were asked to characterise the PI related to their region, propose changes in the described PI in order to improve the protection of PUOS at the regional level, and the manner in which these changes could be implemented (the list of questions is presented in the Appendix Table 1A).

The explorative questionnaire allowed us to identify (1) PIs that are binding in the CSR and that would need to be improved to better protect PUOS and (2) policy improvements that were useful to protect PUOS at the level of regional policy-making (Part 2 in Fig. 2). Finally, the policy improvements were classified according to IPBES and previous PIs classification. By a "policy improvement", we designated the name of a paradigm, solution or tool that could be implemented at the level of regional policy-making (in our case, to improve the protection of PUOS).

Following input from the "support policy" section of IPBES, our policy improvements can neither be directly classified as a PI (IPBES, 2020a), nor as a policy support tool and methodology[1] (IPBES, 2020b). However, the discussed policy improvements could be usable to support either specific types of PI or a policy support tool and methodology. To show their usefulness for this, we classified the policy improvements according to three criteria: (1) type of applicable PI, (2) family of applicable policy support tools and methodologies and (3) type of policy improvement (Fig. 6). Each of the policy improvement was visualised as a frame. The colour of the frame represents a type of policy improvement. Size of the frame and its location in the matrix express which type of specific policy improvement could feasibly support which family of policy support tools and methodologies, and type of policy instruments. For the preparation of this classification, we checked each policy improvement according to its feasibility to support the types and families described below.

(1) Type of applicable PI: we implemented the approach presented by Barton et al. (2014), and Ring and Schröter-Schlaack (2011). Therefore, three main types of PIs were selected: (a) regulatory instruments (including direct regulations), (b) economic instruments (including economic [dis-]incentives), and (c) informational and motivational instruments (including facilitation of self-regulation).
(2) Family of applicable policy support tools and methodologies: we adopted the detailed approach proposed by IPBES, which addresses the direct issues of nature protection, management and planning and is therefore, close to our topic of PUOS protection (IPBES, 2015, 2020a, b). IPBES distinguishes seven families of tools and methodologies:

F1 Assembling data and knowledge (including monitoring),
F2 Assessment and evaluation,
F3 Public discussion, involvement and participatory process,
F4 Selection and design of policy instruments,
F5 Implementation, outreach and enforcement,
F6 Training and capacity building, and
F7 Social learning, innovation and adaptive governance.

(3) Type of policy improvement: we used the approach presented by Geneletti et al. (2017) proposing three types of policy improvements. The policy improvements are presented here in a cascade, from the most general to the most detailed:

[1] Policy support tool and methodology according to IPBES definition are "approaches and techniques based on science and other knowledge systems that can inform, assist and enhance relevant decisions, policy-making and implementation at local, national, regional and global levels to protect nature, thereby promoting nature's contributions to people and a good quality of life." (IPBES glossary https://ipbes.net/glossary/policy-support-tools)

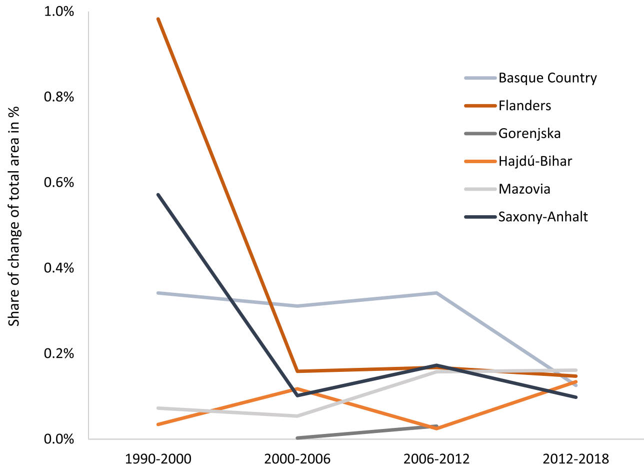


**Fig. 4.** Change of peri-urban open space (PUOS) to non-PUOS as share of total area of the specific case study regions.

a) Policy paradigms: description of the overall approach, which is (or could be) applicable to policy-making that simultaneously address specific issues (e.g., governance or transport), or existing concepts (e.g., the ES concept),
b) Strategies and solutions: description of policy actions that addresses specific issues (e.g., housing policies), or policy paradigms (e.g., implementation of the ES concept), and
c) Operational methods and tools: description of methods and tools applied to operationalise strategies and solutions (e.g., specific tools aiming to implement land use zoning in a more flexible way), or to assess strategies and solutions (e.g., assessment frameworks).

#### *2.2.5. Part 3: semi-quantitative survey*

Closed questions in a Likert-scale between 1 and 5 were used for the semi-quantitative survey (1 = "the policy improvement is not relevant at all" and 5 = "the policy improvement is highly relevant"). The survey was filled in online by the regional policy-maker in Google Forms. After that process, several thematic sessions were organised at different international scientific conferences and workshops related to PU and governance between April and October 2019 in order to collect more data. In this case, the survey was conducted (optionally anonymous) paper-based. The full list of thematic sessions is presented in Table A2. In order to complete the sessions, scientific workshops titled "Innovative environmental governance for sustainable peri-urban landscapes" were organised in Halle (Germany, June 2019) and in Ostrava (Czechia, November 2019).

## 3. Results

### *3.1. Part 1: GIS analyses*

Our analyses showed that in all CSR land conversion from PUOS to non-PUOS is taking place but on different scales and with different dynamics (Fig. Appendix 1A, 2A, 3A, 4A, 5A). In general, changes in our CSR occurred primarily close to urban structures (CLC classes 111 and 112), or along main roads. Exemplified in Fig. 3, LCCs in the Basque Country related to changes from POUS to non-PUOS mainly occurred along the roads and in proximity to economic centres such as Bilbao, Donostia - San Sebastian, and in the southern Basque Country around Vitoria-Gasteiz as the administrative capital of the Basque Country. LCC along the road can also be observed for Mazovia (Fig Appendix 4A). In addition, changes from PUOS to non-PUOS are mainly located around Warsaw. Land conversion in Flanders and Saxony-Anhalt were rather scattered over the region. Larger and recently converted plots are located in Flanders in proximity to the seaside. Land conversion in Hajdú-Bihar were only a few but larger plots mainly located around the regional capital Debrecen. LCC in Gorenjska were only marginal.

We observed differences for PUOS transformed into non-PUOS in the CSR in different time spans (Fig. 4). Highest land conversion from PUOS to non-PUOS occurred between 1990 and 2000 in Saxony-Anhalt and Flanders. For all CSR, the share of LCC from PUOS to non-PUOS has been reduced. Lowest land conversion over the time span was observed for Gorenjska.

The share of PUOS that has been converted into non-PUOS in the CSR in the different times spans is shown in Fig. 5. Mostly, (non-irrigated) arable land has been transformed into non-PUOS in Saxony-Anhalt, Hajdú-Bihar, and Mazovia. In the Basque Country and Gorenjska, a major share of converted land use types is related to forest. Between 2000 and 2006, only forest was converted in Gorenjska. In Basque Country, also the share of converted pastures is high. In Flanders, especially the share of heterogeneous agricultural areas is high; mainly reflected by complex cultivation patterns. However, looking at the share of the total amount of the land cover type in the respective CSR between 1990 and 2018, heterogeneous agricultural areas have been converted mainly in Mazovia and Hajdú-Bihar (Table 1). Major reductions were also related to green urban areas, and sport and leisure facilities (level 2, CORINE class 14: artificial, non-agricultural vegetated areas) where the highest reduction is shown in Saxony-Anhalt with 31.49%. In the Basque Country, 17.11% of this land use type (level 2, CORINE class 14) was converted to non-PUOS. Minor reductions have been taken place for the land cover type forest.

### *3.2. Part 2: qualitative survey with regional policy-makers*

Six PIs were identified (one per CSR) which address PUOS at the level of regional policy-making:

(1) Basque Country: European Regional Development Found (ERDF) Regional Operational Programme 2014–2020,
(2) Flanders: Section 5 on the Act of Land Development (28 March 2014 – published in Belgian Official Gazette 22 August 2014) concerning re-parcelling by virtue of law with zoning exchange,
(3) Gorenjska: Operational programme for Implementation of Cohesion policy 2014–2020,
(4) Hajdú-Bihar: Regional Development Programme of Hajdú-Bihar County 2014–2020,
(5) Mazovia: Regional Operational Programme of the Mazowieckie Voivodeship 2014–2020 (Regional Operational Program (RPO) Mazovia), and
(6) Saxony-Anhalt: ERDF Operational Program Saxony-Anhalt 2014 – 2020, Priority 4 Preserving and protecting the environment and promoting resource efficiency, Investment priority 6e, objective 11: Reducing the soil, sealing of cities through stimulation of inner urban development, and redevelopment of brownfields.

All questions and answers of the survey with regional policy-makers are presented in the Appendix Table A3 and A4.

By analysing the results of the survey, we identified 15 policy improvements which could be useful to protect PUOS at the level of regional policy-making (Fig. 6): (1) Expanding the awareness of the ecosystem services concept in different governance actors groups; (2) Re-parcelling plots; (3) Changing land use zones designated in plans, specifically applicable for wrongly designated zones; (4) Developing

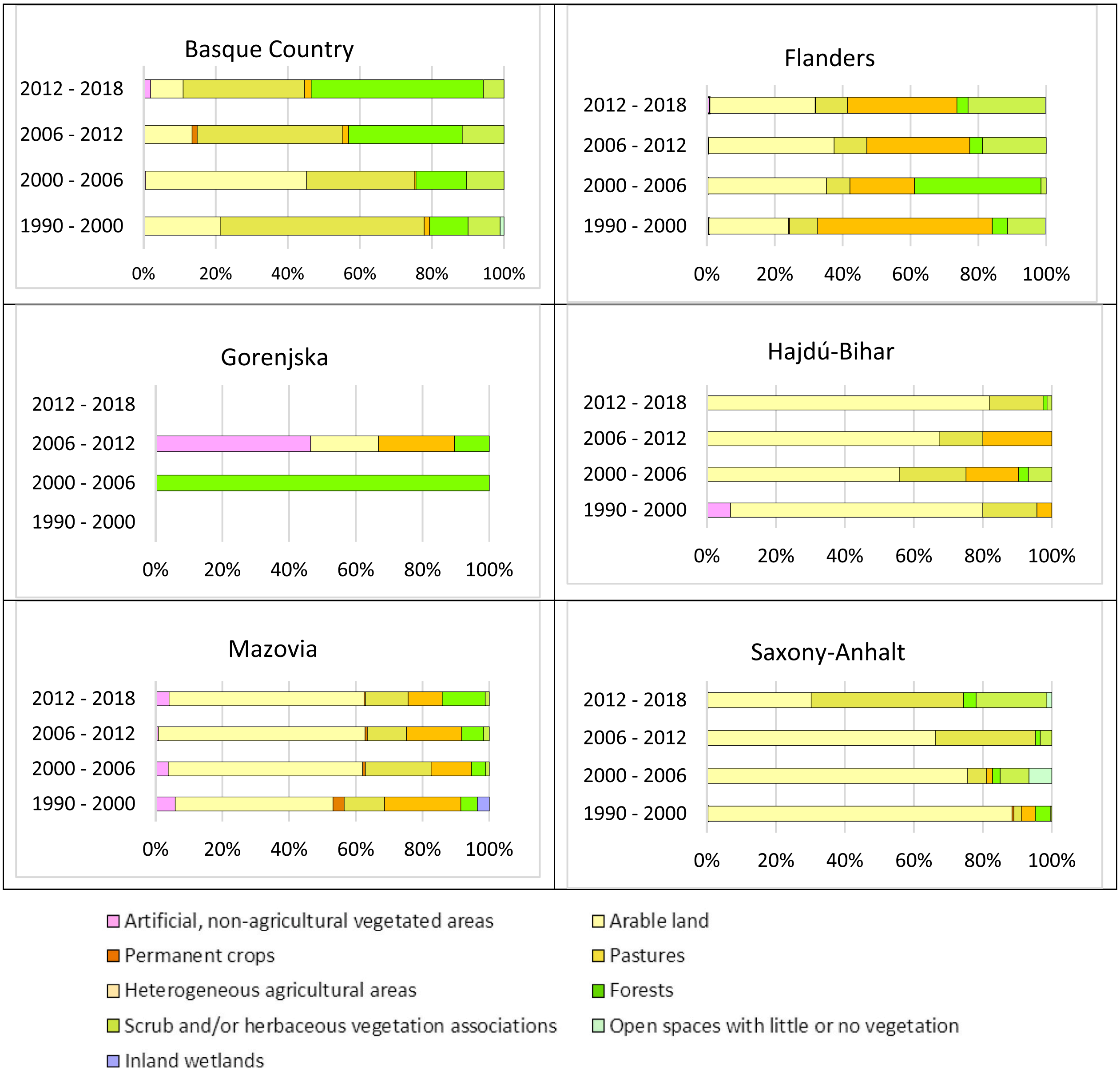


**Fig. 5.** Share of peri-urban open space (PUOS) converted into non-PUOS in the case study regions.

**Table 1**
Transition matrix describing the change (%) from peri-urban open space (PUOS) to Non-PUOS in the case study regions from 1990 to 2018. Reduction of the land cover type in the total case study region of > 10% is highlighted in bold.

| CORINE Land cover types, level 2 | Class | Basque Country | Flanders | Gorenjska | Hajdú-Bihar | Mazovia | Saxony-Anhalt |
|---|---|---|---|---|---|---|---|
| Artificial, non-agricultural vegetated areas (sport and leisure facilities, green urban areas) | 14 | **17.11%** | 2.22% | **13.58%** | 6.29% | **13.13%** | **31.49%** |
| Arable land | 21 | 6.05% | 0.87% | 4.66% | 0.67% | 2.41% | 1.84% |
| Permanent crops (vineyards, fruit trees and berry plantations) | 22 | 2.69% | 0.97% | | 0.96% | 1.71% | 6.73% |
| Pastures | 23 | 9.56% | 0.93% | 2.10% | 0.83% | 1.15% | 1.27% |
| Heterogeneous agricultural areas (e.g. complex cultivation patterns, agro-forestry areas) | 24 | 1.93% | 2.09% | 4.84% | 9.70% | **16.02%** | 5.83% |
| Forests (broad-leaved, coniferous and mixed forest) | 31 | 0.80% | 0.68% | 0.19% | 0.24% | 0.34% | 0.56% |
| Scrub and/or herbaceous vegetation associations (e.g. natural grasslands, moors and heathland) | 32 | 1.89% | 3.04% | | 0.21% | 0.75% | 0.60% |
| Open spaces with little or no vegetation | 33 | 0.12% | 1.44% | 0.02% | | 1.47% | |
| Inland wetlands | 41 | | 0.13% | | 0.50% | | 0.11% |
| Maritime wetlands | 42 | 3.51% | | | | | |

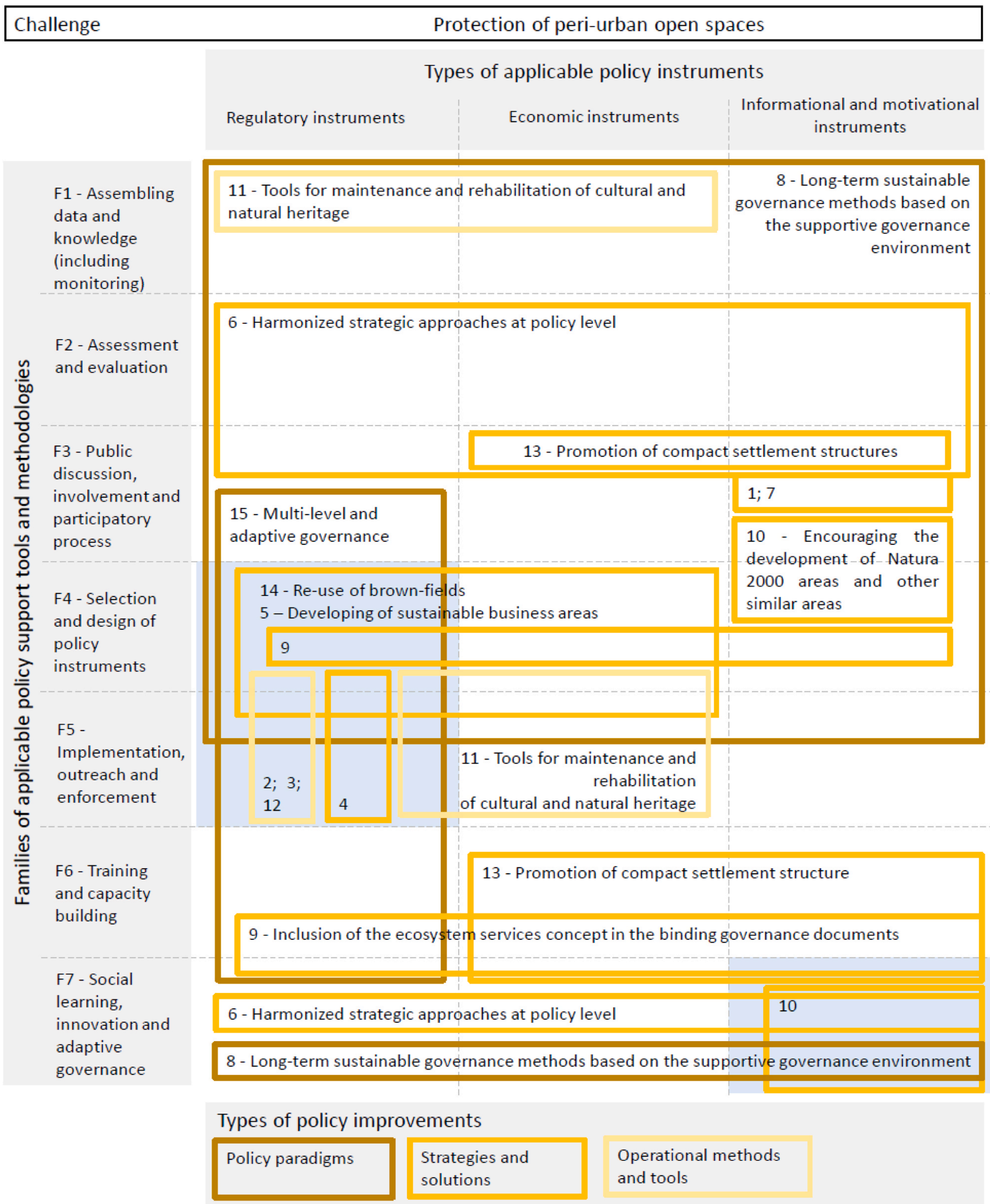


**Fig. 6.** Classification matrix of the identified policy improvements. Location of a frame with a number and name of a specific policy improvement describes for which category of policy support tools and methodologies (axis y) and for which type of policy instrument (axis x above) it could be supportive (for name of policy improvement, see the numbered list in sub-Section 3.2). Blue squares mark the clusters of policy improvements. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.).

