Ecosystem services as the silver bullet? A systematic review of how ecosystem services assessments impact biodiversity prioritisation in policy

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ABSTRACT

The concept of ecosystem services and their valuation have been used extensively across the last 20 years as a means of demonstrating the immense value of nature to policy-makers. Assessing ecosystem services and assigning an economic value to them has been thought of as the silver bullet. They were expected to bring the breakthrough for biodiversity prioritisation that is sorely needed amidst the current environmental crisis. The vast figures and values attributed to nature was thought to be capable of changing decision-makers' rational minds to prioritise biodiversity in their agendas. However, to date, there has been limited research that explores how the focus on ecosystem services assessments (ESA) has impacted on policy. This understanding is profoundly needed as, despite much discussion of ecosystem services, biodiversity loss continues. To understand how policy impact is considered in ESA research and what factors enable it, this paper presents the findings from a systematic review of 137 research articles investigating ESA at the EU level (the EU is considered the trailblazer of environmental policy in the international policy arena). Of the studies captured in the systematic review, 48% of the assessments included monetary valuation methods, 62% involved experts or stakeholders and 72% specifically referred to EU, regional, national, or local policy documents. We found that 8% of the articles reported on policy impact, whilst only 8% assessed the potential enabling and 2% the hindering factors of their research to influence policy. It was evident that economic valuation, although widely used, does not necessarily lead to a higher reported policy impact. On the other hand, wide stakeholder involvement was highlighted as a key element to reach policy impact. In this paper we argue that limited coverage of impact is also partly because research on ecosystem services and their valuation, somewhat paradoxically, does not necessarily focus on the impact of these assessments. The findings thus demonstrate a need for further empirical research into the reasons for the insubstantial coverage of policy relevance in scientific reporting. The results also indicate the necessity for a review of ecosystem services valuations' actual effectiveness as a means of communicating scientific research to policy-makers. Furthermore, a wider discussion on complementary or alternative ways to upscale policy impacts is required, along with a better understanding of the target audience's needs.

1. Introduction

The lack of political and economic consideration and prioritisation of biodiversity is the chief driver of the current biodiversity crisis (IPBES, 2022). Ecosystem services assessments (ESAs) were developed to show the plural values of nature including monetary and cultural benefits for key stakeholders applying both monetary and non-monetary valuations (Braat and de Groot, 2012; Costanza et al., 2017). The idea was that such immense value (e.g., the value of all ecosystem services in the world is estimated to be USD 16–54 trillion annually (Costanza et al., 1997))

cannot be further ignored – biodiversity must be prioritised. Although the concept of ecosystem services was integrated into nature-relevant policies, the current business-as-usual scenarios have hindered major policy breakthroughs. The alarming biodiversity loss continues (IPBES, 2019; OECD, 2017; WWF, 2020). It is therefore important to reflect on where we stand and raise the question: to what extent are ESAs working and what else should be done to increase impacts to adequately prioritise biodiversity in all fields of policy-making?

Worldwide, ecosystem services and their assessments have triggered myriads of relevant research especially in ecosystem services valuation

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(Costanza et al., 2017; Häyhä and Franzese, 2014). While a scientific discourse has been formulated around the concept of economic valuation and its ethics, ecosystem services have been prominently featured in key international and EU policies relevant to nature. Furthermore, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) has also been created (conceived to play a similar role to that of the Intergovernmental Panel on Climate Change (IPCC) (Jacobs et al., 2016)). At the same time, however, other policy fields show minimum consideration of ecosystem services (Bouwma et al., 2018; Mauerhofer and Laza, 2018). Despite the concept having been designed to impact policy, to date very limited information is available about the actual policy impacts of ESAs (Mandle et al., 2021; Posner et al., 2016a, 2016b).

In this paper, we seek to interrogate the evidence base to fill this knowledge gap. We assess whether, and to what extent, the existing research on ecosystem services and their assessments have addressed policy impact. Based on that, we consider how to increase the policy impacts of biodiversity and ecosystem services research. In so doing, we explore firstly, the reported policy impacts of ESAs and their research within the EU. Secondly, we analyse the enabling and hindering factors of these impacts through a systemic review of existing scientific literature. Thirdly, we then discuss how research can increase biodiversity prioritisation in mainstream policy.

2. Impacting policy and measuring policy impacts

In the words of Jones and Cleere (2014, p. 19), policy impact is the "contribution to how policymakers act and how policies are constructed", where impacts can be detected by altered political culture and policy development processes. Brewer (2013) points out that policy impacts can be manifested in improved policy effectiveness and uptake of research. Wilkinson et al. (2012) suggest a broader approach of assessing policy impacts through incorporating the dimensions of stakeholder relationships and exchanges between stakeholders (Alla et al., 2017). To impact on policy, information needs to be provided in a way that fulfils policy needs. This includes constructing such information in a way that feeds into a specific decision point within the so-called policy cycle (Dicks et al., 2014). Within the policy cycle, various stages (agenda-setting, formulation, implementation, monitoring and review) can be distinguished, which can serve as entry points to impact policy (Howlett and Ramesh, 2003). Often, however, a more complex and dynamic approach is adopted, which is complimented by an expanded set of factors influencing policy impact. The factors include, for example, knowledge loops, interactions of stakeholders and co-production of knowledge (Nutley et al., 2007; Fazey et al., 2014).

To allow a more layered understanding of policy impact, Nutley et al. (2007) distinguish between instrumental (a direct change on decision-making triggered by research), conceptual (change in attitudes and knowledge) and capacity building impacts (improved skills, training). Drawing on this work, Meagher and Lyall (2013) add two additional impact categories in order to integrate the consideration of long-term, more complex interactions and processes. The category of 'enduring connectivity' accounts for the relationship building processes between researchers and policy-makers, which may at some point result in instrumental policy impact. The category of 'culture/attitude towards knowledge exchange' addresses changes of view, with the presumption that beneficial cooperation of researchers and policy-makers will result in positive attitudes for collaboration, leading to integrated research into policy-making. Using these five categories (instrumental, conceptual, capacity building, enduring connectivity and culture/attitude towards knowledge exchange) Edwards and Meagher (2020) establish a framework to measure policy impacts. In addition to identifying the category of policy impact, this framework also considers additional elements: the aspects of impacts (who or what changed, how and what is the evidence), causes of impacts (what triggered the change, what enabled/hindered the change) and lessons learnt. These impact

categories and framework elements are drawn upon in this current research as a basis from which to assess the reported policy impacts of the selected literature.