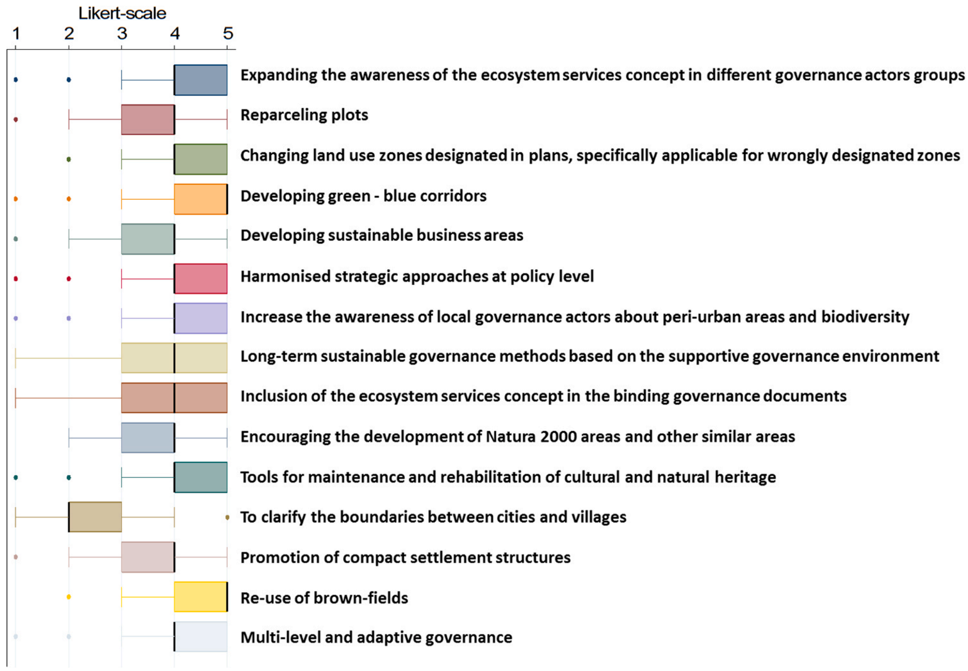


**Fig. 7.** Frequency distribution of replies for each of the policy improvement. Median values are shown in black and bold. Likert-scale: 1 = "the policy improvement is not relevant at all" and 5 = "the policy improvement is highly relevant".

green - blue corridors; (5) Developing sustainable business areas; (6) Harmonised strategic approaches at policy level; (7) Increase the awareness of local governance actors about peri-urban areas and biodiversity; (8) Long-term sustainable governance methods based on the supportive governance environment; (9) Inclusion of the ecosystem services concept in the binding governance documents; (10) Encouraging the development of Natura 2000 areas and other similar areas; (11) Tools for maintenance and rehabilitation of cultural and natural heritage; (12) To clarify the boundaries between cities and villages; (13) Promotion of compact settlement structures; (14) Re-use of brown-fields; and (15) Multi-level and adaptive governance.

Even though most of the names of policy improvements are self-explanatory, we provide further explanation for policy improvement no. 2 and no. 3. "Re-parcelling plots" (policy improvement no. 2) is a tool that allows to exchange the properties assigned to parcels and to reorganise the smaller parcels into a bigger one. "Changing land use zones designated in plans that are specifically applicable to wrongly designated zones" (policy improvement no.3) is a tool which allows to change the designated usage of a specific part of land which is outdated into a more sustainable usage. Policy improvements no. 2 and 3 were proposed by the regional policy-maker from Flanders and correspond to several tools from the toolbox described in the Flemish Parliament Act of Land Development (Flemish Land Agency, 2014).

According to Fig. 6, each of the 15 policy improvements can be considered as at least one of the three types of policy instruments. Our classification shows two larger clusters of policy improvements (indicated in light blue in Fig. 6). Nine of the policy improvements (no. 2, 3, 4, 5, 9, 11, 12, 14 and 15) have the potential to be applicable for regulatory PI and could support the selection, design of new PI (family 4), as well as the implementation, outreach and enforcement of existing PI (family 5). Five of the policy improvements (no. 6, 8, 9, 10, 13) have the potential to be applicable for informational and motivational PI and could support social learning, innovation, and adaptive governance (family 7).

### 3.3. Part 3: semi-quantitative survey

This section presents the main results from the semi-quantitative survey conducted during the last part of the study. The collected data show that the majority of the identified policy improvements is predominantly considered to be "relevant" or "highly relevant" (Fig. 7). In particular, according to the frequency distribution, the policy improvement no. 12 "To clarify boundaries between cities and villages" emerged as the least relevant one, with 21.9% of the experts defining it as "not relevant at all". The policy improvements no. 4 "Developing green-blue corridors", no. 14 "Re-use of brown-fields", and no. "15 Multi-level and adaptive governance" were considered as most relevant with respectively the 59.76–52.44% - 48.78% of experts responding "5 = highly relevant" for these policy improvements.

## 4. Discussion

### 4.1. Land cover changes related to PUOS

Our delimitation approach of PUOS allows to reflect on LCC related to PUOS that are one of the most significant consequences of PU and that often stimulate policy and planning changes (Nuissl and Siedentop, 2021; Shaw et al., 2020). Moreover, this approach matches with the classification by Walz and Stein (2014) who separated the land cover classes according to hemeroby levels. Hemeroby shows the degree of human influence on land. In Walz and Stein (2014), discontinuous urban fabric, mineral extraction sites and dumpsites are polyhermerobic areas with very strong human impact. Continuous urban fabric, industrial or commercial units, road and rail networks, and associated land are metahemerobic areas with excessively strong human impact. Our definition has also similarities to the land take indicator by EEA (2019) because it is also based on CORINE data. The land take indicator includes areas that we have defined as non-PUOS but also "green urban areas" and "sport and leisure facilities" which we have classified as

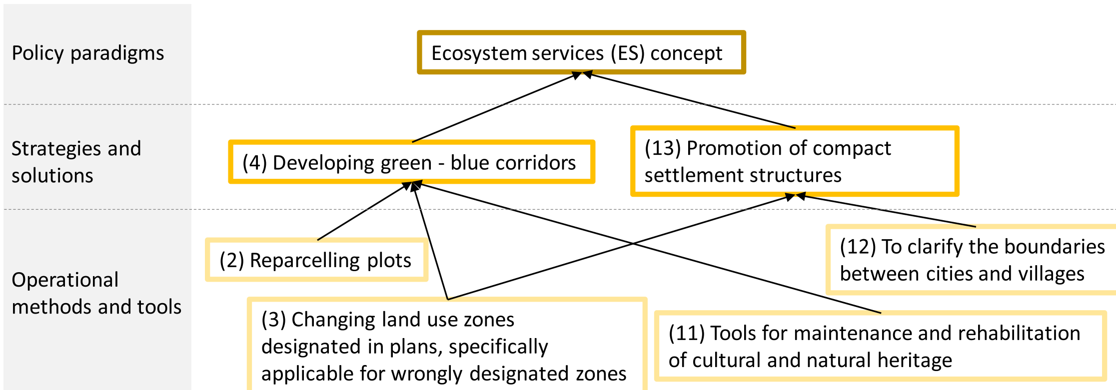


**Fig. 8.** Cascade figure showing the relations between different types of policy improvements identified in our study using the ecosystem services concept as example.

PUOS. This approach to PUOS delimitation can also be transferred to Functional Urban Area (FUA) data provided by Eurostat. In this case, areas that are not related to artificial surfaces can be described as PUOS. However, FUA data do not cover the whole extent of our case study regions and, therefore, we did not use this approach.

Aside from the specific approach that was implemented in our research, several other studies identified LCC as main component of the PU in the European context (Lennert et al., 2020, Shaw et al., 2020, Tavares et al., 2019). Similar to this fact, land conversion from PUOS to non-PUOS was observed for all CSR in our study, even though only marginal changes were visible on regional scale in Gorenjska. The LCC maps showed monocentric as well as polycentric patterns of PU. In monocentric patterns, LCC of PUOS to non-PUOS are clustered close to the dominating city in the CSR. In a polycentric pattern, LCC of PUOS to non-PUOS are clustered around main cities and along existing infrastructures (transportation infrastructures and already urbanised areas; for further reading, e.g. ESPON, 2005). For Mazovia, the monocentric PU patterns were obvious since the region and the country is centralised towards the capital city of Warsaw. PU pressure occurs in the fringes of the capital city. Grochowski et al. (2013) confirmed that the municipalities along the main transportation roads to Warsaw experience the highest level of urbanisation pressure. Mainly agricultural area was converted for housing and service. Population growth was caused by migration because Poland changed during the 1990s from an industry-oriented to a service-oriented economy where the national headquarters moved to Warsaw as capital (Grochowski et al., 2013; Nilsson et al., 2014). LCC in Mazovia – as well as in Hajdú-Bihar - could have been also related to the transition from socialist planning to market-oriented economy (Cegielska et al., 2018).

As seen in Fig. 1, Flanders and the Basque Country have the highest population densities among the CSR besides Mazovia. Population growth is a major pressure on PUOS (Fertner et al., 2016; Poelmans and Van Rompaey, 2009). However, patterns of LCC related to PUOS are different since changes in Flanders are rather scattered, while in the Basque Country development is oriented along the main transportation network, concentrated close to the main cities and also limited by the hilly and forested landscape. Land use in the Basque Country changed in the 1990s after an economic crisis in which the industry and the service sector evolved considerably in this region. Different scientific and technological centres have been strengthened. Rural areas have been transformed to small cities that are interconnected by large-scale infrastructure (Palacios-Agundez et al., 2013). In addition, development has taken place around Vitoria-Gasteiz as it is the administrative capital of the Basque Country (Aguado-Moralejo et al., 2013). Flanders has been densely populated already for a long time, which led to continuous growth of urban centres like Ghent and Antwerp and a growing infrastructural network between the scattered centres leading to further fragmentation of the landscape (Antrop, 2004). LCC of PUOS to non-PUOS are distributed in a highly polycentric way or even equally distributed in this CSR that might be also related to the plain landscape where development can spread into all directions. In Saxony-Anhalt, the largest change from PUOS to non-PUOS can be observed between 1990 and 2000. The German reunification (1990) could be one of the reasons for this development that caused an increasing demand for housing and infrastructure especially near urban centres (Prieler et al., 1996). Nevertheless, the LCC of PUOS to non-PUOS remained polycentric in this CSR. For Gorenjska, literature could not reveal the reasons behind the slow development but the local policy-maker from this region reported that the financial crisis in 2012–2013 (COM, 2020) could have caused a loss of markets and lack of regional investments. Our own observations, confirmed by discussions with local policy-makers, lead to the conclusion that PU in Gorenjska region takes place mainly along transport infrastructural line from Austria to Ljubljana (the capital of Slovenia). This fact has the negative influence on the protection of local PUOS. Moreover, the policy-makers from Gorenjska informed us that the LCC related to PUOS might be observed more in detail on local scale e.g. in communes Bohinij and Škofja Loka. They further mentioned that in those communes POUS are endangered mainly due to intensive tourism activities (e.g. new parking places for tourists, new commercial infrastructures aiming to serve tourists, increasing yearly number of PUOS visitors). Nevertheless, such detailed scale was out of the scope of this research.

The share of the LCC from PUOS to non-PUOS has shown that mainly (non-irrigated) arable land was affected in our CSR, which is in line with the findings of the EEA where mainly agricultural areas were affected by land conversion (EEA, 2019; García-Martín et al., 2021). However, looking at the total share of this land cover type per region, considerable reductions were only seen in the Basque Country. The analysis of the reduction per PUOS of the total land cover per CSR has shown that mainly green urban areas, sport and leisure facilities, and heterogeneous agricultural areas (mainly complex cultivation patterns) were affected by land conversion. Even though green urban area, and sport and leisure facilities belong to artificial surfaces, they are of great value for human health and well-being (Braubach et al., 2017).

### 4.2. Recommendations for the regional policies to better protect PUOS

Landscape protection, as defined in ELC, encompasses "(…) actions to conserve and maintain the significant or characteristic features of a landscape (…)" (Article 1, point d, Council of Europe (2000)) as the measures to preserve the "open" character of PUOS. Even if PUOS are not always protected areas as such, several authors addressed the problem of effective nature conservation outside protected areas (Sepp et al., 1999), particularly in rapidly urbanising areas (Xun et al., 2017) and they see it as important issue to stop, e.g., the extinction of species outside protected areas (Boakes et al., 2019). Furthermore, as shown in our results, transformation of PUOS into non-PUOS is still taking place in CSR. To stop or at least to slow down this unsustainable process, we assert that a better protection of PUOS is needed. Thus, we focus on PUOS "protection" because we argue that a stronger term than "management" of PUOS is needed.

Looking beyond definitions and theories, reality of policy-making is much more complex (Colebath, 2006). We have realised that the results of part 2 and 3 of our study do not conform directly to the existing classifications of either policy instruments, or policy support tools and methodologies. Nevertheless, we argue that it is possible to show the usefulness of the policy improvements to different types of policy instruments, and policy support tools and methodologies. Based on this, it will be possible to provide useful recommendations on how to improve the protection of PUOS at the level of regional policy-making.

The potential to use the policy improvements in governance practices is illustrated in a cascade figure (Fig. 8), which shows the relation between identified policy paradigms, strategies and solutions, and operational methods and tools using the example of the ES concept paradigm.

Our results indicate a large potential for improving the regulatory instruments, which can better address PUOS protection because the largest group of policy improvements was classified as usable for these types of policy instruments (Fig. 6). This finding is in line with Wästfelt and Zhang (2018) who confirmed a positive influence of regulatory instruments into the protection of PUOS related to agriculture. On the other hand, regulatory instruments can also foster PU and reducing PUOS as demonstrated by Christensen (2019) for housing decentralisation in China.

Concerning the "families of applicable policy support tools and methodologies", we identified four of these families with the largest amount of assigned policy improvements. Two clusters can be created from these four families. The first cluster contains F3 (Public discussion, involvement and participatory process) and F7 (Social learning, innovation and adaptive governance). This indicates the need for a more effective dissemination of the PUOS concept and, related to this concept, implications for landscape sustainability and well-being of region inhabitants to wider groups of governance actors. This could be used as backbone supporting adaptive governance concerning to PUOS. Another cluster is composed from F4 (Selection and design of policy instruments) and F5 (Implementation, outreach and enforcement). This shows the potential for careful improvements of the design and implementation phases of policy-making (Perrin et al., 2018), particularly in the context of agro-environmental balance and regeneration in PULs (Cattivelli, 2020).

Important for our recommendations is the policy improvement no. 15 related to multi-level and adaptive governance for the protection of PUOS that was highly ranked by the respondents. Implementation of this policy improvement offers the shift into intersecting and flexible jurisdictions, characteristic for multi-level governance (Hooghe and Marks, 2003), which conforms well to the transitional character of PULs and PUOS (Spyra et al., 2020). This can lead policy-making of PUOS into non-hierarchical, horizontal and polycentric directions. In addition, it can foster the move from the "command and control" type of governance towards the situation where the policy-makers and the governing bodies are rather setting the objectives and supporting the resources acquisition (Peters and Pierre, 2001). In such a system, the role of negotiations among governance actors becomes more important. Literature studies show growing interest in approaches of multi-level governance. Even if it is difficult to find articles that directly address multi-level governance in PULs, some thoughts that originally are related to multi-level governance in metropolitan contexts could be also adopted to aspects of PUOS protection. For example, the implementation of multi-level governance could increase the resilience of PULs and PUOS (Frey and Ramírez, 2018), or could contribute to the required shift in framing PUOS as socio-ecological rather than socio-economical spaces. This as such could highlight ecological aspects for circular and regenerative economy (Frank and Marsden, 2016). Nevertheless, the successful implementation of multi-level governance in the context of PULs and PUOS requires well-designed and planned inter-municipal cooperation (Leck and Simon, 2018). A recognition of barriers on a local scale and coordination across all levels of governance is needed to overcome obstacles that could be disturbing in the multi-level governance of PUOS (Juhola, 2016).

The impact of the thematic policies should be taken into account in order to increase the efficiency of PUOS protection policies (Jann and Wegrich, 2007). For instance, the respondents especially appreciated the policy improvements no. 1, 4, 9, and 10. Policy improvement no. 4 "Green-blue corridors" is among the highest rated in our study. All these policy improvements relate to ecological approaches towards policy-making. This could indicate that nature protection policies could strongly support the protection of PUOS. This aspect is pertinent, even if our results show that mostly agricultural areas as PUOS were transformed into non-PUOS. This is because agricultural areas are both recognised as important part of PULs (Zasada, 2011) and as important land use type for ES and biodiversity (Pérez-Campaña and Valenzuela-Montes, 2015). To be effective, approaches of nature conservation and biodiversity protection need to address agricultural areas in a wider spatial context, meaning agricultural areas and adjoining territories like PULs (Calvache et al., 2015). The requested protection of biodiversity supports the protection of arable land. Both, i.e. reduction of arable land and loss of biodiversity, are strictly related to the dynamics of PU and both could be limited by implementing policy improvement on the regional level. Addressing this topic has a significant importance because PU will result in a significant loss of very productive cropland, particularly in the agrarian economies of the Global South (Bren d'Amour et al., 2016).

It is important to mention that policy-making concerning the protection of PUOS needs to acknowledge not only the aspects of the physical development of PULs but also socio-economic changes and different flows (including also the ecological ones) that take place between urban and rural landscapes (Dávila et al., 1999).

An interesting policy improvement that was highly rated by our respondents is the re-use of brownfields (no. 14), as an example of infill development and as an approach towards the protection of PUOS. In the CSR Saxony-Anhalt, the land development law (LEntwG LSA, 2015) at paragraph 10 stipulates that the operating mining company should have sufficient financial reserves to pay for the consequential costs of mining. This includes the redevelopment of former mining landscapes. Incentives to encourage new investments into brownfields rather than into PUOS reduce the pressure on existing PULs, thus supporting the protection of PUOS (Smith, 2010). In addition, Genske (2003) identified - based on a study by Grimski, Doetsch and Rüpke (1998) - that the remediation of a brownfield in the region of Dresden was financially better than the land conversion from a green area to industrial area.

In that sense, strategies of "land recycling" need to be developed to demolish unusable buildings and to redevelop sealed surfaces (Genske, 2003). The Urban Redevelopment Programme of Germany also set standards for the design of open spaces even though these standards are often implemented at the minimum level (Mathey and Rink, 2020). Funding for demolition is often not available (Bernt, 2009) even though building companies should be more obliged to restore sealed wasteland to its near-natural state. This financial and organisational burden could demotivate investors and encourage them to think twice about soil sealing. However, it is often the burden of the government, or at a public-private partnership approach, to finance the remediation (Genske, 2003).

On the other hand, clarification of boundaries between cities and villages (policy improvement no. 12) is not seen as a valuable improvement by our survey respondents, despite on-going considerations concerning to foundations and evolution of rural planning (Scott et al. 2019). There are different approaches distinguishing between urban and rural areas, thus allowing to delimitate boundaries between them. One of the most well-known is the one adopted by the Organisation for Economic Co-operation and Development (OECD, 2018). Dependence of the urban-rural boundary delimitation on the used methodology could point out that urban-rural boundary might be understood as being “fluid/flexible”. That fact could influence policy making related to PUOS protection. Nevertheless, in the context of our study, jurisdictional overlaps between different administrative bodies (e.g. communes) seems not to hamper much the protection of PUOS. Despite that, it is important to acknowledge that the issue of cooperation between municipalities remains an important factor for sustainable governance for the whole extent of PULs (Nuhu, 2019) and for the multi-level governance as such. It could result in significant governance gaps, if the issue of cooperation between municipalities is not addressed in peri-urban policy-making.

An important aspect is how to avoid the possible risks related to the protection of PUOS. Preventing new investments in PULs could lead to the reduction of commercial investments that potentially provide new employment opportunities in the region and could lead to the loss of competitiveness of the region on the national, or international scale (Turok, 2004). This is in particular pertinent for developing regions and countries where “pro-investment” is still the main asset for decision-makers and for some citizens. Therefore, there might occur a trade-off between the need of PUOS protection and the necessity and political pressure for regional development.

Even if infill development has been promoted for some time as one of the tools for protecting open spaces (Dieleman and Wegener, 2004; Wolff and Haase, 2019), there is still rather limited knowledge on what kind of practical results this policy tool could bring in the context of PU (Kamal and Proma, 2017) and how effectively it could directly protect PUOS. On the other hand, in the wider context of PULs in Flanders, densification of existing clusters of commercial and housing investments in PULs is used as a policy tool to prevent new investments in PUOS (Vermeiren et al., 2018). As described above, specific incentives for densification of urban brownfields are planned in Saxony-Anhalt. Concerning to the risks related to infill development, it has to be mentioned that this tool could (not necessarily must) go hand in hand with, the process of gentrification that is questionable from the perspective of landscapes sustainability (Rose, 2004). Moreover, health risks could emerge in urban areas where infill development is implemented at the expense of urban open spaces, that represent spots of nature in the city (Haase et al., 2018). Such spots of nature provide for urban inhabitants a minimum access to greenery (Chiroma et al., 2018) and, therefore, to several important ES for health and well-being (Prahalad et al., 2019). Nature-based solutions could contribute to solve this problem (Bush and Doyon, 2019).

Our study does not provide direct answers related to governance / policy actors who would need to be involved in the process of a better protection of PUOS. Nevertheless, based on the results, we could acknowledge that families F3 and F6 and the policy improvements that fit to those families could support process of selecting pertinent governance actors for the protection of PUOS. Other studies pointed out the transition character of PULs and the variety of governance actors involved in policy-making and planning (Spyra et al., 2020). For this reason, and due to often conflicting interests of peri-urban governance actors, policy-making should not be implemented in the closed cycles of “elite” policy-makers. Rather extensive feedback loops that are able to inspire new policies or the redefinition of the existing policies are necessary (Howard, 2005). Effective policy-making concerning PUOS will require a larger consultation involving several experts. In this situation, a wider social engagement is required from policy-makers like in similar processes of policy-making (Janssen and Helbig, 2018).

### *4.3. Pros and cons of the research methods*

The main achievements of this study are related to the identification of possible policy improvements that can be implemented for the protection of PUOS. In particular, the classification matrix of policy improvements (Fig. 6) can be converted into a practical tool for policymakers that are interested in developing more efficient policies towards the protection of PUOS. Moreover, this matrix could be used to classify other types of policy improvements that focus on different policy challenges. The combination of GIS analyses and surveys allowed us to get a richer picture of the dynamics in the context of PUOS from an interdisciplinary perspective (natural and social sciences; qualitative and quantitative approaches). The comparison of LCC concerning PUOS in different regions of Europe provided an overview and confirmed that this is an emerging topic and needs to be investigated in different socioeconomic and spatial contexts. This comparison was possible due to the use of CORINE data. The CORINE Land Cover database has the advantage of being both coherent and comparable in all EU countries (Buttner et al., 2004). Nevertheless, some uncertainties are related to the CORINE data set regarding spatial resolution being higher than 25 ha. This could lead to possible misclassifications related to smaller patches. In addition, the LCC observed constant change over time in CSR.

In the transition matrix (Table 3), the percentage change revealed the magnitude of the LCC detected in the CSR. The findings represent relevant information for further analyses of affected land cover types and related intensities. From the point of view of Part 2 of the study methods, a very challenging constraint dealt with the availability of data in line with its tenets and purposes. Due to the specificity of the topic and the lack of relevant and pertinent (secondary) data to be consulted for our analysis, an explorative approach was chosen. In addition, there might be some uncertainties related to data gathered by the survey that have caused limited reproducibility and robustness. The results of the semi-quantitative survey could be biased due to potential misunderstandings of the respondents regarding the specific names of policy improvements, even though these names were explained before the survey and any related question or doubt raised by respondents was answered and/or clarified.

## 5. Conclusion

Our concept of PUOS and non-PUOS is useful for highlighting LCC related to diminishing open spaces in PULs, thus enabling a better understanding of the impact of land take on the sustainability of PULs. This definition overlaps with the hemeroby concept that characterises land cover classes belonging to non-PUOS as areas of strong, very strong or excessively strong human impact.

LCC related to PUOS showed a different dynamic and spatial pattern in CSR. Nevertheless, the process of PUOS diminishing remains a policy and planning problem, which still needs to be addressed. The basis for such study needs to be juxtaposed with the careful delimitation of PULs, distinguishing between PUL as a larger territory and peri-urban areas that can be also located inside PUL.

Our study showed the potential for improving regulatory instruments to better address PUOS protection at the regional level. Furthermore, multi-level governance as a policy paradigm is appreciated to address PUOS protection despite its recent criticism. The clarification of boundaries between villages and cities was not considered to be important for the protection of PUOS by our respondents even if PUOS can stretch over several administrative boundaries between urban and rural landscapes. It is important to harmonise different thematic policies that are related to PU to improve the protection of PUOS at the level of regional policy-making. Furthermore, there is a need to take into account the different flows and dynamics at different levels of policy-making between urban and rural landscapes. Policies that address the protection of the natural environment can take a leading role in such "policy bundles". In general, policy improvements need to be targeted towards more flexible and adaptive policies that are result-oriented and not only focus on theoretical solutions.

## CRediT authorship contribution statement

**Marcin Spyra**: Conceptualization, Supervision, Methodology, Writing – original draft, Writing – review and editing, Investigation, Visualisation, Project administration. **Janina Kleemann**: Writing – original draft, Writing – review and editing, Methodology, Formal analysis, Investigation. **Nica Claudia Calò**: Writing – original draft, Writing – review and editing, Formal analysis, Investigation. **Alina Schürmann**: Writing – review and editing, Formal analysis, Visualization. **Christine Fürst**: Supervision, Funding acquisition.

## Declaration of Interest Statement

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## Appendix A

See Figs. 1A–5A.
See Table 1A–4A.