Building on Edwards and Meagher (2020), in section 3.2 we consider mostly instrumental policy impacts (with changes including new policies, amendments to regulations, relevant decisions and EU and national implementation). In section 3.3, we focus on conceptual changes (changes to awareness and knowledge); capacity building; enduring connectivity (increased networks, relationships, connections), and change in culture/attitudes.

3. Ecosystem services assessments – not seeing the forest for the trees?

3.1. The development of ecosystem services and their assessments

Alarming and exacerbated loss of biodiversity compromises both the biosphere and human life by diminished delivery of fundamental ecosystem services (e.g., materials for food, clean water, pest control and climate change mitigation) (IPBES, 2019; Cardinale et al., 2012). Despite overwhelming scientific evidence on the vital importance of biodiversity and prominent biodiversity-relevant international processes demanding more ambition (e.g., the new Post-2020 Kunming-Montreal Global Biodiversity Framework, IPBES processes and the new EU Biodiversity Strategy for 2030), biodiversity is still not considered a priority in the mainstream political agenda (IPBES, 2019; Mace et al., 2018; WWF, 2018). Accordingly, in spite of their profound and long-term effects on society and economy, the challenges of biodiversity loss are not systematically integrated into policy. Such failure to regard and address these challenges according to their gravity, result in a lack of action and the continuation of a business-as-usual scenario, ultimately jeopardizing nature and our societies (IPBES, 2019; WWF, 2020).

Ecosystem services and their assessments, especially where they include monetary valuation aspects, were originally considered to be the 'silver bullet'. They were to turn the tide and raise the awareness of policy-makers about the importance of the services nature provide to humanity, their probable value and thus, the significance of its protection (Braat and de Groot, 2012; Costanza et al., 2017). Ultimately, the preconception was that if decision-makers have more understanding about the vast benefits of nature, they will value them more, consequently leading to biodiversity's adequate policy recognition and prioritisation (IPBES, 2019). Apart from researchers, practitioners have also welcomed ecosystem services and their valuation concepts. Many regard them as a useful (if mostly rhetorical) tool to increase awareness, enhance private funding and induce wider stakeholder participation. Moreover, they are perceived as having higher potential to resonate with policy-makers (Fisher and Brown, 2015). Many also believe that the concept is not necessarily exclusive, populating not only the idea of economic commodification, but rather constituting a demonstration technique that can go hand in hand with moral and intrinsic rationale to conserve nature (Chaudhary et al., 2015; Fisher and Brown, 2015).

Despite attracting the support of both researchers and practitioners, during its lifetime, the ecosystem services' concept has also received criticism. This is due to its utilitarian, anthropocentric and economic focus, which, it has been argued, risks omitting the intrinsic values of nature, and highlights primarily nature's monetary merits (Gómez-Baggethun et al., 2010). The originally intended rational metaphor of raising awareness of the abundant value of nature has been deemed by many to entail emphasising a neoliberal economic idea, whereby ecosystem services are conceived as purely market products (Norgaard, 2010). Rather than challenge the paradigm that causes biodiversity and ecosystem services' loss in the first place, this framing serves only to underline the current market mechanisms (Fisher and Brown, 2015).

In part as a reflection of it being a relatively young field, numerous discussions on the theoretical level are still on-going about specifying and

pinning down definitions and nuanced differences among associated concepts (Chaudhary et al., 2015; Fisher et al., 2008). Additionally, assessing ecosystem services is not a standardized process with universal steps and measures; as such its accounting is not without calls for adjustments. As they stand, the assessments require modification to include: accounting for uncertainty, the challenge of double accounting, scales and the monetarization of ecosystem services. Furthermore, the consequent focus on economic values often sets aside additional issues of socio-cultural importance and plural values (Arias-Arévalo et al., 2018; Chaudhary et al., 2015).

Despite the above noted limitations, the widespread use of ESAs by the scientific community can be connected to the argument that such a human (mostly monetary) values centred approach is needed to enable mainstreaming of the challenge and potential solutions among a wider range of stakeholders (Schröter et al., 2014). That is, to demonstrate nature in a language that people, particularly decision makers, are able to grasp (Bekessy et al., 2018). The idea behind the valuation of ecosystem services ("putting a price tag on nature") is embodied in the notion that decision makers will understand the immense value of ecosystems and their services. Thus, rational choices will be made to prioritise and protect them (Braat and de Groot, 2012; Costanza et al., 2017). Not surprisingly, ecosystem services findings are also mainly prepared for these specific stakeholders (Bekessy et al., 2018).

Although ESAs and various valuation tools to express biodiversity in economic and social terms are flourishing in biodiversity research (Costanza et al., 2017), the actual impact of ESAs on policy-makers appears to have received scant attention. As a consequence, knowledge remains scarce about their effectiveness in a policy-making context across a range of different scales, including the environmental policy-trailblazer: the European Union (Mandle et al., 2021; Martinez-Harms et al., 2015; Posner et al., 2016a, 2016b; Wright et al., 2017). Our purpose in this paper is to fill this knowledge gap, through a systematic review of existing ESAs and their plausible impact on policy.

3.2. Instrumental impacts of ecosystem services and their assessment in international and EU policies

Following plentiful research and numerous scientific discussions, the concept of ecosystem services has continued to gain ground over the decades since its coining. Notably this has included it being adopted by the UN's Convention of Biological Diversity (CBD) and the Millennium Development Goals in the early 21st century. A rapid uptake has been witnessed in multiple fields and disciplines, reaching a peak in 2005 with the global Millennium Ecosystem Assessment (MEA) synthesis report. The MEA provided frameworks and standards on definitions, which were the basis of many following initiatives and studies. For example, the Economics of Ecosystem and Biodiversity (TEEB) was launched in 2007 as a response to a G8+5's proposal to assess economic benefits of ecosystem services and the associated economic loss. In the same year, the idea of IPBES was formulated with the aim of establishing a body similar to the International Panel on Climate Change (IPCC), specifically for biodiversity. It came into realization in 2010 with the overall aim being to communicate the importance of biodiversity and ecosystem services and to transfer scientific messages to policy-makers. Since this era, ecosystem services have gradually received prominence in a wider portfolio of global policies (mostly environment and biodiversity relevant) including, for instance, the Convention on Biological Diversity's Aichi Targets, the Sustainable Development Goals and EU nature-relevant policies. They also become the focus of thousands of scientific articles (Chaudhary et al., 2015; Jacobs et al., 2016; Trégarot and Failler, 2021).