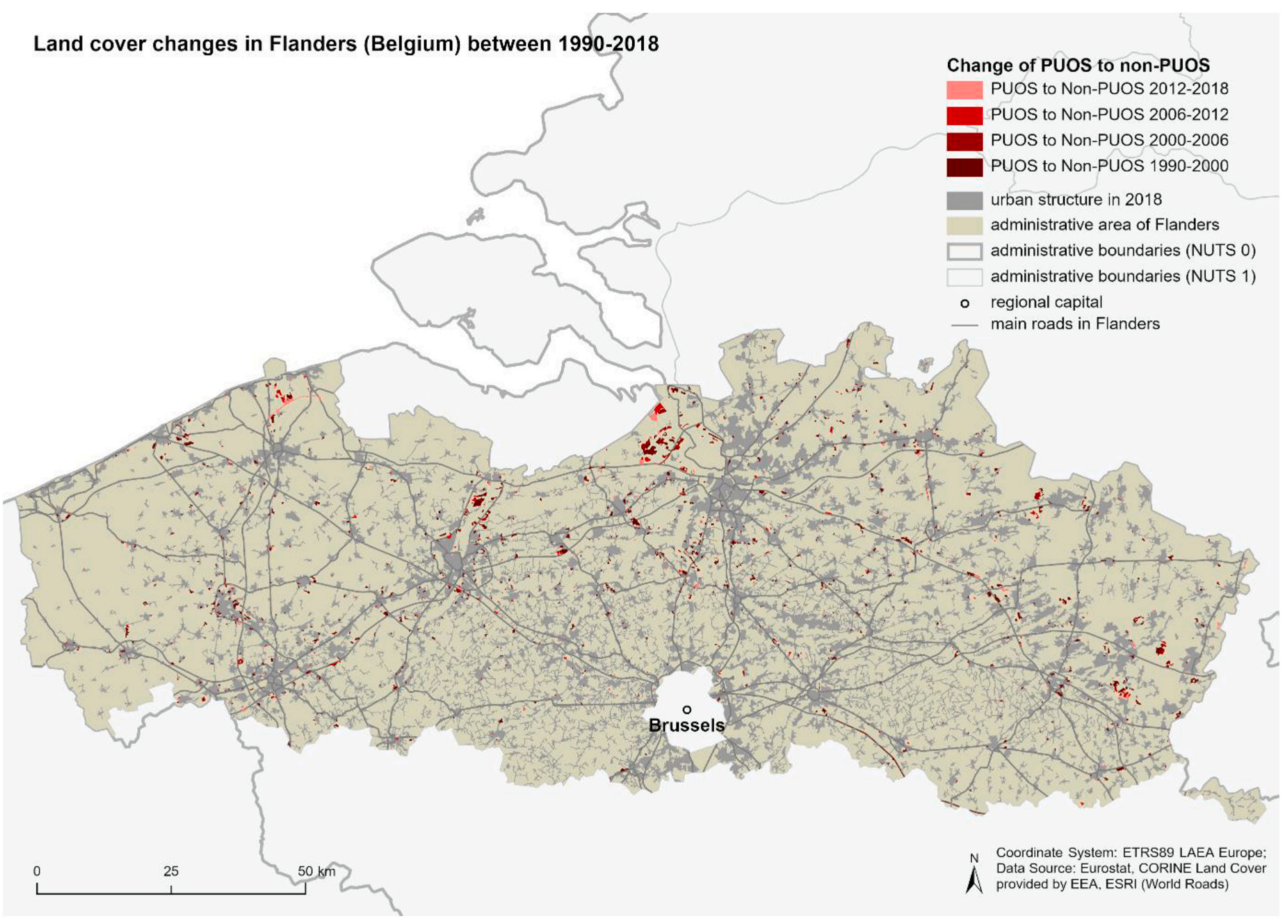


**Fig. 1A.** Land cover changes of PUOS to non-PUOS in Flanders (Belgium) between 1990 and 2018.

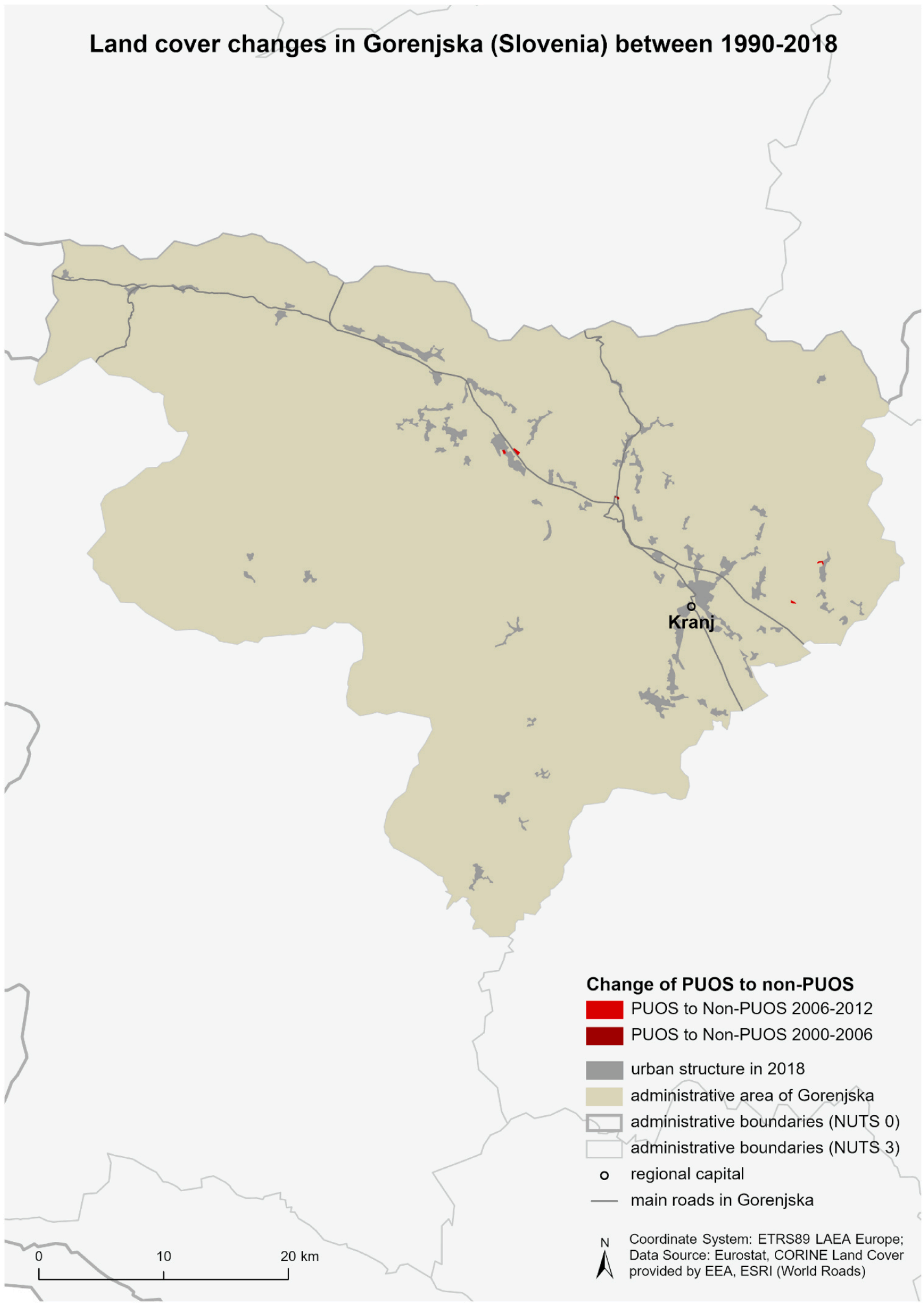


**Fig. 2A.** Land cover changes of PUOS to non-PUOS in Gorenjska (Slovenia) between 1990 and 2018.

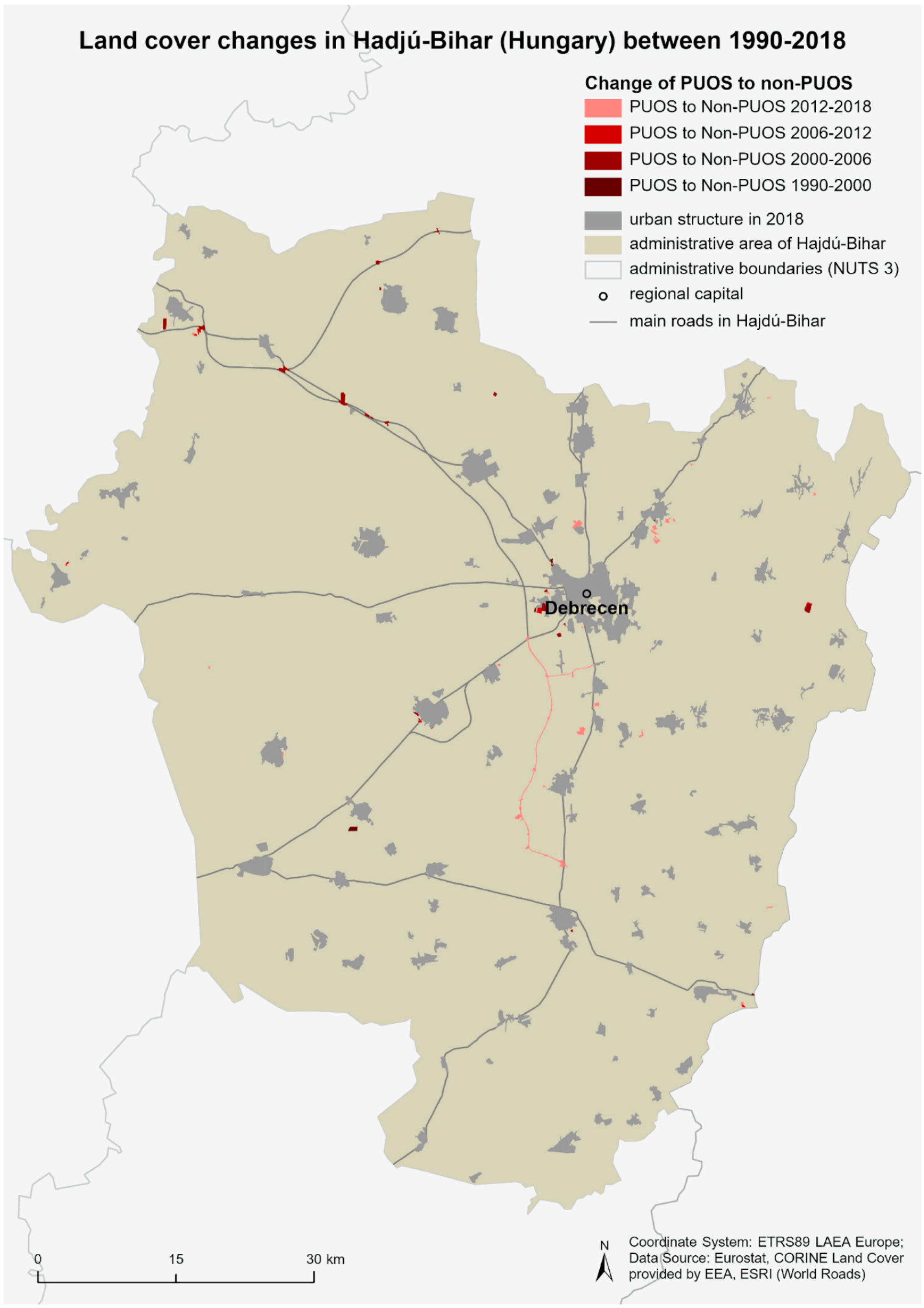


**Fig. 3A.** Land cover changes of PUOS to non-PUOS in Hadjú-Bihar (Hungary) between 1990 and 2018.

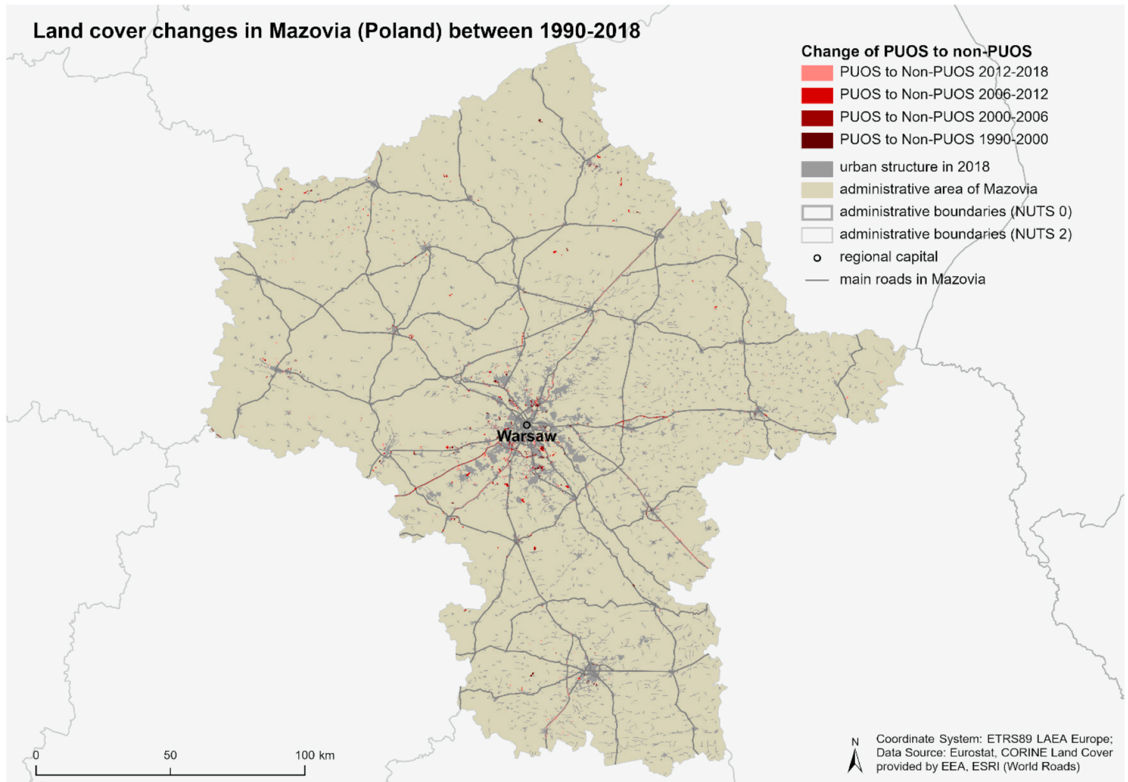


**Fig. 4A.** Land cover changes of PUOS to non-PUOS in Mazovia (Poland) between 1990 and 2018.

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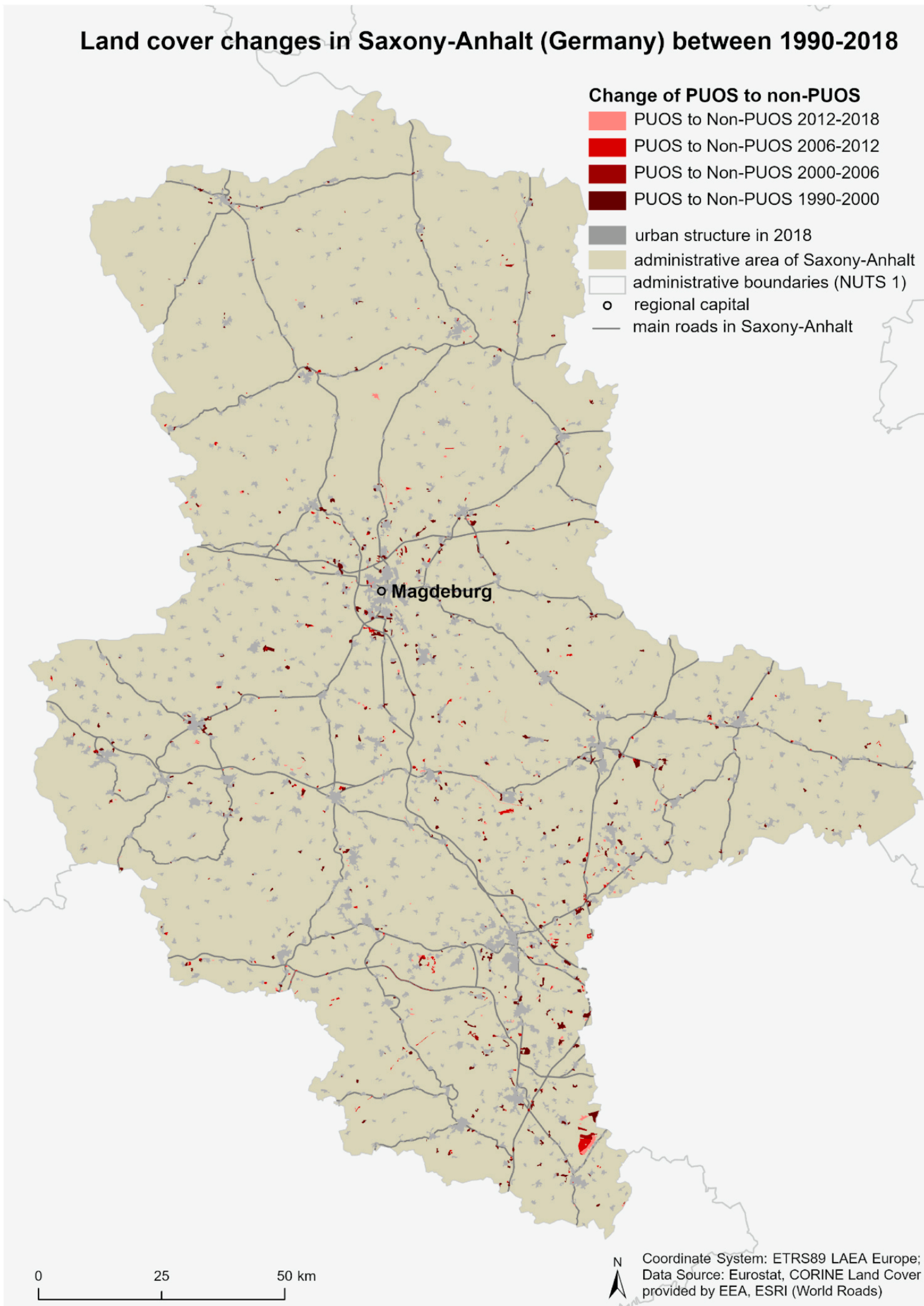


**Fig. 5A.** Land cover changes of PUOS to non-PUOS in Saxony-Anhalt (Germany) between 1990 and 2018.

**Table 1A**
Questions of explorative questionnaire.

| |
|---|
| Name of the case study |
| Geographical location (country) |
| Name of the region |
| Name of the organisation responsible for the regional governance |
| Name of the policy instrument |
| Please describe the main features of this policy instrument (e.g. objective, characteristics, priority or measure concerned) and the reason(s) why it should be improved? |
| Is this policy instrument related to the national or regional Structural Funds operational programme (ERDF/ESF)? |
| How do you envisage the improvement of this policy instrument (e.g. through new projects supported, through improved governance, through structural change)? |
| What is the geographical coverage of this policy instrument?1/ local; 2/ regional; 3/ national; 4/ cross-border; 5/ transnational |
| What is the state of play of the issue addressed by this policy instrument in the territory? What needs to be improved in the territorial situation? |

**Table 2A**
List of thematic sessions for the semi-quantitative survey of potential governance approaches to improve the protection of PUOS.

| No. | Place and time | Title of the session | Name of the conference |
|---|---|---|---|
| 1 | Bern, Switzerland, April 2019 | Governance of natural heritage in peri-urban open spaces | Open Science Meeting of the Global Land Programme |
| 2 | Milano, Italy, July 2019 | Towards visionary peri-urban landscapes? Environmental governance mixes for sustainable peri-urbanisation | International Association of Landscape Ecology World Congress |
| 3 | Lublin, Poland, September 2019 | Towards the better understanding of land-use conflicts in rural, remote and peripheral areas | Regional Studies Conference of Central and Eastern Europe |
| 4 | Hanover, Germany, October 2019 | "Governance approaches for ecosystem services in urban and peri-urban open spaces" | Ecosystem Services Partnership World Conference |

**Table 3A**
Flanders, Belgium.

| | |
|---|---|
| Geographical location (country) | Belgium |
| Name of the region | Flanders |
| Name of the organisation responsible for the regional governance | Flemish Land Agency |
| Name of the policy instrument | Section 5 on the Act of Land Development (28 March 2014 – published in Belgian Official Gazette 22 August 2014) concerning reparcelling by virtue of law with zoning exchange |
| Please describe the main features of this policy instrument (e.g. objective, characteristics, priority or measure concerned) and the reason(s) why it should be improved | the actual rules in the Act of Land Development foresees different public consultations, procedure rules (different steps, plans of real estate exchange, spatial implementation plans, advisory bodies) defined in Section 5 of the Act, that aren't flexible, but are time consuming. To improve this, a new smother approach is needed in implementation of the policy instrument. In a shorter time period Flemish Land Agency (VLM) needs to develop effective solutions, to reorganise PUAs and keep them open, to exchange zoning, to adapt to climate change, to develop green-blue corridors, to develop sustainable business areas on the scarce space etc. This could be implemented through the exchange of land property and land use and reparcelling plots in PUAs combined with an exchange of designated uses determined in zoning plans (= Flemish destination plans). This can be realised by refurbishing the current legislation (make procedures shorter, easier, more flexible), to apply the system of accountable tradeable development rights and integrate it into Section 5 of the addressed policy instrument. With these rights VLM will have the possibility to negotiate with all involved land users and real estate owners to reach a short time span solutions concerning to the reparceling with zoning exchange. The project should lead to the right policy recommendations for a more efficient implementation in exchange of real estate and for renewed, more sustainable land use zoning. |
| Is this policy instrument related to the national or regional Structural Funds operational programme (ERDF/ESF)? | no |
| How do you envisage the improvement of this policy instrument (e.g. through new projects supported, through improved governance, through structural change)? | VLM wants to formulate an answer for a more efficient use of the limited space. The objective is related to a smarter and more balanced functional use of PUOS by accelerating the exchange of use in the context of supported by law reparceling operation. VLM wants to implement the participative governance approaches (including all members of the stakeholders group) to increase the awareness of the peri-urban open spaces for the natural heritage. VLM also aims to solve challenges in peri-urban poorly-based legal zoning plans, e.g. wrong designed land use zones according to their potential to adopt to climate change Specifically saying through multi-stakeholder participatory governance approaches VLM wants to provide change related to:<br>– Introducing mechanisms/tools for a smooth facilitation of zoning exchange (change destination of space e.g. into more green/blue zones; green = destination is nature, blue = create flooding areas to mitigate to climate change). Change wrong designated areas into others e.g. to avoid floods, to adapt to climate change) and to motivate private governance actors to support the need of spatial interventions<br>– Introducing a methodology for valuing the real estate for users and owners (e.g. for a smooth exchange of property values) so private governance actors are supportive of the policy intentions<br>– Developing the action plan for phase 2<br>2 case study areas, are defined in RENATUR to experiment with the improved tools during the Phase 2. |
| What is the geographical coverage of this policy instrument?<br>1/ local; 2/ regional; 3/ national; 4/ cross-border; 5/ transnational | regional |

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**Table 3A** (*continued*)

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| What is the state of play of the issue addressed by this policy instrument in the territory? What needs to be improved in the territorial situation? | The realisation of more green, green-blue infrastructure and the improvement of the environment through the more efficient use of the limited space is an ongoing challenge in peri-urban area in Flanders. The objective is to have a better and more balanced use of peri-urban areas and to create a more livable peri-urban and urban environment. This approach is only possible if we support status quo between built-up and open spaces by mains of land policies and legal instruments.Sometimes governments have to deal with conflicting or competing objectives at different planning levels, for example owners of land in peri-urban areas want to have building permits and to build houses in flooding areas (due to climate change). Right tools (to exchange property, to value the real estate, etc.) need to solve several regulatory obstacles (e.g. land use zoning) and conflicting interests (e.g. area to build or to store water during heavy rainfall). These obstacles must be eliminated through the tool reparcelling by law what is further integrated into the procedure for drawing up spatial implementation. Through bridging the gap between the technical expertise concerning reparceling by law (= land readjustment) and spatial planning practice (=zoning) for the implementation of these spatial plans into practice, the conflicts will be solved. Also, the project will deliver better balanced land-use zoning to adapt to climate change and other pressures on scarce land resources. To realise that VLM needs to exchange land property and land use by developing a system of tradeable rights (= valuing real estate). The project will subsequently lead to implementation issues which are to be tackled in shifting spatial governance context in the involved peri-urban areas in Flanders and especially in the peri-urban area of the Province Antwerp where the battle for peri-urban open spaces is the most significant and relates to housing, agriculture, recreation, business development. |
| Saxony-Anhalt, Germany. | |
| Geographical location (country) | **Germany** |
| Name of the region | Saxony-Anhalt |
| Name of the organisation responsible for the regional governance | Ministry for Regional Development and Transport of Saxony-Anhalt |
| Name of the policy instrument | ERDF OP Saxony-Anhalt 2014 – 2020, Priority 4 Preserving and protecting the environment and promoting resource efficiency, Investment priority 6e, Specific objective 11: Reducing the soil sealing of cities through stimulation of inner urban development and redevelopment of brownfields |
| Please describe the main features of this policy instrument (e.g. objective, characteristics, priority or measure concerned) and the reason(s) why it should be improved | Overall aim of specific objective 11, ERDF OP Saxony-Anhalt 2014 – 2020, is the reduction of soil sealing with the main focus of cities. With the compensation of urban deficits new land occupation should be avoid. Thus, the focus is on promotion of inner urban development and revitalisation of brownfields. The population density of Saxony-Anhalt is 109 persons per km$^2$, whereas the average of Germany is about 231 persons per km$^2$. At first glance, the threat of urban sprawl in Saxony-Anhalt seems to be negligible. Nevertheless, land-use conflicts are also noticeably increasing. Functions like housing, commercial use, agriculture, energy production, exploitation of raw materials as well as the required infrastructure compete for land.Especially peri-urban areas of bigger cities in Saxon-Anhalt are affected by an intensive urban pressure. It can be assumed, that also smaller cities with a good education infrastructure and affordable housing will benefit from the crowding-out processes of bigger cities in the future. Migration for education, immigration and rural-urban migration will increase the population of these cities and their adjacent areas.To view the problem of soil sealing in its entirety, a more holistic approach is necessary. Certainly, inner urban development and revitalisation of brownfields are important instruments, but to avoid urban sprawl and increasing land-use, an early setting of political and planning co-operation beyond administrative borders are needed. |
| Is this policy instrument related to the national or regional Structural Funds operational programme (ERDF/ESF)? | yes |
| How do you envisage the improvement of this policy instrument (e.g. through new projects supported, through improved governance, through structural change)? | The specific objective 11 of the ERDF OP of Saxony-Anhalt 2014 – 2020 targets the reduction of soil sealing. The programme focuses on inner urban development, which means promotion of densification and compact settlement structures as well as re-use of brownfields. For the reduction of soil sealing and protection of open spaces a sustainable and holistic approach, also in the wider context of peri-urban functional areas, is needed. For a successful reduction of land-use the functional interdependency of the main cities with the urban hinterland should take into account.Furthermore, the ERDF OP is one of the most important funding sources for regional development. In connection with the revision of the Regional Development Plan of Saxony-Anhalt in the next years, there is the opportunity to coordinate and combine the planning objectives directly to the funding objectives. The exchange within the partnership will contribute to collect new ideas for planning instruments at local and regional level and governance structures in the context of dealing with land-use conflicts and preservation of peri-urban open spaces. At regional level the partner will cooperate with different key actors of the study region and planning system to get a better understanding of local problems, existing cooperation between cities and their urban hinterland and current obstacles that hinder the reduction of soil sealing and the long-term protection of open space. |
| What is the geographical coverage of this policy instrument? | regional |
| 1/ local; 2/ regional; 3/ national; 4/ cross-border; 5/ transnational | |
| What is the state of play of the issue addressed by this policy instrument in the territory? What needs to be improved in the territorial situation? | Currently the policy instrument is focused on the inner-city development and revitalisation of brownfields, whereas the functional areas around the cities are neglected. For a sustainable and long-term development of cities and their urban hinterland strategic approaches and government structures beyond administrative borders are needed, especially in the context of the protection of peri-urban open spaces.Growing population and low interest rates as well as missing alternative financial investments foster the construction activities and investments in “concrete gold”, whereas the open space has no well-financed lobby.As a consequence, planning instruments and the sensitisation of key actors and population must be particularly strong to protect peri-urban open spaces. To strengthen the peri-urban open spaces, different planning levels and interests must be brought to together. With the help of legal planning instruments and appropriate governance structure in connection with a better understanding |

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**Table 3A** (*continued*)

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| | of the functions and importance of open spaces, negative impacts on the peri-urban open spaces can be mitigated. |
| Hajdú-Bihar, Hungary | |
| Geographical location (country) | **Hungary** |
| Name of the region | Hajdú-Bihar |
| Name of the organisation responsible for the regional governance | Hajdú-Bihar County Government |
| Name of the policy instrument | Regional Development Programme of Hajdú-Bihar County 2014–2020 |
| Please describe the main features of this policy instrument (e.g. objective, characteristics, priority or measure concerned) and the reason(s) why it should be improved | The Regional Development Programme of Hajdú-Bihar County for 2014–2020 integrates the strategic goals of the county at both sectoral and territorial levels. The objectives of the programme include 8 priorities; within this project we plan to address Priority 1: Sustainable environment focusing on Measure 1.2: Conservation of natural and landscape values of the county. Due to the significant loss of biodiversity and the decrease of natural areas the importance of landscapes clearly strengthens. There is a strong need to create an adequate ecological perspective concerning both policy makers and the wider community. The policy instrument encourages the development of Nature 2000 and other natural areas applying an integrated landscape management approach with specific focus on biodiversity and the sustainability of ecosystems. It is also an essential objective to ensure an attracting and safe livelihood for citizens considering climate adaptation.The main aim of the policy instrument is clear, but an improved structural background is required with an appropriate approach, enhanced capacity and the potential to integrate enhanced governance of ecosystem services to conserve biodiversity. New methodologies to efficiently implement the preservation and maintenance tasks are also needed. |
| Is this policy instrument related to the national or regional Structural Funds operational programme (ERDF/ESF)? | no |
| How do you envisage the improvement of this policy instrument (e.g. through new projects supported, through improved governance, through structural change)? | We plan to improve the selected policy instrument through improved governance (as type 2 suggested by Interreg Europe). Based on new aspects, fresh ideas and solutions originating from lessons learnt at/from other partners, we try to find applicable and long-term sustainable methods in the management/governance of peri-urban open spaces when creating and enhance a supportive governmental/policy environment. We also plan to develop/gain an appropriate methodology to monitor and evaluate the efficiency and sustainability of the above-mentioned solutions within the county.Implementing the project in Hajdú-Bihar County will have a potential impact on different sectors; the proper design and interpretation of respective potential brought by the ecosystem services to social and economic assets enable to achieve and generate added value in the form of strengthened and enhanced institutional and territorial capacity. There is a strong need for the integrated and harmonised development of respective peri-urban areas with potential through the preservation of natural heritage. |
| What is the geographical coverage of this policy instrument?<br>1/ local; 2/ regional; 3/ national; 4/ cross-border; 5/ transnational | regional |
| What is the state of play of the issue addressed by this policy instrument in the territory? What needs to be improved in the territorial situation? | The natural and landscape values of the county are diverse and colourful. There are ecological networks of special importance; natural areas, ecological corridors, protected landscape areas mean significant natural resources. Besides, agricultural and other economic production activities are also essential for the quality life of citizens; to preserve natural values, brownfield investments are preferred instead of greenfield ones, but huge peri-urban areas have been selected to serve as the location for new industrial parks.Considering the significance of ecological objectives, there is a strong need to focus on the governance of ecosystem services to conserve biodiversity; the peri-urban ecosystems of Hajdú-Bihar county can provide different services related to reducing the impacts of climate change, air/water purification, waste management, food security serving environmental and social purposes at the same time. The county needs a better coordination of natural, social, cultural and institutional resources and capacities built on appropriate participatory processes; moreover, it is important to find proper answer on how to help policy makers to integrate knowledge into decision making process. |
| Mazovia, Poland | |
| Geographical location (country) | Poland |
| Name of the region | Mazovia |
| Name of the organisation responsible for the regional governance | The Office of the Marshal of the Mazowieckie, Voivodeship in Warsaw |
| Name of the policy instrument | Regional Operational Programme Of The Mazowieckie Voivodeship 2014–2020 (RPO Mazovia) |
| Please describe the main features of this policy instrument (e.g. objective, characteristics, priority or measure concerned) and the reason(s) why it should be improved | RPO Mazovia 2014–2020 is a programme implemented at the regional level in support of the implementation of cohesion policy from the European Union funds for the years 2014–2020. Within the framework of the programme it is possible to obtain co-financing for the projects supported by the European Regional Development Fund (ERDF) and the projects for human resources, supported by the European Social Fund (ESF). High quality of life has been selected as a one of four Smart Specialisations of Mazovia. It refers to one of the aims of RIS Mazovia and statues the areas with the greatest development potential.Mazovia, as the only voivodeship in Poland, has been classified as a "transition region" – a more developed one in relation to other regions of the country, primarily due to the influence of Warsaw. However, it still has a number of areas struggling with serious structural problems. Currently in RPO Mazovia there is a lack of proper governance approaches to address the issues related to the protection of natural heritage of peri-urban open spaces. ROP Mazovia is primarily focused on urban renewal programmes. Participation in the project should contribute to creation of mechanisms and patterns of management of peri-urban areas and should result in a change in the strategic focus of the policy instrument for the new programming period. |
| Is this policy instrument related to the national or regional Structural Funds operational programme (ERDF/ESF)? | yes |
| How do you envisage the improvement of this policy instrument (e.g. through new projects supported, through improved governance, through structural change)? | The improvement of RPO Mazovia 2014–2020 is envisaged through a new project that will ensure the support to the regional programme by dedicated research and series of |

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| | participatory activities in order to create a mechanism for protection of natural heritage of peri-urban open spaces (PUOS). Peri-urban areas (PUAs) in Mazovia emerge in the vicinity of the biggest cities, such as Warsaw, and also around sub-regional urban centres and smaller towns. Many activities undertaken in PUAs are endangering the spatial cohesion and fostering local environmental conflicts. Therefore, the project will promote methods to deal with the integrated management of similar kinds of areas located in other regions in Europe. These methods will include tools for maintenance and rehabilitation of closely linked natural and cultural heritage and landscape in the peri-urban zone, in a manner similar to the urban renewal programmes. Governance tools will be described and proposed to include in the ROP Mazovia and in other policy instruments. One of the major advantages of the project, due to its participatory approach, will be the envisaged strengthening of the territorial aspect related to the influence of ROP Mazovia on local communities. |
| What is the geographical coverage of this policy instrument? 1/ local; 2/ regional; 3/ national; 4/ cross-border; 5/ transnational | regional |
| What is the state of play of the issue addressed by this policy instrument in the territory? What needs to be improved in the territorial situation? | The territorial situation in the peri-urban areas of Mazovia is typical for the zone of environmental conflicts between the traditional small-scale and big-scale farming, individual and collective housing, industrial and commercial investments, development of new transport networks, natural and cultural environment. Typical problems in peri-urban open spaces (PUOS) include: penetration of new housing into the nature protection areas, overlapping of conservation and cultural protection, adjoining old industrial areas within the cities. Some examples of challenges are: penetration of housing constructions into the Kampinoski National Park buffer zone, degradation of natural systems typical for small-scale agriculture in the region (watercourses, margins, woodlands, shrubs) or related to the heritage of the Central Vistula Valley.This is accompanied by the problem of the perception of city-village boundaries, the emergence of identity and social conflicts. Investors and developers endanger the natural heritage of PUOS by fostering conflicts with their inhabitants and users and by damaging the quality of air and soil. It occurs both in the Warsaw agglomeration and in the sub regional area (NUTS3). Also attempts to interfere in the heritage of the Vistula River, as the last wild river in Europe almost entirely covered by the Natura 2000 programme, brings conflicts between investors and environmentalists. The aim of actions to be implemented in the ROP Mazovia should be therefore to preserve the natural landscape, to protect the system of ecological linkages, to restore spatial order, to clarify the boundaries between the city and the village, and - where possible – to introduce solutions that will prevent environmental conflicts. All this is possible thanks to broad participation and creation of social awareness and business responsibility of local stakeholders (e.g. authorities and managers). |
| Kranj, Slovenia | |
| Geographical location (country) | Slovenia |
| Name of the region | Kranj |
| Name of the organisation responsible for the regional governance | Government Office for Development and European Cohesion Policy, Cohesion Policy Department |
| Name of the policy instrument | Operational programme for Implementation of Cohesion policy 2014–2020 |
| Please describe the main features of this policy instrument (e.g. objective, characteristics, priority or measure concerned) and the reason(s) why it should be improved | The National operational programme for 2014–2020 integrates the strategic goals of the Slovenia at both sectoral and territorial levels. The project will address priority 9: “Social inclusion and reducing the risk of poverty” with sub priority: 9.7.“Investment in the framework of the strategy of local development, led by community_ Community led development”. The specific goal within the priority is “Better economic and social inclusion of society in the areas of Local action groups”; with measure: “protection and improvement of environment (including natural heritage and landscape)”, which is the strategic topic.Due to the significant loss of biodiversity and the decrease of natural areas, the importance of open spaces in PUAs of the major cities is an important development challenge. Additionally, biodiversity in urban settlements and PUAs should become the value (among diverse stakeholders) and its value for development of the areas should be increased and recognised from the planning, biodiversity, working places, climate change points of view. Especially we see that protection of the biodiversity in peri-urban open spaces can contribute to the preservation of the Natura 2000 areas, which are already overcrowded with visitors. |
| Is this policy instrument related to the national or regional Structural Funds operational programme (ERDF/ESF)? | yes |
| How do you envisage the improvement of this policy instrument (e.g. through new projects supported, through improved governance, through structural change)? | We plan to improve the selected policy instrument. We will build on exchange of ideas; practices and we will upgrade the approaches for settlements and peri-urban areas having in mind the needs of the natural heritage protection. There is a strong need for strategic and harmonised development of peri-urban settlements and peri-urban areas with the main emphasis on preservation of biodiversity, new approaches in planning. We will improve the policy through new projects developed, improved governance and we will prepare the proposal for policy changes (in the context of the coming programming period 2021–2027). |
| What is the geographical coverage of this policy instrument? 1/ local; 2/ regional; 3/ national; 4/ cross-border; 5/ transnational | national |
| What is the state of play of the issue addressed by this policy instrument in the territory? What needs to be improved in the territorial situation? | The natural and landscape values of the region Gorenjska Region, as well as the whole country, are very diverse. In the region we have almost 50% of Natura 2000. Moreover the land cover of the region is characterised by over 60% of forests.Thus peri-urban areas peri-urban open spaces and new emerging peri-urban settlements are becoming important from the point of biodiversity protection, quality life of local citizens, and overlay saying the future sustainable development of the region.Peri-urban open spaces (PUAs) in Gorenjska Region can become green lung of the area and will empower citizens and visitors with knowledge about biodiversity. Additionally, it will contribute to the decreasing the amount of visitors in Natura 2000, using PUAs settlements as the recreational and other purposes (e.g. educational). Also green areas will contribute to protection of fertile land - in the surroundings of the settlements (prevent - spreading of settlements on the fertile land). Additionally new open spaces will be |

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**Table 3A** (*continued*)

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| | the added value for visitors from bigger cities in the region and they will serve as green lungs of the region.To tackle that challenges we need to have harmonised strategic approaches and solutions, especially from the point of policy level and decision making processes. So far biodiversity in settlements were not tackled at all by policy level, there is also lack of understanding of importance of the approaches, possibilities. |
| Basque Country, Spain | |
| Geographical location (country) | **Spain** |
| Name of the region | Basque Country |
| Name of the organisation responsible for the regional governance | Directorate for Economy and Planification, REGIONAL GOVERNMENT OF PAIS VASCO |
| Name of the policy instrument | Basque Country ERDF Regional Operational Programme 2014–2020 |
| Please describe the main features of this policy instrument (e.g. objective, characteristics, priority or measure concerned) and the reason(s) why it should be improved | among the six investment priorities of addressed policy instrument (BC-ERDF) is Priority 06: Preserving & protecting the environment, and promoting resource efficiency, Specific Objective 6.4.1: promote management, protection and maintenance of natural habitats and their biodiversity (BD), in particular in protected ones). We assume that the BD has to be managed in the relation to the whole region and special focus has to be on peri-urban open spaces (PUOS) of bigger cities. Thus, there is a need for a new and innovative way of holistic governance which introduces the ES concept and BD through a good design of Green Infrastructure (GI). The aim of the revision of Bilbao Metropolitan Partial Territorial Plan (BMPTP) is to address those issues. The BMPTP is binding for the planning of the 35 town-holds that are included in the Bilbao Metropolitan area (nearly a million inhabitants, 2000 inhab/km2), characterised with continuous pressure on PUOS due to rapid urbanisation and intensive growth of industrial sites. The BMPTP represents the guiding document to define measures to be implemented with funding out of the operational programme (BC-ERDF). Improvement of BMPTP, as an result of RENATUR implementation, will cause a significant improvement of the selection of measures in the BC-ERDF and thus improve the governance of the operational programme.Thus, the measures developed in RENATUR will be very much in accordance with the BC-ERDF, in the investment priority is P.I.6.4. (IP6d). |
| Is this policy instrument related to the national or regional Structural Funds operational programme (ERDF/ESF)? | yes |
| How do you envisage the improvement of this policy instrument (e.g. through new projects supported, through improved governance, through structural change)? | The current revision of the Regional Planning Guidelines (DOT, the general reference framework for all the territorial policy instruments) incorporates new guidelines in relation to biodiversity, ES and GI. Thus, there is a need to develop a new methodology to incorporate these new aspects in the territorial management and improve the addressed BC-ERDF.Through the BMPTP revision, in the frame of early setting of political and planning, an improved policy instrument suitable to protect natural heritage of PUOS will be created. This policy will support to improve the regional governance of PUOS and will help to tackle better the pressure on PUOS to maintain and improve the regional natural heritage (BD, ES, improve natural ecosystems connectivity, citizens perception of natural heritage) through the better introduction of GI concept in regional policy instruments. All will improve the governance of the BC-ERDF. For example: Natural heritage could be taken into account in an innovative way when developing plans in the territory, in this way recognising the ES that these open spaces provide to the local citizens. Moreover, the new governance will open a new scope of opportunities in relation to growth and jobs related to the improvement of the natural heritage.There is not much experience on the inclusion of these new structures in the planning so the collaboration with other European partners is essential, and it will help us to address new ideas and design new instruments. |
| What is the geographical coverage of this policy instrument?<br>1/ local; 2/ regional; 3/ national; 4/ cross-border; 5/ transnational | regional |
| What is the state of play of the issue addressed by this policy instrument in the territory? What needs to be improved in the territorial situation? | The Region of Pais Vasco has highly populated sites where there has been a high impact on natural heritage. The new DOTs will improve the natural heritage situation having included now the ES and GI. Thus, there is currently a need to address the new opportunity of governance. Nevertheless, there is a lack of knowledge on how to include the ES and GI in the plans, so the RENATUR project is an innovative way of doing it.The opportunity to work at the scale of the BMPTP is a good way to start to improve the policy instrument. When the BMPTP approved in 2006 there was another economical situation (economical crisis started 2008). Under that BMPTP, the PUOS were facing a high pressure for urbanisation and industrial sites. The new environmental legislation approved since then, such as the Environ Impact Assess (Decreto 211/2012 Basque Government & Ley 21/2013 at State Level), in relation to Landscape conservation (Decreto 90/2014 of Protection, and landscape management), and the initial approval of the DOT, has led to the revision of the BMPTP. These changes will also affect in the near future other regional partial territorial plans.Currently the importance of the natural heritage and ES into citizenś well-being is wildly recognised and request the effective introduction of GI in the regional planning in order to improve the quality of life of the local citizens. This affects not only the future planning of town-holds that are the institutions that really develop the BMPTP at local level, but also all the Pais Vasco Region partial territorial plans and their town-holds.The increment in habitat fragmentation and urbanisation, plus the loss of BD and ES has led to the loss of citizenś wellbeing. The revision of the BMPTP under the new methodology, developed in this project RENATUR, will be the beginning for the recognition of the contribution of natural heritage through its ES and BD to human well-being and, the improvement of the regional territorial situation. |

**Table 4A**
analysis of answers from the qualitative survey with the regional policy makers.

| Country | Region | NOW - How the PI is discussing protection of PUOS? | FUTURE - What kind of changes related to better protection of PUOS are proposed? | FUTURE - How can the proposed changes be implemented? | Proposed policy improvements |
|---|---|---|---|---|---|
| | **Policy instruments focus on PUOS** | | | | |
| **Spain** | Basque Country | Under that existing PI, the PUOS were facing a high pressure for **urbanisation and industrial site**The increment in habitat fragmentation and **urbanisation**, plus the loss of BD and **ES** has led to the **loss of citizen's wellbeing.**The BMPTP is binding for the planning of the 35 town-holds that are included in the Bilbao Metropolitan area (nearly a million inhabitants, 2000 inhab/km2), characterised with continuous pressure on PUOS due to **rapid urbanisation and intensive growth of industrial sites.** | This policy will support to improve the regional governance of PUOS and will help to tackle better the **pressure on PUOS** to maintain and improve the regional natural heritage (**BD**, **ES**, improve natural ecosystems connectivity, citizens perception of natural heritage) through the better introduction of GI concept in regional policy instruments.It should be recognised that peri-urban open spaces provide **ecosystem services** for the citizens | Revision and improvement of Bilbao Metropolitan Partial Territorial Plan (BMPTP) including new guidelines in relation to **biodiversity, ES** and GINatural heritage could be taken into account in an **innovative** way when developing plans in the territory. The whole area has to be managed as a whole with special focus on PUOs of bigger cities.Good design of **Green Infrastructures (GI)** | **1) Expanding the awareness of ES concept in different governance actors groups** |
| **Belgium** | | Sometimes governments have to deal with conflicting or competing objectives at different planning levels, for example owners of land in **peri-urban areas** want to have building permits and to build houses in flooding areas (due to **climate change**)The project will subsequently lead to implementation issues which are to be tackled in shifting spatial governance context in the involved peri-urban areas in Flanders and especially in the peri-urban area of the Province Antwerp where the battle for **peri-urban open spaces** is the most significant and relates to housing, agriculture, recreation, business development. | In a shorter time period Flemish Land Agency (VLM) needs to develop effective solutions, to reorganise PUAs and keep them open, to **exchange zoning**, to adapt to **climate change**, to **develop green-blue corridor**s, to develop **sustainable business area**s on the scarce space etc. Change wrong destination areas into others e.g. to avoid floods, to adapt to **climate change**) and to motivate private governance actors to support the need of spatial intervention. The objective is to have a better and **more balanced use** of **peri-urban areas** and to create a more livable peri-urban and urban environment. | This approach is only possible if we support status quo between **built-up** and **open space**s by mains of land policies and legal instruments. Obstacles must be eliminated through the tool **reparcelling** by law what is further integrated into the procedure for drawing up spatial implementation. Objectives could be implemented through the exchange of land property and land use and **reparcelling plots** in PUAs combined with an exchange of designated uses determined in **zoning plans** (= Flemish destination plans). | **1) Reparcelling plots;2) Changing land use zones designated in plans, specifically applicable for wrongly designated zones;3) Developing green - blue corridors and sustainable business areas** |
| **Slovenia** | **Gorenjska** | Due to the significant **loss of biodiversity** and the **decrease of natural areas**, the importance of open spaces in PUAs of the major cities is an important development challenge. Also green areas will contribute to **protection of fertile land** - in the surroundings of the settlements (prevent - spreading of settlements on the fertile land). | **Biodiversity** in urban settlements and PUAs should become the value (among diverse stakeholders) and its value for development of the areas should be increased and recognised from the planning, biodiversity, working places, climate change points of view. Peri-urban open spaces (PUAs) in Gorenjska Region can become **green lung** of the area and will empower citizens and visitors with **knowledge about biodiversity**. Additionally it will contribute to the decreasing the amount of visitors in Natura 2000, using PUAs settlements as the recreational and other purposes (e.g. educational) | There is a strong need for strategic and harmonised development of peri-urban settlements and peri-urban areas with the main emphasis on **preservation of biodiversity**, new approaches in planning. To tackle that challenges we need to have **harmonised strategic approaches** and solutions, especially from the point of policy level and decision making processes. So far biodiversity in settlements were not tackled at all by policy level, there is also **lack of understanding** of importance of the approaches, possibilities. | **1) Harmonised strategic approaches at policy level;2) Increase the awareness of local governance actors about PU and biodiversity** |
| **Hungary** | **Hadju-Bihar** | Due to the significant **loss of biodiversity** and the decrease of natural areas the importance of landscapes clearly strengthens. Brownfield investments are preferred instead of greenfield ones, but huge periurban areas have been selected to serve as the location for **new industrial parks**the peri-urban ecosystems of Hajdú-Bihar county can provide different **services** related to reducing the impacts of **climate change**, air/ water purification, waste | The policy instrument **encourages the development of Nature 2000** and other natural areas applying an integrated landscape management approach with specific focus on **biodiversity** and the sustainability of ecosystems. It is also an essential objective to ensure an attracting and safe livelihood for citizens considering **climate adaptation.** Considering the significance of ecological | Based on new aspects, fresh ideas and solutions originating from lessons learnt at/from other partners, we try to find applicable and **long-term sustainable methods** in the management/ governance of periurban open spaces when creating and enhance a supportive governmental/policy environment. | **1) Long-term sustainable governance methods based on the supportive and governance environment;2) Inclusion of the ecosystem services concept in the binding governance documents;3) Encouraging the development of Natura 2000 areas and other similar areas** |