Of course, other similar terms have been forged over the years, which incorporate or cover the idea of ecosystem services (e.g., green infrastructure, nature-based solutions, nature's contributions to people), with differing 'policy careers'. Nevertheless, we strictly focus here on the ecosystem services term leaving aside the question whether it is useful to

have multiple overlapping terms running their parallel courses. Schleyer et al. (2015) and Bouwma et al. (2018) provide an overview of the uptake of the ecosystem services concept by nature-focused and other EU policies. They state that the concept started to enter the EU policy arena at the beginning of this century, occurring at first within the field of environmental policy attributed to the MEA and TEEB studies and their integration into CBD policies. A target was established within the EU's Biodiversity Strategy 2020 to map and assess ecosystems and their services of all EU Member States (the so-called MAES process) (European Commission, 2011). In support of this, a universal typology, the Common International Classification of Ecosystem Services (CICES), was produced. The international tendency of highlighting nature's services in communication was also picked up by the European Commission, who underlined the social benefits of the Natura 2000 protected area network of the EU (e.g., Brink, P. ten et al., 2013). Natural resources policies (e. g., the Forest Strategy, the Common Agricultural Policy, the Marine Strategy Framework Directive and the Water Framework Directive) also started to incorporate ecosystem services. However, the concept has only appeared to a limited extent in other policy fields of the EU (e.g., Urban Strategy, Adaptation Strategy, TEN-T (Trans-European Transport Network), Cohesion and Regional Policy) (Bouwma et al., 2018; Maes et al., 2013). Mauerhofer and Laza (2018), when analysing legal documents of the EU, found that in 2017, in binding EU legislation the term "ecosystem services" occurred 42 times. In other, non-binding EU documents (e.g., action programmes, strategies) this number reached 123. The importance of the term within the specific policy also varies, with some policy documents directly focusing on the concept (e.g., the Biodiversity Strategy and the Forest Strategy), while other documents (e.g., the TEN-T) merely note it (Bouwma et al., 2018). To a certain extent this variation relates to the nature of EU policy making. Potentially, one of the reasons the term of ecosystem services was unable to infiltrate more universally is because the texts of legislation are complicated to amend, with many of the policies and legislation having been formed decades ago. In spite of this, however, even more recent and relevant policy documents (e.g., the EU Adaptation Strategy) only refer to the concept marginally. Or rather, they tend to refer to it as a general concept of ecosystem services, but do not distinctly use the specific term, nor necessarily incorporate it in the main communication (Bouwma et al., 2018). Further inconsistencies within one field of policy and related documents can also be detected (e.g., one communication of water policy refers to ecosystem services specifically, which cannot be found in other related policy documents) (Bouwma et al., 2018). Also, due to the fact that EU policy follows a sectorial approach, policies have limited scope to address the complexity of ecosystem services, and commonly centre around those services that are important for that specific sector (Bouwma et al., 2018). In terms of policy implementation, only a few policies require that Member States report on progress also in terms of ecosystem services (Bouwma et al., 2018). Among these fewer still are legally binding instruments (e.g., the Habitats and Birds Directives, the Water Framework Directive and the Marine Strategy Framework Directive).

Starting from 2020, most EU policies have been revised as a result of reaching the end of their original intended duration (e.g., the Biodiversity Strategy was mandated until 2020 thus, a new 10-year strategy was published in 2020). Also, the new EU 7-year budgetary period started from 2021. Accordingly, numerous new policies, amendments and related regulations have been brought in to being. Despite this new opportunity to incorporate ecosystem services, to date it does not appear to have been enthusiastically taken up. For instance, the most promising venue of ecosystem services, the new EU Biodiversity Strategy for 2030 contains only limited reference to ecosystem services compared to the EU Biodiversity Strategy 2020. Specifically, whilst the 2020 strategy included the term ecosystem services 23 times, the 2030 strategy makes direct reference to it only nine times. Similarly, the role of ecosystem services in the strategies has also changed: while the 2020 strategy considered ecosystem services as a target to map and assess, the 2030

strategy rather turns towards restoring ecosystems (European Union, 2011; 2020). This change of orientation may be because the MAES process and its own timeline were to be completed by 2020, with the focus thereafter being on restoring ecosystems. Nevertheless, while progress on mapping and assessing ecosystem services and associated impact have been significant at both the EU and national levels (Maes et al., 2020), evidence of instrumental impacts and the operationalizing of ecosystem services remains relatively scant. In turn, the limited integration of ecosystem services into policy documents makes operational integration practically non-existent (Rounsevell et al., 2019).

3.3. Operationalizing ecosystem services – conceptual and other policy impacts

Despite its somewhat limited integration of non-nature related sectorial EU policies, the ecosystem services concept reached operational level in urban planning, national park management and river basin management decision making. At the same time various in-the-field assessment cases mushroomed all around the globe involving a wide range of stakeholders, including policy decision makers (Dick et al., 2018; Jax et al., 2018; McKenzie et al., 2014). The analysis of these assessment cases provides valuable insights about the current status of operationalization, but with very few evidenced impacts. Dick et al. (2018), for instance, in a survey assessing 27 EU case studies of ESAs, show that only 13% of respondents indicated some change of actions (most respondents noted changes e.g., in awareness, communication, community processes and opportunity to input into decision-making). Saarikoski et al. (2018) through an assessment of 22 case studies, show that limited policy uptake was unsurprising as the ultimate aim of the research was not to feed into policy. Their analysis found no mandate in these case studies from a policy aspect or consideration of policy timelines. This was coupled with lack of national policy sector participation. Nonetheless, information was shared and often co-produced with local policy stakeholders (e.g., municipality spatial planners), who could operationalize the concept in their work.

Overall research on how the concept of ecosystem services is utilized on a wider scale, and what impacts it has at a higher level (e.g., at an EU policy scale), remains limited and piecemeal (Dick et al., 2018; Posner et al., 2016a, 2016b). The few studies that have made attempts at such analysis of policy uptake have not produced encouraging findings. Waylen and Young (2014), for example, indicate that the UK National Ecosystem Assessment was barely used for any operational decision. Schleyer et al. (2015), as well as Russel and Turnpenny (2020), report that policy actors and relevant institutions have faced difficulties in grasping and utilizing the concept, while often they also stigmatize it purely as an environmental agenda. The state of the research raises the concern whether ESAs, in parallel to focusing on the quality and accuracy of studies, have also sufficiently focused on their impact.