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**Table 4A** (*continued*)

| Country | Region | NOW - How the PI is discussing protection of PUOS? | FUTURE - What kind of changes related to better protection of PUOS are proposed? | FUTURE - How can the proposed changes be implemented? | Proposed policy improvements |
|---|---|---|---|---|---|
| | Policy instruments focus on PUOS | | | | |
| | | management, food security serving environmental and social purposes at the same time | objectives, there is a strong need to focus on the governance of **ecosystem services** to conserve **biodiversity** | | |
| **Poland** | **Mazovia** | Currently in RPO Mazovia there is a lack of proper governance approaches to address the issues related to the protection of natural heritage of **peri-urban open spaces.** Many activities undertaken in PUAs are endangering the spatial cohesion and fostering local environmantal conflicts. The territorial situation in the peri-urban areas of Mazovia is typical for the zone of environmantal conflicts between the traditional small-scale and big-scale farming, individual and collective housing, industrial and commercial investments, development of new transport networks, natural and cultural environment. Investors and developers endanger the natural heritage of PUOS by fostering conflicts with their inhabitants and users and by damaging the **quality of air and soil.** | The aim of actions to be implemented in the ROP Mazovia should be therefore to **preserve the natural landscape, to protect the system of ecological linkages**, to restore spatial order, **to clarify the boundaries between the city and the village**, and - where possible – to introduce solutions that will prevent environmental conflicts. | The project will promote methods to deal with the integrated management of similar kinds of areas located in other regions in Europe. These methods will include **tools for maintenance** and **rehabilitation** of closely linked natural and cultural heritage and landscape in the peri-urban zone, | **1) Tools for maintenance and rehabilitation of cultural and natural heritage;2) To clarify the boundaries between cities and villages;** |
| **Germany** | **Saxony-Anhalt** | Functions like **housing, commercial use**, agriculture, energy production, exploitation of raw materials as well as the required infrastructure compete for land.Especially peri-urban areas of bigger cities in Saxon-Anhalt are affected by an **intensive urban pressure**Growing population (enhanced by **migration**) and low interest rates as well as missing alternative financial investments foster the construction activities and investments in “concrete gold”, whereas the open space has no well-financed lobby. | The programme focuses on inner urban development, which means **promotion of densification** and **compact settlement structures** as well as **re-use of brown-fields**. At regional level the partner will cooperate with different key actors of the study region and planning system to get a better understanding of local problems, existing cooperation between cities and their urban hinterland and current obstacles that hinder the reduction of **soil sealing** and the long-term protection of open space. | For the **reduction of soil sealing** and protection of open spaces a sustainable and holistic approach, also in the wider context of peri-urban functional areas, is needed. For a successful reduction of land-use the **functional interdependency** of the main cities with the urban hinterland should take into account.To strengthen the peri-open spaces, **different planning levels and interests must be brought together**. With the help of **legal planning instruments** and appropriate governance structure in connection with a better understanding of the functions and importance of open spaces, negative impacts on the PUOs can be mitigated | **1) Promotion of densification and compact settlement structures;2) Re-use of brown-fields;3) Multi-level and adaptive governance** |

**Abbrevations:** BD - biodiversity, ES - ecosystem services, GI - green infrastructure, PU - peri-urbanisation, PUOS - peri-urban open spaces,

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# XII

Spyra, M., & Hamerla, A. (2021). Bicycle Accessibility to Cultural Ecosystem Services in a Cross-Boundary Landscape. In D. La Rosa & R. Privitera (Eds.), Lecture Notes in Civil Engineering Innovation in Urban and Regional Planning (Vol. 1, pp. 91–99),
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# Bicycle Accessibility to Cultural Ecosystem Services in a Cross-Boundary Landscape

**Marcin Spyra and Adam Hamerla**

**Abstract** In our research we focus on the bicycle accessibility to cultural ecosystem services areas (CES), located in the cross-boundary landscape. As a case study we selected the part of the cross-boundary landscape of Upper Silesia located between Poland and the Czech Republic, Europe. We designed a spatially explicit methodology, which allows us to analyze the accessibility between CES benefitting areas (urban fabric) and CES providing areas (Natura 2000 areas). The results show unequal distribution of CES providing areas in the analyzed landscape. We classified CES benefitting areas according to their accessibility to CES providing areas. We delimitated CES providing areas, which have a potential for better accessibility to CES benefitting areas. To delimitate the missing cross-boundary links between CES providing and benefitting areas, particular attention was given to the aspect of the national boundary. Our findings can inform planning and governance in the analyzed cross-boundary landscape. These findings support delimitation of the missing links between CES providing and benefitting areas. By analyzing the amount of such links, this study can support sustainability of different kinds of landscapes and inhabitants' well-being.

**Keywords** Cultural ecosystem services · Ecosystem services benefitting areas · Ecosystem services providing areas · Accessibility · Cross-boundary · Landscapes · Bicycles

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# 1 Introduction

Cultural Ecosystem Services (CES) are easy recognizable and directly appreciated by people. Among other classes of CES, entertainment CES (according to CICES V4.3 classification) plays an important role as a constituent of inhabitant well-being. Similarly, regarding the definition of ecosystem services (ES) providing and benefiting areas, the CES providing area (SPA) is the spatial unit that is able to provide various types of CES. On the other hand, the CES benefiting area (SBA) is the spatial unit that in general serves as an absorber of CES, meaning that it is benefitting from CES produced in another location (Syrbe and Walz 2012). The delimitation of SBA and SPA and the spatial linkage between these areas is the basis for discussing the flow between them (Palomo et al. 2012) and the accessibility aspects between such areas.

Accessibility is a basic indicator that shows the distance between two points located in space. It is widely implemented in planning and governance practices and can be calculated with different methods (Koenig 1980). Good accessibility to SPA is a driver that promotes people's visits into different parts of landscapes and could increase the quality of life of landscape inhabitants. In our study we explicitly focus on the bicycle accessibility. The average cyclist speed depends on several variables such as type of bicycle (e.g. standard bike or e-bike), age of the cyclist and quality and steepness of the cyclist road (Schleinitz et al. 2017). Acceptable cycling time depends on its purpose: whether it is recreation cycling, or transport cycling. For example in urban neighborhoods, 20 min of cycle accessibility is discussed as the desired level (McNeil 2011). Slow cycling accessibility is estimated to be in the range of 15–90 min (Karpova et al. 2008). Recreational time of cycling depends on several aspects such as physiological determinants (Støren et al. 2013). Heesch et al. (2012) assessed the time spent in recreational biking per week for men at the level of 279 min and women 240 min (Heesch et al. 2012).

Currently, not much is being written in the scientific literature about accessibility to CES in the cross-boundary landscapes (CBL). From the ecological point of view, a CBL is a cohesive spatial unit. Nevertheless, from the perspective of planning and governance it is not, as it is divided into smaller spatial units by the administrative boundary (Spyra et al. 2018). This aspect makes the accessibility analyses between SPA and SBA interesting from the planning and governance point of view, and the spatially explicit methods of accessibility calculations in such a context could inform both governance and planning practices in cross-boundary contexts. Our research is willing to close this gap by fulfilling the specific research aims: (1) to delimitate SBAs and SCAs located in the CBL and (2) to analyze accessibility to SPAs from SBA in the selected example of CBL.

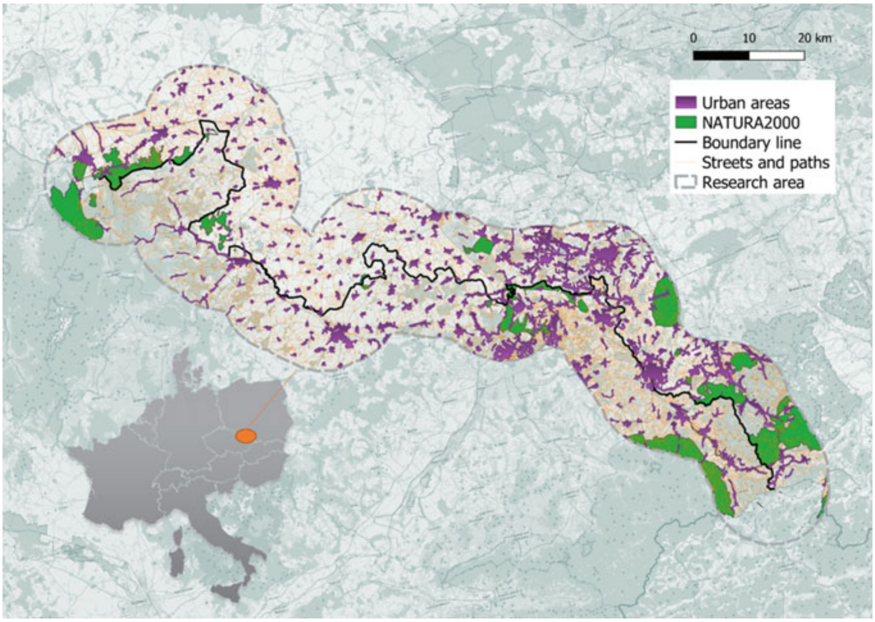


**Fig. 1** Preliminary map showing the case study area

## 2 Method

As a case study area, we selected a part of CBL located between Poland and the Czech Republic (Fig. 1). To grasp the specificity of CBL, our study area is limited to a 10 km buffer from the boundary line between Poland and the Czech Republic. For the needs of this study, we assumed that on the regional scale the urban fabric patches (urban areas) indicate the entertainment SBA and the NATURA 2000 areas indicate entertainment SPA.

In our study we analyze bicycle accessibility between SPA and SBA. Based on the study from Schleinitz et al. (2017) we estimate two types of mean speed per trip on bicycle infrastructure: (1) for a standard bicycle at the level of 16.7 km/h; (2) for an s-pedelec (e-bike with pedaling supported up to 45 km/h) at the level of 23.6 km/h. Based on the acceptable time of cycling, described in the introduction, we estimated as the acceptable one-way cycling distance: (1) for a standard bicycle at the level of 5.6 km; (2) for an s-pedelec at the level of 7.9 km. This is in line with the findings of the survey by Sahlqvist and Heesch (2012) conducted among 1,813 cyclists, which describes the distance of more than 5 km as acceptable by the largest number of survey respondents (Sahlqvist and Heesch 2012).

*Data*

SBA in our study are equivalent with two classes 1.1.1. Continuous Urban Fabric and 1.1.2. Discontinuous Urban Fabric, as described in CORINE Land Cover (CLC) data set from the year 2018. SPAs in our study are equivalent with Natura 2000 areas, which were delimitated using data provided by the European Environmental Agency. As data showing road networks, we used local data from Poland and the Czech Republic, prepared according to INSPIRE regulations, together with Open Street Data (OSM). From the analyzed road network, we excluded roads that are not accessible for bikes, meaning motorways, express-roads as well as hiking trails. All calculations and spatial analyses were done in the QGIS application.

*Step 1*

We calculated the accessibility over the road network from the (1) intersection point of a road line with a boundary line of a polygon, which determines SBA to the (2) intersection point of a road line with a boundary line of a polygon (access point), which determines SPA.

*Step 2*

We selected 2 types of SBAs which have accessibility to SPAs higher than: (a) 5.6 km for standard bike and (b) 7.9 km for s-pedelec.

*Step 3*

For each polygon, which delimitates SBA patches selected in step 2a, we designated polygon centroid and a buffer from this centroid with a radius of 5.6 km. The same procedure was implemented for patches from step 2b, but with a radius of 7.9 km.

*Step 4*

We selected SBA buffers that overlap with SPAs. These urban fabric patches have the potential for better accessibility over the road network to SPAs. Particularly interesting in the cross-boundary context are those buffers and assigned SBAs that overlap only with SPAs, located on the other side of the national boundary (meaning in the other country).

## 3 Results

In the analyzed research area there are 365 SBAs with a total area of 408.88 km$^2$ and 37 SPAs with a total area of 408.7 km$^2$.

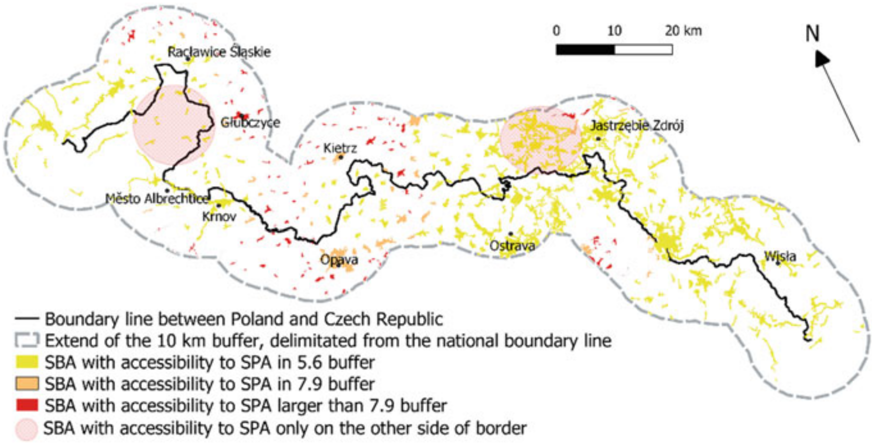


**Fig. 2** Accessibility in the buffers delimitated from the centroids of the SBA

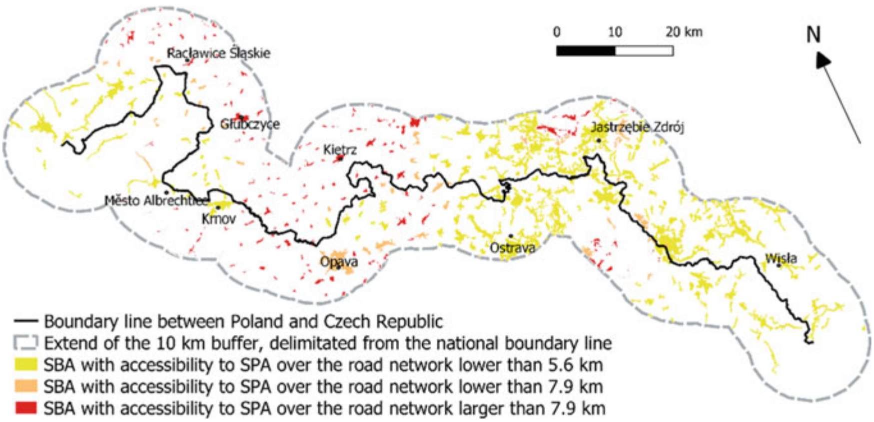


**Fig. 3** Accessibility over the road network

*Accessibility from the perspective of service benefitting areas (SBA)*

The general accessibility calculated within a buffer is displayed in Fig. 2. The analysis shows that 81% of SBAs are located within a radius of 7.9 km from SPA and 67% within a radius of 5.6 km from SPA. 7% of SBAs are not conveniently connected to SPAs within a 5.6 km radius (cyclists using traditional bicycles), while 13% of SBAs are not conveniently connected to SPAs within a 7.9 km radius. 19% of SBAs are not conveniently connected to SPAs either within 5.6 or 7.9 km radius. We delimitated 8% of SBAs, which have a potential for good accessibility to SPAs located on the other side of the national boundary (Fig. 2). With this we delimitated the possible location of new cross-boundary links (bicycle routes) between SPAs and SBAs.

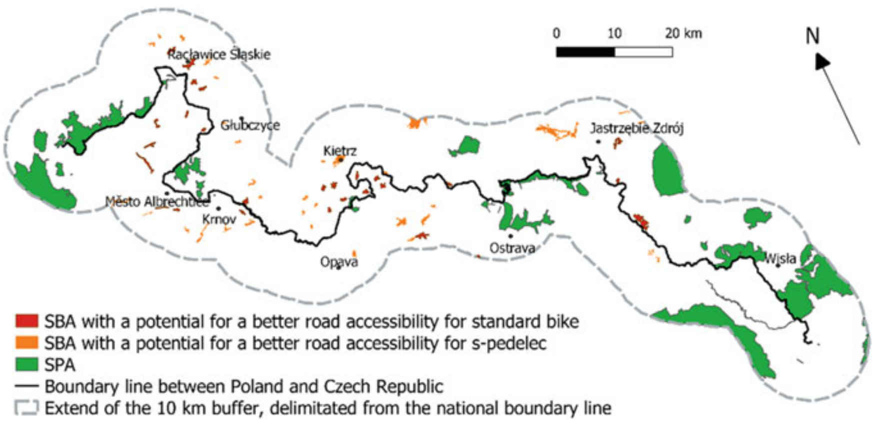


**Fig. 4** Accessibility from the perspective of SPA

The accessibility over the road network is presented in Fig. 3. 11% of SBAs without access to SPAs are located on the Polish side of the boundary north from the city of Opava, including the city of Kietrz. This is an area where only two small SPAs are located and where the road network around them is poorly developed. The situation is different between the towns of Racławice Śląskie, Głubczyce, Miesto Albrechtice and Krnov. The network of roads and paths is better developed and there are many SPAs, especially on the Polish side of the boundary.

The best accessibility to SPA was indicated in the mountain areas (Beskidy, Zlate Hory), which are connected with developed systems of routes, bicycle paths and facilities for tourists. Moreover, in those areas Natura 2000 sites cover a large percentage of the total area.

Few SBAs, even if they are in a straight-line distance of about 2 km, do not have an access less than 5.6 km via existing road network to SPAs. This involves SBAs located very close to the Polish—Czech boundary. There are several reasons for this. The road network is based on the former boundary crossings, which results in a concentration of roads along the boundary line insufficient cross-boundary linkages. Moreover, we observed a concentration of roads and paths towards larger towns located very close to the boundary line (e.g. Krnov). Natural landscape barriers such as rivers or hills do not seem to be, in our case at least, a big obstacle in achieving better road accessibility.

*Accessibility from the perspective of service providing areas (SPA)*

We calculated a quantity of SBAs that (according to our criteria) have good road accessibility to SPA (Nature 2000 areas). We also indicated those SPAs that have a potential for good accessibility to SBAs, meaning which overlap with 5.6 km or 7.9 km buffers (Fig. 4). Currently, this potential is not being implemented due to the lack of road linkages joining SBAs and SPAs (Fig. 4). Most of those SPAs are located in the central part of our case study area. In this case, there are some similarities to SBAs with poor accessibility to SPAs (compare the results presented above).

## 4 Discussion

*Implementation for cross-border planning and governance*

Accessibility of SPA is an important factor that determines the quality of life of inhabitants. Our methodology can be useful to detect existing entertainment CES connecting areas (SCA) and potential new SCA. It helps to analyze the accessibility of SPAs, taking into account the presence of the national boundary, which could be an important accessibility obstacle in CBR (Spyra et al. 2018). More equal distribution of SPAs in CBL could increase the quality of life of cross-border inhabitants by improving the accessibility to CES. Implementation of our methodology could support governance and planning in various cross-border contexts. For example, it could foster coordination of ecosystems governance (Gass et al. 2009) facilitate social exchange among governance actors (Fischer et al. 2019) or support interagency coordination related to CBL governance (Cyphers and Schultz 2019).

On the other hand, if some of the SPAs are being used by too many people, it creates the risk of landscape degradation. Implementation of our method helps to better govern and to plan more equal accessibility to SPAs, which are distributed in a portion of CBL. In this way it could support the governance and planning of CBL.

The method could be expanded to indicate those SPAs which are at risk of being over-used by tourists and other people who are looking for recreation and are inhabitants of nearby SBA. To do this, usage factor of SPAs (U) with the following equation could be calculated for each considered SPA:

$$U = \frac{A_n}{N_{SBA} I}$$

An—SPA area; NSBA—amount of linkages to different SBA; I—number of inhabitants in connected SBA

Currently, the literature does not describe many spatially explicit, quantitative methods that grasp the presence of administrative boundary lines in the landscape. The method helps to have wider perspective on planning and governance of different types of CBL, thus helping to avoid, or at least better manage, the not-in-my-backyard issue, which is typical for CBL (Spyra 2014). Our study analyzes national boundary, but it could be implemented as well for other types of administrative boundaries. In this way our method could be extended to analyze accessibility between SBAs and SPAs and to grasp the specificity of an administrative boundary in other types of landscapes, like peri-urban landscapes (Spyra et al. 2020), that can be related to functional urban areas or metropolitan areas.