3.4. Potential explanation of limited policy uptake and impact

Mauerhofer and Laza (2018) point out that in legal practices the term ecosystem services is mostly (90%) detectable in soft legal documents (under the scope of policies without enforcing power). Such documents, however, do not divulge specific interpretation of the scope, definition or implementation and enforcement mechanisms of ecosystem services, and thus, can be easily omitted. The term ecosystem services is often considered as a buzzword and an unessential addition to biodiversity. Authorities and implementers rather prefer to focus on biodiversity without the technical knowledge, tools of assessments and the adequate resources to map and value ecosystem services (Ainscough et al., 2019; Mauerhofer and Laza, 2018). Based on surveying over 100 researchers and policy-makers, Ainscough et al. (2019) show that numerous frustrations are present regarding the concept. One of the most important underlying issues is the conflict between the ecosystem services community when it comes to expressing ecosystem services in economic

terms. Also problematic is the related limited integration of social-cultural values and the use of inter- and transdisciplinary sciences. Additionally, Ainscough et al. (2019) report that survey participants expressed frustrations because of limited demonstrable policy impacts due to institutional hindrance factors, silos and utilitarian technicalities. Also, limited user-friendliness contributed to missing standardization of data, an overwhelming number of methods and a hard-to-grasp academic language. The lack of integration with the sustainability agenda was furthermore mentioned as a weakness. Meanwhile, Rounsevell et al. (2019) report, based on interview data, that ecosystem services were not considered to demonstrate well the options to make decisions (which was supposedly one of its original intentions), because of the complexity involved in evaluating trade-offs among services. Schleyer et al. (2015) add the problematic issue of vagueness in the concept. In their analysis of EU policies, Schleyer et al. (2015) found that few Directorate Generals (the various "ministries" of the European Commission responsible for specific policy fields) considered ecosystem services as relevant for their field. They highlight its complexity and technicality as a challenge, as well as limited knowledge and capacity in this field to be able to deal with the concept in the policy sphere. An additional difficulty pointed out by them, is not explicitly a problem with mainstreaming the ecosystem services concept, but rather how to prioritise environmental issues in other policies and sectors. The term ecosystem services is not favourably considered by certain DGs and sectors, because it centres around the environment (ie. with this creating the risk of being perceived as a hindrance factor in the way of development). Accordingly, there is limited consideration given towards integrating environmental aspects into other areas of policies. Alongside, this is often further stalled by the perception of environmental related conventional command and control policies, which are considered to restrict and prohibit actions that impact the environment. Dick et al. (2018) also identify a similar perception of ecosystem services from the practitioners' points of view. Practitioners reported the main hindrance of policy integration is lack of political will; a finding which has subsequently been backed up by other independent research (Rose et al., 2018; Rounsevell et al., 2019).

Schleyer et al. (2015) note that the participatory approach often used in ESAs could aid integration of the concept in various policy spheres. However, exactly because of the participatory approach they also assert that it can be regarded as a cumbersome and lengthy process. Furthermore, Jax et al. (2018) point out the process of ESAs which, in contrary to the assumption of being a linear process, is more commonly a multi-step, multi-dimensional, complex and time-consuming task. Rall et al. (2015) also detail challenges specifically in terms of urban planning. They consider this to be due to differing cultural values of ecosystem services and socio-economic interests of stakeholders, as well as low awareness of ecosystem services and the resulting hurdles in policy integration and implementation.

In some other cases (and contexts), it is concluded that further restructuring from the policy and governance sides would be needed for successful integration of ecosystem services. This in turn requires inclusive and integrative policy approaches that could connect potentially involved governance actors (Mann et al., 2015; Russel and Turnpenny, 2020). It is further suggested by Rose et al. (2018) that in order to fully integrate a concept at the policy level, other factors need to be enrolled. They include message framing and persuasive communication, windows of opportunities and solution-seeking policy-makers. However, in the case of Dick et al.'s (2018) case study-based survey, only 3% of the respondents reported that they shared the ESA results with additional stakeholders not involved in the assessment. Jax et al. (2018) found that none of the case studies featured in their study were produced for a policy interest. Limited interaction between decision-makers, scientists and practitioners can result in poor uptake of any scientific evidence (Rose et al., 2018).

If ESAs as stakeholder-driven processes are to impact policies, it is essential to understand the ecosystem services governance and operation. It is needed to comprehend the conflicts, values, culture, set-up and

functioning of institutions, of which currently we have limited knowledge (Schröter et al., 2015; Primmer et al., 2015). Other associated under-researched issues include facts about how knowledge of ecosystem services influences decision making, and in turn how this results in ecosystem services protection or consideration in practice (Primmer et al., 2015).

Due to the nature of especially non-instrumental policy impacts, however, it also needs to be acknowledged that impacts can be manifested later or in other processes. Consequently, it can be difficult to monitor, report and follow-up on them. This aspect nevertheless further highlights the importance of improving the current understanding and assessment of policy impact.

3.5. Focus of this research

More adequate ambitions to deliver policy-savvy messages to policy-makers' desks call for an improved understanding of, firstly, how ecosystem services assessments facilitate decision-making and prioritisation of nature, and secondly, what policy impacts have been reported so far by the scientific community. It is also essential to understand how and why certain impacts have been achieved according to the scientific evidence available and what factors enabled them. Comprehending achieved policy outcomes and impacts can improve not only the format of knowledge, but also further biodiversity research and communication approaches. This can aid to set nature higher on the political agenda, and ultimately as a result, in practice too.

To understand how ecosystem services and their assessments could come closer to functioning as the 'silver bullet' for achieving policy impacts, and how articles report policy influence, in the research project supporting this paper we analysed studies that have both carried out ecosystem services assessment and highlighted policy relevance. This was limited to studies in which policy relevance was highlighted either in relation to or within the area of the European Union (considering this specific region as one of the trailblazers of ecosystem services and biodiversity policy and related funding). In undertaking the analysis, we were guided by the following research questions.

- Which scientific articles, dealing with a specific ESA case, report policy impact?
- What type of policy impact do they report on?
- What are the key characteristics of all such reported ESAs?
- Do ESAs that include a monetary valuation report more policy impact?
- What are the reported enabling and impeding factors for policy impact?

4. Materials and methods

4.1. Process of the systematic review

To understand how ecosystem services assessments reportedly impact policy within the European Union, a systematic literature review was conducted with the help of Scopus, using specific keywords concerning a ten-year period (2011–2020) to ensure inclusion of actual and recent policy-relevant articles. As our assumption was that ESAs were tailored to target specific policy-makers according to the ESA's original purpose, we were interested in ESA case studies with specific empirical evidence. Whilst we acknowledge that grey literature may hold additional relevant information about policy impacts, we intentionally limited our study to investigating how peer-reviewed scientific research articles reported on and considered policy impact. Therefore, only peer-reviewed journal articles were considered with specific ESA cases involved. Drawing on the systematic mapping framework of Rasmussen et al. (2018), the following review methodology was applied (Fig. 1). The total number of research articles that specifically referred to both ecosystem services and policy impact were modest in numbers, merely

30 pieces, with many being out of the scope of the EU (on Scopus on July 1, 2020). Therefore, a wider pool of expressions was applied, including key words that were used in previously identified articles considering both ecosystem services and policy. The following primary search framework was adopted after several trials and combining various wordings, ensuring that the widest possible coverage of papers is included. The searches took place between 1st May and June 30, 2020. Keywords included: 1) ecosystem services, 2) valuation, 3) policy, 4) impact, 5) case, 6) EU. The specific search string applied was the following:

TITLE-ABS-KEY ("ecosystem services" AND "valu*" OR "asses*" OR "monetiz*" AND "evalue*" AND "policy" OR "decision*" OR "decision-mak*" OR "decision mak*" AND "impact" OR "effect" OR "implication" OR "relevance" OR "outcome" OR "embed*" OR "steer*" OR "influenc*" OR "driv*" AND "case") AND ALL (Europe* OR "European Union'' OR "EU").

Articles provided by this search were combined in one list. The search yielded 621 entries. Secondary searches for narrowing down the number of papers proved inconclusive. From a subsequent preliminary screening it was concluded that many articles could be excluded based on their title or abstracts. This was due to there being either: 1) no EU policy relevance as per the geographical scope,[1] 2) the key words found in the article not being used together in the context of ecosystem services and policy implications, 3) no relevant and primary ESA case study, and/or 4) the article being a review paper, editorial or theoretical paper only.

Screening of abstracts based on the criteria noted above resulted in 201 articles. These were then further fine-tuned due to case studies not being first-hand assessments, including only a review of assessments, focusing primarily on theoretical aspects, not actually focusing on ecosystem services assessments but rather, for example, on a species valuation, or a technical tool. This further step, undertaken via the reading of the entire article, eliminated additional records, resulting in a final selection of 137 articles.

In order to understand these articles and the various characteristics, scope and impact of the case studies reported within them, the selected 137 articles were analysed and coded in a spreadsheet according to the following in-depth content analysis categories (Annex 1). The categories included.

1) Article information

This category was further divided by sub-categories including the name of the authors, the title of the scientific article, publishing date and the title of the journal. This information was derived based on the information provided in the article.

2) Description of case study

This category was further divided by sub-categories including the case study's given name by the authors of the paper (based on location and focus of the case study), case location (country/region/settlement) and case dimension (social, economic, environmental or all aspects). The specific purpose of the assessment as per the article's stated objective was also noted in a separate cell. A pre-prepared list of multiple stakeholder selection was applied. Source of funding was also recorded through a pre-prepared list of multiple selection.

3) Ecosystem types and services assessed

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[1] UK-based case studies are included in the review in case they were compiled before 31st January 2020 or contain EU policy relevance before this date. Other non-EU countries e.g. Iceland, Switzerland and Norway case studies are also included if the study provides specific EU policy relevance.
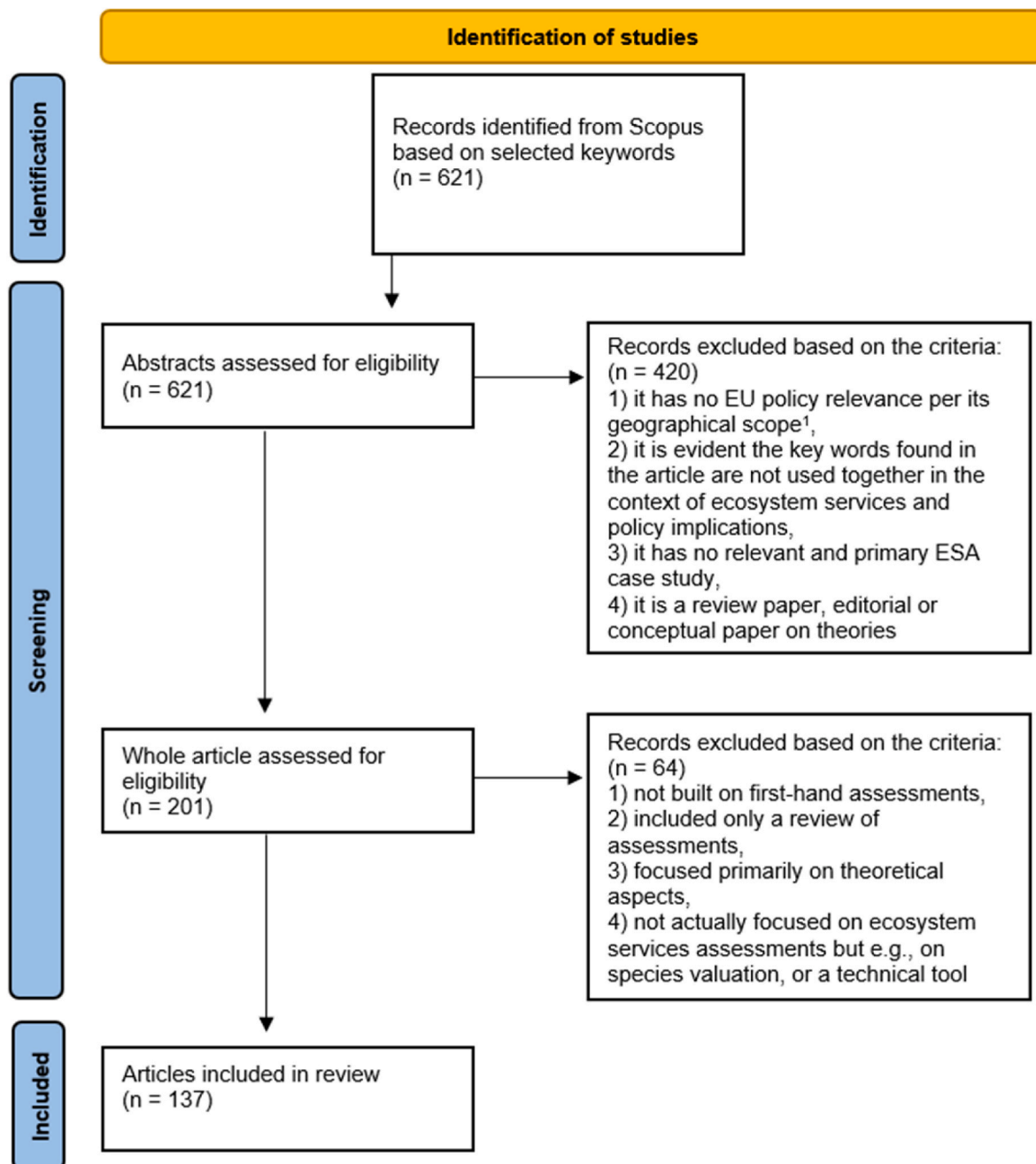
Fig. 1. Prisma chart of the systematic review process.