*Limitations of the research method*

Limitations of our research method are primarily concerned with the type of implemented data. CORINE data are quite general (resolution of 25 ha), are good for spatial analyses in the regional scale, but do not offer the opportunity to assess CES in a more detailed scale (e.g. urban scale). However, similar to those calculations presented in this study, calculations could be implemented with the use of more detailed data (e.g. Urban Atlas data for functional urban areas) that would allow implementation of similar aims, but in the more detailed scale (urban scale). We implemented our method of bicycle accessibility only, but similar calculations could be also made for other types of accessibility (walking, car accessibility). Another limitation is related to our assumptions of average bicycle speeds and acceptable riding times. We are aware that our results are vulnerable to these variables, but in order to reduce the uncertainties, we carried out detailed literature research concerning bicycle accessibility.

In our research we decided to use Nature 2000 areas as SPAs. We are aware that there are other green areas which could serve as SPAs, but Nature 2000 areas are attractive from the recreational point of view, can be visited by tourists and do not have strict guidelines regarding, for example, their use as designated areas.

A considerable advantage of our method relates to the relatively easy and quick implementation of it. Thus, it can provide information relatively quickly from the point of view of cross-boundary planning and governance results.

Due to the usage of the CORINE data base, our method provides results which are comparable across many European countries.

## 5 Conclusions

Our research showed that SPAs are not equally distributed along the CBL. Some of the SBAs are favored by a good bicycle accessibility, other SPAs have the potential to be better accessible by bicycles, while selected SPAs could be at risk of being over-used by urban citizens. These facts influence the quality of life of the CBL inhabitants as well as the sustainability of this landscape. Also, the national boundary line is larger than the natural-barrier obstacles, hindering accessibility between SBAs and SPAs. Nevertheless, our study shows that these obstacles could be overcome with the assistance of effective planning and governance tools, that are implemented in various cross-boundary context (e.g. peri-urban landscapes).

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# XIII
Palacios-Agundez I., Rodríguez-Loinaz G., Hagemannd N., Sylla M. and Spyra M. (2022). Teaching the ecosystem service concept: experience from academia.
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*Insight*

# Teaching the ecosystem service concept: experience from academia

*Igone Palacios-Agundez* [1,2], *Gloria Rodríguez-Loinaz* [1,2], *Nina Hagemann* [3], *Marta Sylla* [3,4] *and Marcin Spyra* [5,6]

ABSTRACT. Although ecosystem service (ES) is a well-established concept among the scientific community, it has not reached the mainstream of public awareness because it lacks wide recognition among citizens and educators. Teaching of ES may contribute to the mainstreaming of the ES concept and its framework in society in a critical and meaningful way, toward sustainable development. In fact, the ES concept is a key tool for communicating our social dependence on natural ecosystems, and therefore it has high didactic potential. However, this didactic potential is under-explored, because there is a lack of scholarship related to teaching the ES concept. There is little evidence, for example, on whether scientists who research ES also teach the concept and thus contribute to raising the level of ES awareness in society, and if so, how such teaching processes could be improved, to broaden the impact to citizen awareness. To close this knowledge gap, we delved deeper into how the ES concept is taught and which teaching strategies are currently being used by ES research academics. We aimed to establish connections between those teaching practices and best educational practices described in educational literature. This analysis will help to provide insights into academics' teaching approaches, as well as how these practices could be improved. A key finding of our research is that teachers with little experience in ES teaching are less likely to use active teaching methods or to evaluate their teaching (both related to best educational practices), whereas lecturers with more years of experience in teaching the ES concept are more in line with best educational practices. Therefore, collaboration and networking among teachers with different levels of experience could help improve the quality of ES concept teaching. We suggest the establishment of a platform to facilitate regular exchange among teachers and educators from different teaching contexts and educational levels. Finally, we propose several future research directions in this emerging research area in order to continue revealing the existing research gap in the teaching of the ES concept.

Key Words: *active learning; ecosystem services; evaluation; interdisciplinarity; networking; teaching*

## INTRODUCTION

Ecosystem services (ES) are the ecological characteristics, functions, and processes that directly or indirectly contribute to sustainable human well-being (Costanza 2020). As previously stated in the Millennium Ecosystems Assessment (MEA 2005), the ES concept could support the acquisition of general knowledge regarding how nature around us functions and how important it is for human beings. The ES concept has the potential to support, in a straightforward way, ecological wisdom (Xiang 2014), ecological literacy (Pitman et al. 2018), ecological sensitivity, and even ecological ethics (Naveh 1995). Furthermore, the ES concept has the advantage of addressing all parts of society, and can be used as a door-opener to raise people's awareness of the significance nature represents for well-being (Costanza et al. 2017, García-Llorente et al. 2018); to highlight the need for mainstream ES approaches; and to emphasize that substantial contributions of ES to the sustainable well-being of humans and the rest of nature should be at the core of the fundamental social change needed to achieve a societal transformation to a sustainable future. Much progress has been made at different scales, both in science and at the policy and planning levels, to delve deeper into the theoretical and practical aspects related to the ES concept. However, the ES concept is still in its infancy with respect to greater public awareness, because it still lacks wider recognition among citizens and educators (Barracosa et al. 2019). Therefore, teaching the ES concept assumes a relevant role concerning improvement of this situation. In fact, increasing education levels can contribute to increasing awareness of the importance of different ES (Xun et al. 2017). Moreover, teaching can contribute to a better understanding of the ES concept, which can support the general public to better understand the need for effective biodiversity management (Buijs et al. 2008).

The ES concept is a key tool for communicating our social dependence on natural ecosystems (Torkar and Kraûovec 2019), and therefore it has high didactic potential (Rodríguez-Loinaz et al. 2017). The basic idea behind the ES concept is simple, related to the fact that people perceive benefits obtained from nature and may link them directly to their well-being. In connection with nature conservation and sustainability issues, the ES concept could help explain such benefits and links to society through teaching. Nevertheless, research on teaching and learning the ES concept, although it is recently starting to emerge, is relatively sparse (Taylor and Bennett 2016, Alonso and Gutiérrez 2017, Ruppert and Duncan 2017, Löw Beer 2018, Schneider and Lüderitz 2018, Barracosa et al. 2019, Schneider and Popovici 2019, Rodríguez-Loinaz and Palacios-Agundez 2022). Moreover, the concept is recognized as relatively new by the community of teachers (Rodríguez-Loinaz et al. 2017). Current research experiences related to what is being taught about the ES concept are limited, and concern, for example, what types of ES are being taught and how specific ES types are perceived by students (Alonso & Gutiérrez 2017). Because the ES concept is highly interdisciplinary, the specific ES teaching content depends on the

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addressed knowledge area(s), e.g., biology, geology, and economics, in each specific course, as well as on the teaching audience and teaching context. However, there are many basic ideas on the importance of nature for human well-being that every ES teaching should cover. In this sense, Kurt and Ulrich (2015) defend a basic argument for teaching the ES concept, linked to biodiversity: it helps students to understand that life on earth, in its abundant variety, is of existential value to human beings. Moreover, interdisciplinary conceptual thinking is an important element of the teaching process of the ES concept, and allows showing this concept in a wider perspective related to the implementation of Sustainable Development Goals (SDGs; Schneider and Lüderitz 2018). Therefore, analyzing the methods applied in ES teaching and establishing connections between those teaching practices and the best educational practices described in the educational literature would give insight on how to improve ES teaching experiences. This may be beneficial for ES teaching as a whole, regardless of the knowledge area(s), e.g., natural sciences, or social sciences, involved in each specific course or teaching context, which may help to increase the social understanding of the ES concept.

Currently, little is known about the extent to which students develop knowledge and understanding related to the ES concept (Torkar and Kraûovec 2019). What we do know is that paying attention to the applied teaching approaches and methodologies is of great importance for improvement of learning outcomes (Drew and Hess 2003, Prince 2004, Freeman et al. 2014), as well as for achievement of transformative education toward sustainability (UNESCO 2017, Leicht et al. 2018). In this sense, teaching ES through active teaching methodologies has proven to be useful and necessary to help students understand and be able to defend the importance of nature conservation (Rodríguez-Loinaz and Palacios-Agundez 2022). Moreover, recent studies suggest that teaching ES through the use of active teaching methodologies, such as inquiry-based learning, provides an ideal opportunity to help students make connections between ecological, geological, and social systems (Taylor and Bennett 2016). Analyzing how the ES concept is taught and how these teaching practices are evaluated provides a common discussion space regarding ES teaching among academics from different disciplines working on ES and, more importantly, provides the opportunity to improve such teaching experience.

There is little evidence on whether scientists who research the ES also teach the concept and, therefore, contribute to raising the level of ES awareness in society, and if so, how such teaching processes could be improved to broaden the impact on citizen awareness of ES. ES is a concept generated by academia that still lacks wider recognition among citizens and educators. Therefore, it is important to analyze the teaching practices that take place at the academic level, and then to see how they could continue to play a role in society. In our study, we have compared teaching practices used by ES academics with best educational practices described in educational literature. First, we aimed to analyze how academics taught the ES concept at universities and research centers, and to establish connections between those teaching practices and best educational practices described in educational literature. This analysis aims to help provide insights into academics' teaching approaches and into how ES teaching experiences are being evaluated, as well as into how these practices could be improved. Second, we aimed to discuss further steps and research directions to support teaching the ES concept, as a key step toward making it more relevant for society. To implement our aims, we conducted an international survey that focused on academics' current experiences in teaching the ES concept, involving 99 scientists who research ES and teach the ES concept.

## MATERIALS AND METHODS

This research is based on an ad hoc web-based survey (Jamsen and Corley 2007) aimed at academics from universities and research centers around the world who teach the ES concept.

### Questionnaire design and validation

The ad hoc questionnaire was designed by the authors of this study. It included both open-ended (17) and closed questions (six) distributed in five main parts: (1) respondent's personal information; (2) teaching experience; (3) teaching methods; (4) effectiveness of the teaching processes; and (5) interest in participating in a working group on ES teaching (Table 1). Parts two, three, and four asked about their experience in ES teaching. Respondents with no experience in teaching the ES concept did not have to answer questions concerning teaching methods and effectiveness of their teaching. They were redirected to the last part of the questionnaire in order to detect whether there was interest in teaching the ES concept among people who have never done it.

**Table 1:** Questionnaire design

| Questionnaire's main parts | Questions concerning |
|---|---|
| 1. Respondent's information | Representing institution<br>Membership to different communities |
| 2. Teaching experience in ES | Target audience<br>Type of courses<br>Years of teaching |
| 3. Teaching methods | Active vs. lectures<br>Use of inductive teaching methods<br>Outside classroom activities (outdoor activities)<br>Online exercises<br>Teaching ES in relation to SDGs |
| 4. Effectiveness of the teaching processes | Evaluation techniques used<br>Perception of most effective evaluation techniques |
| 5. Interest in participating in a working group on ES teaching | Kind of Interest |

In the third part of the questionnaire, the teaching methods were organized into two main categories: (1) traditional lectures, where students passively receive information from the teacher; and (2) active and collaborative learning methods that engage students in the learning process and where students work together in small groups toward a common goal. Based on the classification used by Prince and Felder (2006), inside the active teaching methods, eight categories were considered: inquiry learning, problem-based learning, project-based learning, case-based learning, discovery learning, just in time teaching, peer instruction, and educative gamification (Appendix 1).

Before distributing the questionnaire, it was validated by 10 external experts in the field of teaching and ES (Appendix 2) in order to confirm that the questions captured the anticipated data and would not be interpreted differently by researchers and participants (Ball 2019). The validation process focused mainly on content validation, because such validity is essential to making inferences and generalizations from the results obtained with a questionnaire (Escofet et al. 2016). To do so, the authors used the Delphi method (Linstone and Turoff 1975, Loo 2002). This method has been widely applied as a questionnaire-validation instrument in numerous studies and fields of knowledge (Hung et al. 2008). In this method, the questionnaire is sent to several experts and is modified and improved, if necessary, according to various recommendations made by the experts obtained in successive rounds. After each round, the experts' opinions were collected and analyzed. Suggested modifications were made to improve the instructions and the understanding of some questions, and several questions considered irrelevant were also deleted. The authors repeated this procedure in three rounds until arriving at the final version of the questionnaire.

**Sampling method**

In order to reach as many people as possible, the questionnaire was distributed online by different methods to reach both sampled and self-selected respondents (Jamsen and Corley 2007). The sampled participants were contacted proactively and invited to answer the questionnaire. To do so, the authors used the snowball sampling method (Goodman 1961), which identifies the individuals who have the desired characteristics and uses these individuals' social networks to recruit similar subjects (Sadler et al. 2010, Kowald and Axhausen 2012). Using this approach, the authors sent the questionnaire link by email to all the participants of the scientific session "Effective teaching strategies for making the ecosystem services concept relevant to society" of the Ecosystem Services Partnership conference held in Hanover, Germany, in October 2019, asking them to fill in the questionnaire and to forward the message to their contacts who might teach the ES concept. After the conference, the authors carried out a more thorough sampling campaign by identifying researchers who could be teaching ES and contacting them directly. Following the snowball sampling method, the contacted researchers were asked to fill out the questionnaire and to forward the message to their contacts who might teach the ES concept. Using this snowball approach, over 700 individuals were directly emailed.

To reach potential self-selected respondents, the survey was published several times on different websites relevant for the ES community, such as the Ecosystem Service Partnership and Young ES Specialists (YESS), and in their newsletters. ESP and YESS members were also invited to take part in the survey via social media (Twitter and Facebook). The questionnaire was also published on websites relevant for ecology researchers, such as International Association of Landscape Ecology (IALE), Global Land Program (GLP), and researchers in general, such as ResearchGate. The sampling took place between 11 October 2019 and 6 January 2020.

**Ethical considerations**

All participants who completed this voluntary survey were adults aware of the purpose of the research. Participants provided consent after reading the specific notice on data protection that the survey included (Appendix 3).

## RESULTS

**Respondents' general profile**

A total of 136 responses were received. About 2.2% of the questionnaires were incomplete and, therefore, were eliminated from further analysis. In the end, the total number of completed responses was 133. The responses came from 43 countries all over the world (Table 2), mainly concentrated in Europe (79.6%). Data showed that 50.4% of the respondents were members of different professional scientific communities, whereas 49.6% were not members of any professional scientific community.

The target group in this research was academics from universities and research centers lecturing on ES. The authors excluded responses from further analyses given by (1) respondents with other profiles (secondary and informal educators, government workers, and NGO/consultancy professionals; 10% of the total sample); and (2) respondents who had never taught the ES concept (18% of the 133 respondents). Therefore, the results shown below correspond to the answers given by the 99 responders who were academics from universities and research centers who had ever taught the ES concept (Table 2), except for the case of the analysis of the interest in participating in a working group on ES teaching, where all 133 responders were considered.

**Experience in teaching the ES concept**

The level of expertise in teaching the ES concept among the 99 respondents included in the final analysis was quite diverse. One-third of the respondents had more than five years experience teaching the ES concept, whereas 27% of the sample had less than one year of experience or had taught the ES concept occasionally. Regarding the type of course taught, the results showed that 74% of the sample had taught a course, module, or workshop with a specific focus on the ES concept, whereas 82% of the respondents had taught about ES in other courses not specifically focused on ES. The number of hours devoted to teaching ES courses differed substantially depending on the type of course, from two to 110 hours. Regarding the target audience, although the great majority of respondents (98%) taught at the university level (bachelor, master's, and PhD), half of them had also given courses to public administration workers, and 37% of them to the general public; interestingly, 23% of the academics who answered the survey had given courses focused on including the concept of ES in compulsory primary and secondary education (Fig. 1).

**Teaching methods**

According to the classification of teaching methods described in the methodology section, 34% of the respondents used only active teaching methodologies, 21% taught the ES concept only through traditional lectures (where students passively receive information from a teacher), and the remaining 45% combined traditional lectures with active teaching methodologies. The most often-used active methodologies were project-based learning (49% of the studied sample), case-based teaching (46%), problem-based learning (39%), and inquiry-based learning (36%; Fig. 2).

**Table 2**. Place of origin of respondents (only the countries with two or more answers are specified, which means that the number of respondents of "others" equals the total of other different countries). Note that the percentages have been included in the total number of respondents (133), and in the total 99 respondents finally included in the analysis (those respondents from universities or research centers who teach ecosystem services).

| Continent | Country | Nº respondents | % of respondents | % of respondents finally included |
|---|---|---|---|---|
| Africa | TOTAL | 6 | 4.5 | 2 |
| | Kenya | 2 | | |
| | Other countries | 4 | | |
| Asia | Total countries | 8 | 6.0 | 5 |
| | Israel | 2 | | |
| | Other countries | 6 | | |
| Europe | TOTAL | 106 | 79.6 | 85 |
| | Spain | 20 | | |
| | Germany | 19 | | |
| | Poland | 14 | | |
| | Romania | 7 | | |
| | Netherlands | 7 | | |
| | Czech Republic | 5 | | |
| | Portugal | 5 | | |
| | Switzerland | 5 | | |
| | Italy | 4 | | |
| | Sweden | 4 | | |
| | United Kingdom | 3 | | |
| | Turkey | 2 | | |
| | Other countries | 11 | | |
| North America | TOTAL | 3 | 2.2 | 2 |
| South America | TOTAL | 10 | 7.5 | 6 |
| | Brazil | 3 | | |
| | Argentina | 2 | | |
| | Colombia | 3 | | |
| | Other countries | 2 | | |

**Fig. 1**. Percentage of respondents who selected each target audience category in the closed question on the target audience of the ES teaching (multiple choices allowed). Those who answered "others" were asked to specify their answer in an open-ended format. Received answers on "others" category in the open-ended answer include NGO, policy makers, and industry.