This category was divided into sub-categories of ecosystem type (e. g., forest, marine, grassland) and ecosystem services assessed, as recorded per the article.

4) Valuation methods and stakeholders' participation

This category was divided into four sub-categories and collected information on whether the case study relevant research included economic evaluation, and if included, what type and methods (revealed (e. g., using market prices or hedonic price methods) or stated preference (e.g., using contingent valuation or choice experiment)) were applied. Non-economic methods used for the assessments were also included. Involvement of stakeholders was marked, as well.

5) Research results

This category collected information about the output of the research, the key messages formulated by the research and the research limitations noted.

6) Policy aims

This category recorded information on the intended policy aims. Namely, whether the research had a mere informing[2] potential, or the purpose was to specifically assess a situation ex ante or ex post. Additionally, data was collected in terms of the specific policy field addressed

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[2] There are additional categories of ESAs on top of being informative including e.g. explorative, decisive, design (e.g. Barton et al., 2018). However, under informing we mean all the other categories, as well, as we deem that all of them to inform policy.

as noted by the article (e.g., spatial planning, agriculture) and any specific EU/national/local policy noted and addressed (e.g., the Habitats Directive or the Cornwall Maritime Strategy).

7) Intended scope of policy impact

This category focused on the intended policy impact scale, as noted by the article, being either local, regional, national, EU or international (beyond EU).

8) Specified policy target group

This category aimed to list the policy-makers addressed, as specifically noted by the article.

9) Reported policy impact

This category contained four sub-categories, and was based on Edwards and Meagher's (2020) policy impact classifications. In the first sub-category the type of policy impact was noted according to the classification of instrumental, conceptual, capacity-building, enduring connectivity, and culture/attitudes towards knowledge exchange. Following literature (Edwards and Meagher, 2020), we considered instrumental those reported changes that included amendments to regulations, relevant decisions, implementations and actions; conceptual changes were perceived as changes to awareness and knowledge; capacity building was noted if changes to capacities were reported along with increased skills and expertise; enduring connectivity was marked if networks, relationships, connections were built; culture/attitudes change was noted if clear implications of attitude and behaviour change were reported by the article. In the second sub-category, the level of policy impact was recorded marking either low, medium, high or unknown. This was classified as per researchers' judgment based on the information provided by the article. The third sub-category captured the type of policy impact listed by the article, which was a free-floating text category and included information according to the article's data. This included e.g., incorporation of results to policy relevant discussion or an approach to investigate policy and industry change. The fourth sub-category included information on whether the provided evidence was strong, ambiguous, weak or unknown as per the experts' judgement. The selection of strength of evidence depended on the information provided by the article. If the policy impact was evidenced clearly with specific information (e.g., the particular process of how the assessment entered into policy consideration or pieces of policy documents referring to the ESAs), it was deemed strong. If references were made to policy consideration but it was unclear how specifically it achieved impacts even though its impacts were highlighted, the ambiguous category was selected. If impact was noted, but limited or no evidence was provided, it was considered weak or unknown.

10) Policy impact factors

In order to assess the reasons driving desired policy impacts and reasons impeding having these policy impacts disclosed by the article, two corresponding sub-categories were included.

It is important to highlight that, across all categories, data was compiled solely as per the information disclosed by the article and further speculations (even if they might have been straightforward) were avoided.

4.2. Analysis of the articles

Following the categorisation procedure, we undertook an in-depth content analysis of the articles and performed some simple, descriptive statistics. The in-depth content analysis (Bryman 2016) of the articles was performed according to the main research questions –

empirical cases reporting policy impact, type of policy impact, characteristics of those ESAs that report impact, the role of monetary valuation, and finally, enabling and impeding factors in achieving policy impact. In doing so, we adapted and closely followed the PRISMA approach (Liberati et al., 2009). Subsequently, the articles were analysed with simple descriptive statistics assessing the tendencies in the main categories and their relevant sub-categories. As the evidence base is highly diverse and context-specific, which makes direct comparison of various factors not particularly relevant, the goal was to understand the trends primarily qualitatively.

5. Results

5.1. ESA might have peaked with overwhelming concentration in Western Europe

An overview of the main elements of the systematic review can be found in Table 1. The numbers of papers published increased year on year between 2011 and 2018, which was the peak-year with most ESA articles referring to policy impact. After this year a gradual decrease can be noted up to 2020 (Fig. 2). Relevant articles were published in 63 journals, with most papers appearing in Land Use Policy (13), Ecological Indicators (12) and Ecosystem Services (8). Region-wise, most cases are from Western and Southern Europe with only a minority depicting cases from Eastern Europe (15). Altogether 26 EU countries were covered. The countries with most assessments were Italy (23), the UK (21), Spain (15) and Germany (15). Many articles (13) include multiple cases having EU or regional coverage.

5.2. Funding of the research mainly from national and EU sources

National sources funded 41% of the research (often co-funded with other private or regional sources), while 35% was covered by EU funding mechanisms (e.g., FP or Horizon funds, Interreg, LIFE) or by a mix of EU and national sources. Only a small segment of the papers (5%) note private sector or NGO contributions to the research. One-fifth of the articles did not note any funding received for the scientific work.

5.3. Relatively well-balanced coverage of environmental, social and economic dimensions

In terms of case dimensions, 54% of the articles focus on all three - environmental, social and economic – aspects, while 23% of the articles focus on at least two aspects of the three. Research articles that are predominantly centred around either social or economic or environmental aspects are less than 5%. For instance, articles with primarily environmental focus are centred around the physical, biological and ecosystem conditions (e.g., Lehmann et al., 2014; Santos et al., 2018). Articles with a chief economic interest focus on, for example, investigating forest owners' willingness to accept contracts for providing ecosystem service (Vedel et al., 2015). Articles with a centre of attention on social aspects discuss ecosystem services with a main purpose of understanding social preferences (e.g., Rosário et al., 2019), perceptions, or the use of ecosystem services for social issues (e.g., De Meyer et al., 2013).