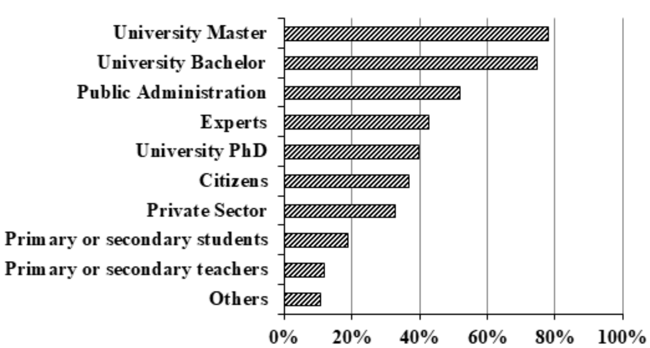
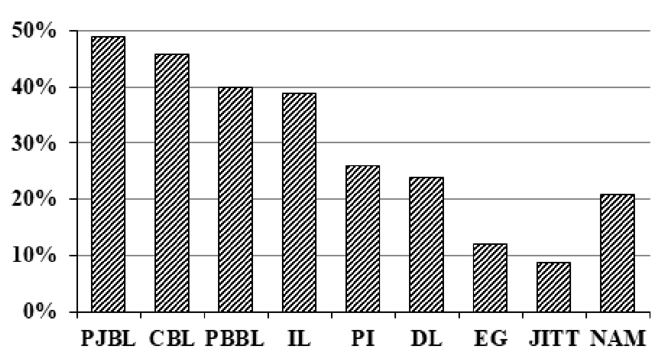


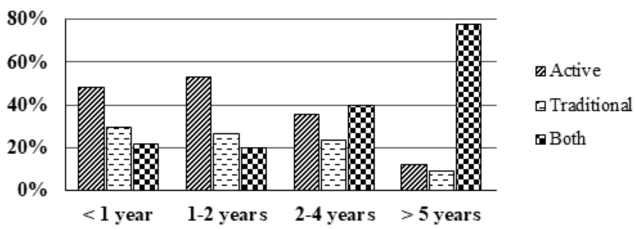

**Fig. 2**. Percentage of respondents that use each method to teach the ecosystem services concept (multiple choice allowed). PJBL: Project-based learning; CBL: Case-based teaching; PBBL: Problem based learning; IL: Inquiry learning; PI: Peer Instruction; DL: Discovery learning; EG: Educative Gamification; JITT: Just-in-time teaching; NAM: Non-active methods.



In addition, 59% of the respondents developed outdoor classroom practical teaching activities, and 17% included online exercises in their ES teaching strategies. Finally, 57% of the respondents included in their teaching strategies the relationship of the ES concept to the SDGs.

The analysis of the applied teaching methodologies according to academics' expertise on teaching the ES concept shows that the use of active teaching methods, alone or combined with traditional lectures, increases with teaching experience (Fig. 3).

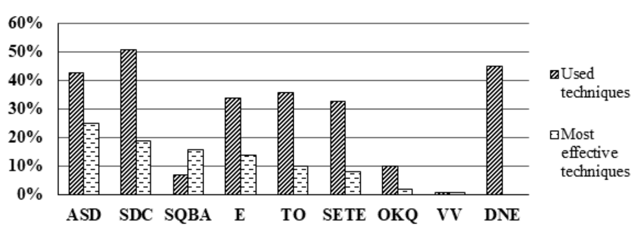
**Fig. 3**. Percentage of active and passive teaching methods by respondents' teaching experience.




**Evaluation of the teaching and learning processes**

In their questionnaires, 55% of the respondents stated that they evaluated the effectiveness of their teaching (Fig. 4). Their evaluations were conducted using the following techniques: students' direct comments (51%); analysis of the students' deliverables (46%); teachers' observations on students' learning process (36%); an exam that measures student performance or learning (34%); and students' evaluation of teaching effectiveness (33%).

**Fig. 4**. Percentage of respondents by each evaluation technique: used techniques by respondents (multiple choices allowed) and most effective evaluation techniques perceived by respondents (single-answer question). Name codes: ASD: Analysis of the students' deliverables; SDC: Students' direct comments; SQBA: Specific questionnaire to student on Ecosystem Services before and after the class/course/module; E: Exam; TO: Teacher's observations on students learning process; SETE: Students' Evaluation of Teaching Effectiveness; OKQ: Other kind of quiz; VV: Video or voice recording of the lessons; DNE: Do not evaluate.




When respondents were asked about their opinion on what was the most effective technique to make such an evaluation, the first two positions in the ranking of preferences matched with the most commonly used evaluation techniques (i.e., analysis of the students' deliverables and students' direct comments; Fig. 4). However, the third position, "specific questionnaire to students on ES before and after the class, course, or module," did not match with the most used evaluation techniques. Moreover, it was almost the least used technique (Fig. 4). The results indicate that scholars who used active teaching methods to teach the ES concept were more likely to evaluate the effectiveness of their ES teaching and learning processes (62% of them do so) than those who only used traditional lectures (Fig. 5), and that scholars with little experience in teaching the ES concept were less likely to evaluate the effectiveness of their teaching (Fig. 6).

**Fig. 5**. Percentage of respondents who evaluated (or did not evaluate) the effectiveness of their ecosystem services teaching and learning processes using active teaching methods, in contrast to those who only used traditional lectures.

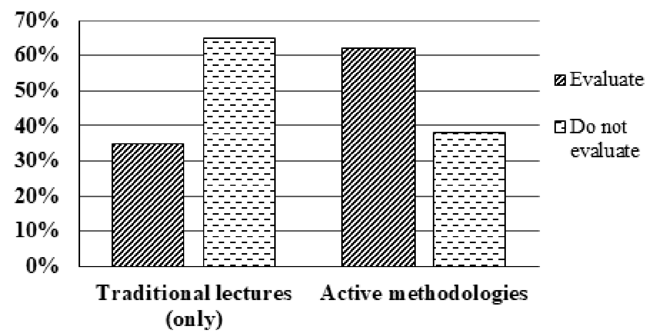
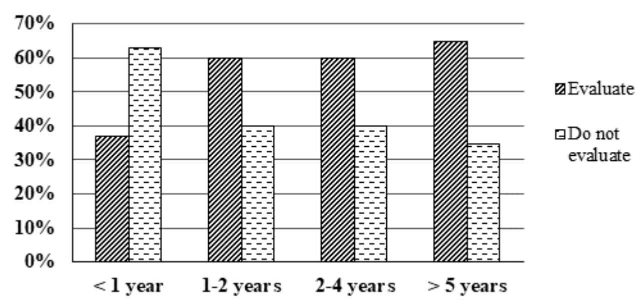



**Fig. 6**. Percentage of respondents who evaluated (or did not evaluate) the effectiveness of their ecosystem services teaching processes by teaching experience.




**Interest in participating in a working group on teaching the ES concept**

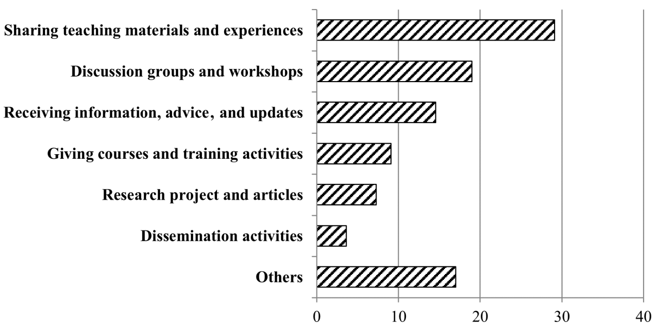
As explained above, the 133 respondents, regardless of whether or not they had experience in ES teaching, or whether they were academics or not, were also asked about their interest in being part of a thematic working group on teaching the ES concept. The overall aim of such group would be to provide an interdisciplinary exchange platform about ES concept teaching.

Interest was expressed by 78% of the total 133 respondents. Interestingly, 78% of the respondents who have never taught the

ES concept were inside this group. In addition, 90% of non-academics who teach the ES concept also showed interest in participating in a working group on teaching the ES concept.

Among the 68 respondents who specified the type of collaboration they were interested in, 29% stated they were willing to share teaching materials and experience, followed by 19% who were interested in participating in discussion groups and workshops (Fig. 7). There was also an important fraction (15%) of respondents who were not willing to actively participate but were interested in receiving information, advice, and updates.

**Fig. 7**. Percentage of the 68 respondents that specified the type of collaboration they are interested in by type of collaboration (open-ended answer).




## DISCUSSION

Our results show that academics are teaching the ES concept both through teaching specific courses on ES and through teaching the ES concept in courses with a more general focus (e.g., biology, environmental economics, landscape planning, sustainability). This is in agreement with other recent studies that show the ES concept is indirectly involved in educational courses that address broader issues such as life on earth and its impacts on human existence (Kurt and Ulrich 2015), or climate change impacts (Fortmann et al. 2020). Interestingly, the results of our study show that academics from universities and research centers do not only teach the ES concept at the university level where they do research and teach, but they also teach it in many different contexts to very diverse audiences such as professional workers of the administration or private consultancy, and NGOs. This finding is promising, because these stakeholders are often involved in planning and policy-making processes related to biodiversity and ES (Spyra et al. 2019). Planners' understanding of the ES concept supports the general public to acknowledge human-nature relations that are crucial for the sustainable future of our planet (Musacchio 2018). Therefore, current ES teaching experiences from academia seem to be contributing to raising social awareness.

Regarding teaching expertise in ES, our results show a wide variety of expertise levels among academics, from those with brief teaching expertise, to others with over 10 years of experience in teaching the ES concept. One-third of our respondents have been teaching the ES concept for only a short time (i.e., less than a year). This could indicate that the ES concept has entered the university arena on a larger scale only recently. In contrast, another third of the sample had over five years of experience in teaching the ES concept. This means that there is a wide range of educational experience in ES that can be shared within the ES community.

**Are these teaching experiences in ES in line with best educational practices?**

The authors have shown that academics use a wide variety of teaching methods. Importantly, a high percentage (79%) of academics who participated in the survey use active teaching strategies and methods to teach ES (e.g., project-based learning, problem-based learning, and inquiry-based learning), either alone or combined with passive methods. Through the use of such active teaching methods as problem-based learning, students will retain information longer and may develop critical thinking and problem-solving skills (Prince 2004). This is a very positive outcome, because stimulating critical thinking among students and problem-solving skills can be a good basis for more effective implementation of the ES concept in research and practical work. This method of teaching the ES concept could be specifically valuable for a more intuitive and effective understanding of this concept, because it allows a direct application of ES concept into open-ended, complex, and authentic (real-world) problems. Our results also indicate that lecturers teaching ES combine, in their active and inductive teaching methods, in-class activities with outdoor classroom activities. This is also a positive outcome because outdoor classroom activities have been acknowledged to increase well-being and boost subsequent classroom engagement (Kuo et al. 2018, Largo-Wight et al. 2018). Besides, this finding is in line with the International Union for Conservation of Nature's claims regarding the need to increase education in nature or in naturalized school environments (https://www.hawaiiconservation.org/our-work/iucn-hawaii-commitments/). Moreover, studies on inquiry-based science learning also identify outdoor learning as a best practice in teaching concepts related to ES, such as biodiversity and climate change (Regan et al. 2014). Therefore, the ES teaching experiences of academics are often in line with current best educational practices concerning related subjects such as science education (Freeman et al. 2014) or Education for Sustainable Development (Lozano et al. 2017, Leicht et al. 2018).

Measuring teaching effectiveness is of great importance because the evidence produced is used to improve the quality of teaching (Berk 2005), and therefore to improve students' learning and social understanding of the ES concept. Our results show that teachers involved in implementing active teaching methods for ES are more likely to conduct the evaluation of the teaching and learning processes they have implemented. This could indicate that, aligned with educational science knowledge (e.g., Prince 2004, Berk 2005), there are scholars who are aware of the importance of both the use of active teaching methods and the evaluation of such teaching experience for successful ES learning processes. A key finding of our research is that teachers with little experience in ES teaching are less likely to use active teaching methods and to evaluate their teaching experience. This may be because of the fact that successful teaching evaluation practices require gradual implementation of lessons learned from evaluation results, and time to allow for such change (Peterson 2000). In contrast, lecturers with more than five years of experience in teaching the ES concept are more in line with best educational practices, applying active teaching methods and evaluating the effectiveness of their teaching processes. Therefore, creating a platform for collaboration and networking among teachers with different levels of experience could help to improve ES teaching among various groups of teachers.

**Why teaching the ES concept is relevant to society and how to improve its social understanding**

A large part of the problem of ecosystems degradation lies in the population's lack of awareness of the link between nature and human well-being (Rodríguez-Loinaz and Palacios-Agundez 2022). This is largely because of the way nature is treated in compulsory education, where, generally, humans are presented as a separate unit from the environment (Ruppert and Duncan 2017), and the conservation of nature and biodiversity is decontextualized from the social sphere (García and Martínez 2010). The ES concept, making explicit the close relationship between humans and ecosystems, can contribute to solving some of the limitations of the educational models currently used in Environmental Science Education (Ruppert and Duncan 2017). Increasing awareness and understanding of the ES concept through teaching processes could, for example, contribute to improve landscape planning and governance (Flint et al. 2013, Spyra et al. 2020), and may contribute to reducing unsustainable ES trade-offs (Richards et al. 2017). On the contrary, a poor understanding of the ES concept can risk increasing environmentally or socially harmful activities (Ainscough et al. 2019). For this reason, when raising awareness of the ES concept, critiques need to be considered (e.g., Bekessy et al. 2018). Therefore, it is crucial to teach the ES concept effectively and link it to the concepts of biodiversity and sustainability. Active teaching methodologies, which stimulate problem-solving skills (Wieman 2014) and critical thinking among students (Duron et al. 2006), offer the possibility of engaging students in fruitful dialogues that stimulate critical thinking, helping students understand and appreciate ES provided by overlooked and under-protected ecosystems (Leigh et al. 2019). Moreover, such methodologies encourage students to look for win-win planning and governance solutions leading toward SDGs implementation. Recent studies have shown that teaching ES can contribute to the achievement of SDGs by helping students understand the close relationship between the protection of nature and human well-being and by providing them with strong arguments to defend the need for sustainable development (Rodríguez-Loinaz and Palacios-Agundez 2022). In short, we argue that by improving and mainstreaming the ES concept teaching practices, social awareness and understanding of the importance of ecosystems and nature to our well-being will increase, contributing to the necessary cognitive paradigm shift away from the dominant and flawed neoliberal/neoclassical economic view and toward a more holistic and regenerative worldview, based on the life cycle and social well-being.

Collaboration and networking among academics who teach ES would provide a helpful basis for improving current ES teaching practices. Moreover, this kind of collaboration would help to establish a foundation for how to teach the ES concept that would improve current teaching practices, ultimately enabling one to increase both the scope and depth of understanding related to this subject at different educational levels. Our results show that there is demand for further collaboration concerning how to teach the ES concept, not only by teachers who already teach it, but also by those who do not. The primary interest lies in experience exchanges, i.e., either personal classroom experience or shared teaching materials (e.g., Ban et al. 2015, Cox 2015). Exchanging experience and materials could encourage interested teachers who do not yet teach the ES concept to start doing so. Besides, fostering collaborative activities in teaching the ES concept is also important to enable academics already teaching ES to continuously improve their teaching. In these exchange networks, many academics who already apply different active teaching methods and evaluate their teaching practices can be mentors for others by providing best practice examples. Furthermore, an interest in covering the existing research gap inherent in the teaching of ES has also been detected among respondents. In fact, 19% expressed interest in participating in discussion groups and workshops, whereas 7% directly stated that they were interested in collaborating on research projects on the subject. The results of our research support the need for establishing a network based, interdisciplinary working group on ES education, which would further facilitate regular exchanges concerning teaching the ES concept. This could lead to joint work related to a collaborative approach to share experience, to systematize the evaluation of teaching practices on the ES concept, and to increase knowledge regarding effective teaching approaches.

In order to increase social awareness and understanding of the importance of ecosystems and nature to our well-being, further steps need to be taken, not only at the university level, but also at other educational levels, such as primary and secondary education. Non-university levels of education would also benefit from sharing, with academics, experience, materials, and evaluation methods for teaching the ES concept. Interestingly, our results also show that non-academics who teach ES are interested in networking with academics to collaborate in a working group regarding teaching the ES concept and its framework in a critical and meaningful way toward sustainable development. The joint collaboration between ES academics and primary and secondary school teachers may have a significant educational impact. That collaboration is beginning to take place (Spyra 2014, Palacios-Agundez et al. 2017, Perdices and Ruiz-Alonso 2019); however, mechanisms need to be developed to incorporate the lessons learned from these experiences, so that these collaborative practices can be generalized. In the end, well-conducted science-practice interaction processes can help increase awareness and communication of the ES concept (Dick et al. 2018).

**Strengths, limitations and future research directions**

We draw attention to the lack of research around teaching the ES concept and provides valuable insights, based on experience from academia, on how to improve teaching experiences in ES, as well as on the importance of sharing and mainstreaming such experience. The novel nature of the study implied that the target group for the research, meaning the total population of academics teaching the ES concept, is unknown. In such cases, the sample size and selection process are subject to different interpretations, sampling strategies, and approaches. In this study, we used the snowball sampling method following several recommendations by Kirchherr and Charles (2018) to enhance sample diversity (e.g., we used diverse sample seeds, reasonable persistence and different waves of sampling). This sampling method is often used when a sampling frame cannot be constructed (Kirchherr and Charles 2018). Furthermore, it allows one to gather a wide diversity of perspectives within a subject or knowledge area, beyond organizations or institutions. Although distribution of the questionnaire started within scientific communities and their social network, the snowball sampling method was also used to reach academics who were not members of these communities. In this sense, the sampling method used in this study was successful, as almost half of the respondents were not members of a scientific community. However, the sampling method was not as successful, in terms of the geographical coverage of the respondents, because the responses showed a bias toward Europe. Further research, apart from uncovering how the ES concept is taught by academics from universities and research centers, is needed to provide a broader picture of ES teaching. For example, because the ES concept and its framework present an interdisciplinary approach that can be taught within different disciplines (e.g., ecology, economy, political studies) involving many different topics (e.g., mapping, economic valuation, landscape planning, cultural values), further research directions could focus on what exactly is being taught when teaching ES. This could mean exposure of various aspects related to which disciplines teach ES concepts and which aspects of the ES framework are being considered. Another relevant future research direction involves a study of current experience by non-academic teachers and, more importantly, investigation of how to promote a collaborative network between respective university lecturers and school teachers, because the inclusion of the ES concept in compulsory education is crucial for mainstreaming the ES concept in society. In this respect, inclusion of the ES concept in the Next Generation Science Standards, a multi-state effort in the United States to create, with teachers and researchers, new education standards for improving science education, was an important ES milestone (National Academies of Sciences, Engineering, and Medicine 2013). However, little is known about what and how the ES concept is taught at compulsory schools, and very little collaborative experience between school teachers and respective ES research academics has been reported. Future research directions in this emerging research area point to the need to help establish solid mechanisms to generalized collaborative practices between formal education and ES research academics.

## CONCLUSIONS

Our research addresses a novel research area related to the teaching of the ES concept by analyzing current ES teaching experiences from academia and exploring their potential to help improve and mainstream such educational experiences. Teaching the ES concept in a comprehensive, practical, and meaningful way could support ecological wisdom and literacy, and thus help ensure the proper dissemination and implementation of the ES concept, which may help achieve the SDG. When comparing teaching practices used by ES academics with current best educational practices described in educational literature, we have seen that many of the interviewed academics teach the ES concept in line with current best educational practices, and that the use of the best practices is influenced by the academics' experience in ES teaching. These results show that there is enough quality experience in the field of ES teaching to disseminate this knowledge and, therefore, to help improve and mainstream ES teaching practices. Thus, collaboration and networking among teachers with different levels of experience could help improve the quality of ES concept teaching and, therefore, public awareness and understanding of the importance that ecosystems and nature have on our well-being would increase. Finally, we suggest that sharing good practices in the teaching of the ES concept at different educational levels could play an important role that requires further attention.

*Responses to this article can be read online at:*
https://www.ecologyandsociety.org/issues/responses.php/13286

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**Data Availability:**

*The raw data that support the findings of this study are available on request from the corresponding author. The raw data are not publicly available because they contain information that could compromise the privacy of research participants.*

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