5.4. High but not universal stakeholder involvement

The majority (62%) of the assessments included some level of involvement of stakeholders. Thirty-eight percent of the case studies either did not specify the extent of stakeholder involvement, or the specific stakeholders involved, or did not consult stakeholders. Twenty-eight percent of all research papers include more than one stakeholder. Frequently named stakeholders involved in the research are specified as local communities (25% of the articles), national, regional or local governments or relevant authorities (21% of the articles), business

Table 1
Summary of the main results of the systematic review.

| No. of articles assessed	No. of journals including relevant articles	No. of countries covered	Rate of articles cover all four ecosystem services types (provisional, regulating, cultural, supporting)	Rate of research including stakeholders	Rate of research applying monetary valuation
137	63	26	42%	62%	48%
Rate of research referring to policy documents	**Rate of research referring to specific EU policy documents**	**Rate of research specifying policy target group**	**Rate of research including policy impact**	**Rate of research describing enabling factors of policy impact**	**Rate of research describing hindering factors of policy impact**
72%	55%	22%	8%	8%	2%
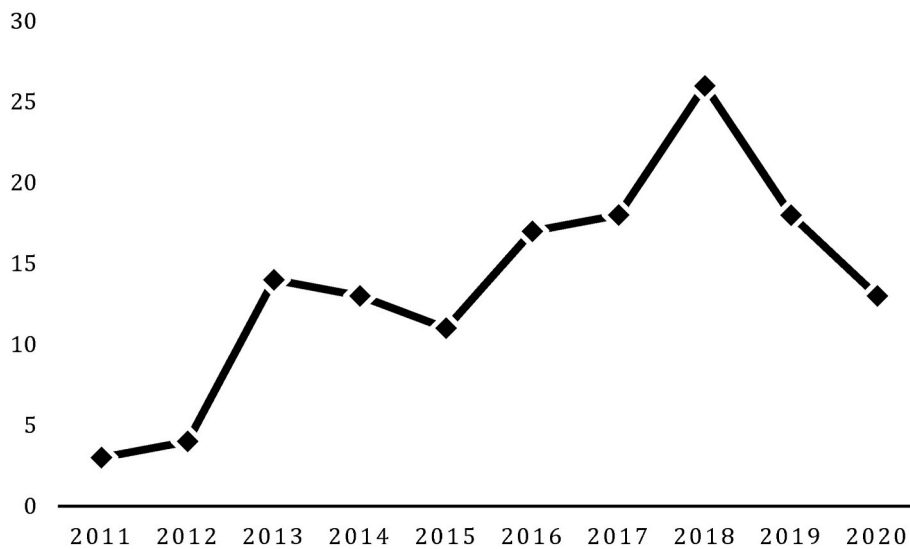
Fig. 2. Number of papers including ESA referring to policy impact per year.

participants (12% of the articles), NGOs (11% of the articles) and general public (9% of the articles).

5.5. Agriculture and anthropogenic ecosystems in focus

Twenty percent of the assessments do not specify the ecosystem types, but rather consider all relevant ecosystems in a given area. Eighteen percent of all articles assess agroecosystems, cropland or other agriculture related ecosystems, 16% assess freshwater and wetlands habitats, 15% are centred around coastal, estuary or marine assessments, 15% tackle forests, 13% urban or anthropogenic ecosystems. A smaller number of articles include grassland, heathland, scrubland and mountain ecosystems. Thirty percent of the articles focus on more than one ecosystem type.

5.6. Focus on nutrition and cultural ecosystem services

Sixty percent of the articles assess food, fodder, hay, etc. that serve as nutrition, while 58% articles evaluate recreation and tourism. Many articles focus on cultural heritage (45%), raw materials and energy (39%), water regulation and flood control (37%) and carbon sequestration (31%) as an ecosystem service. Articles assessing more than one ecosystem service, on average, include more than six services within one assessment. Forty-two percent of the research papers evaluate all four types of ecosystem services (provisioning, regulating, cultural and supporting). Twenty-three percent focus on three types, 12% on two types and 23% only on one type.

5.7. Monetary valuation methods play a key role

Forty-eight percent of all the research papers incorporate some type

of economic valuation. Twenty-one percent applied more than one economic method usually mixing stated preferences with revealed preference methods. Most commonly used methods included market price analysis (30% of the relevant cases), value transfer (30% of the relevant cases) and willingness to pay (20% of the relevant cases). Additional, less frequently applied methods included choice experiment, willingness to accept, cost-benefit analysis, replacement costs, avoided costs, damage costs, opportunity costs, surrogate markets and shadow prices. No additional evaluation methods (on top of economic valuation) were applied in only 7% of the economic valuation cases.

In the other 52% of all cases, non-monetary evaluation methods were used, with these ranging from literature reviews, case study analysis, GIS and land use data assessment, scenario building and modelling, to surveys, interviews, focus groups, and workshops.

5.8. Only a minority of articles with recommendations to specific policy

Most assessments fell into the "providing information in general" category (94%). However, due to overlaps or non-specified policy relation, some assessments (7%) were considered to be providing information ex ante or also ex post. Concerning fields of policy, the majority of the articles covered land-use/spatial and urban planning (43%), agriculture (19.5%), conservation/biodiversity/restoration (17%), water (12%), marine and fishery (11%) and forestry policies (8%). A few articles were centred around regional planning, energy, pesticides, environmental impact assessment, accounting, trade, tourism, climate change and health policies. Thirty-four percent of the articles named more than one policy area focus, while 62% solely highlighted one field of policy. Four percent of the articles did not refer to any fields of policy.

In terms of specific policies and policy documents highlighted, 28% of the articles did not include any reference to pieces of policies. Fifty-

five percent of all articles made a note of one or more pieces of EU policies, whereas only 3% referenced international processes (mainly, the Convention on Biological Diversity, Ramsar Convention or the Sustainable Development Goals). Sixteen percent of all case studies addressed either specifically or in general national, regional or local policy documents. As regards these legislation pieces, 17% of the articles referenced the Common Agricultural Policy, 15% the Habitats and Birds Directives, 10% the Water Framework Directive, 8% the Marine Strategy Framework Directive or the Common Fisheries Policy and 2% forestry policies (EU Forestry Strategies or forest management plans). Other EU policies documented include the Strategic Environmental Planning or Environmental Impact Assessment (3%), renewable energy policies (Renewable Energy Targets and the Renewable Energy Directive) (3%), the Invasive Alien Species Regulation (2%), the EU Strategy on the Adaptation to Climate Change (1%), the REACH regulation, the Pesticide Regulation and the Environmental Liability Directive (1%) and the Air Quality Directive (1%). Concerning the scale of policy impact envisioned, 4% were assessed to be international (beyond EU), 14.5% at the EU level, 17% national, 46% regional and 54% local.

5.9. Limited coverage of how policy messages presented

It is perceived that in 89% of the cases, the policy message document might have been the research paper itself. Few scientific articles disclose additional elements about how the policy messages were deciphered for the target audiences. In these cases, policy messages were delivered through participatory workshops with policy-makers, compiling recommendations directly to policy-makers, directly inputting the results of the assessment to policy documents, discussions and expert meetings with policy-makers. Concerning the target audience for receiving policy messages, 78% of the articles do not specify it. Those articles that do note the policy target group highlight audiences as per scale (e.g., EU, regional or national policy-makers) without further specification (8% of the articles), or by sector (e.g., urban planning or forest managers) (8%). Only in a few instances (3%) do the research articles specify the exact target group (e.g., Lazio Regional Government).

5.10. Policy impacts not in focus

An overwhelming 92% do not cover impacts. Those few (8%) that report on policy impacts (Table 2) refer to conceptual (all of the articles reporting impact) and capacity building aspects (7%). Instrumental (4%), enduring connectivity (4%) or changes to culture/attitude (5%) can also be traced.

In terms of how these impacts can be evidenced, only 2% was deemed to provide sufficient information to be categorised into the "high" category. An additional 2% was grouped as having "medium" evidence for policy impact. The policy impact level of 3% of these articles was assessed as unknown.

Regarding the policy impact achieved by the research articles, 3% of the articles reported concrete outcome as the direct effect of the research. In one case, local policy documents referred to a specific tool that was developed for finding and assessing urban green space in the United Kingdom (Raum et al., 2019). Another ecosystem services assessment in Alentejo, Portugal resulted in changing cycling and biking routes within the protected area and the ecosystem services approach was integrated to the National Park management plan (Clemente et al., 2019). Holzinger et al. (2014) assessed how Birmingham integrated ecosystem services assessment into decision-making at the municipal level. And, an assessment on the border of Austria-Hungary and the relevant discussions with stakeholders achieved integration of the ecosystem services and landscape framework into the nature conservation and regional development project: 'Biosphere Reserve Neusiedler See' (Hermann et al., 2014).

Other, 'softer' outcomes noted include mostly measuring the feedback from stakeholders and their opinions of the assessment. According

to the involved stakeholders, the applied approach was useful and can serve as a potential tool to identify policy changes or interest to incorporate ecosystem services into management practices (e.g., Corrigan et al., 2019; Ray et al., 2019). In 4%, the evidence of policy impact was deemed strong, in 4% ambiguous and in one case unknown. Five percent (seven of these research articles) also reflect on the potential enabling factors, while only 2% disclose plausible hindering elements standing in the way of ecosystem services' policy impact.

5.11. Context-specificity and being need-driven as key enablers, lack of resources and engagement as key barriers

On the enabling factors, scientific articles highlighted needs-driven research and a clear aim on how the data can be applied for policy. Evident showcasing of both qualitative and quantitative values, importance of exchanges and creating opportunities for dialogue (workshops, working together) were also highlighted as key enablers. Concentrating on specific local issues and showing examples with adequate and underpinned methodology were additional success factors (Burdon et al., 2019; Raum et al., 2019). The presentation of the results should happen in the relevant format, attracting attention and raising awareness (Holzinger et al., 2014). The involvement of stakeholders, joint stakeholder planning, joint selection of ecosystem services and mapping methods should be perceived on a participatory basis aiming for consensus in certain decision points (Burdon et al., 2019; Hermann et al., 2014; Holzinger et al., 2014). Identifying policies to feed into, along with relevant institutions, were also stressed as a key enabling factor. Recommendations on how to improve the management of these ecosystem services and how decisions affecting them could be better informed after joint stakeholder involvement were also noted (Holzinger et al., 2014; Oikonomou et al., 2011). The early identification of implementation barriers and opportunities, were additionally highlighted (Holzinger et al., 2014; Oikonomou et al., 2011). The application of practical tools can overcome the frequently used argument that ecosystem services accounting can be too complicated, money- and time consuming (Holzinger et al., 2014). Thus, user-friendliness, transparency, flexibility and scientific reliability are key elements for ecosystem services assessment impacting policies (Broekx et al., 2013). Preliminary steps of adequate mapping of social actors, initial conflict sources, understanding of social preferences and functioning of institutions were also earmarked as potential success factors (Oikonomou et al., 2011).

As for the hindering factors, lack of resources, engagement and political will were highlighted. More specifically, lack of funding, lack of endorsement within the institution, lack of time and timeline, lack of local champions, lack of engagement within different departments, staff changes, lack of follow up activities, challenges in quantifying ES, lack of data interpretation, lack of effective communication of results, narrow-mindsets with regards to incorporating ES, insufficient policy drivers with lack of incentives to tackle biodiversity loss and lack of target audience, were all identified as providing hurdles in the way of policy impact (Raum et al., 2019; Holzinger et al., 2014). Mismatches between evidence provided by the scientific community and evidence demanded by decision-makers may also act as a key hindrance (Holzinger et al., 2014). Ecosystem services are often not characterised in economic terms, which according to one research paper may also prove an obstacle for policy impact (Holzinger et al., 2014). Lack of clarity of science communication (e.g., inadequate format for policy-makers, complex terminology) and gaps in evidence (in some cases only those services are mapped for which data are available) can cause limited policy uptake (Broekx et al., 2013). The scale of research not overlapping with standard policy scales can also result in limited policy consideration (Broekx et al., 2013). Social perception of ecosystem services and assessment tools not being inclusive on some cultural ecosystem services, including for instance, health or aesthetic value, can signify additional difficulties (Raum et al., 2019). Another article

Table 2
Overview of research articles reporting policy impact.

Authors	Article title	Year	Country	Stake-holder partici-pation	Ecosystem assessed	Monetary valuation	Specific policy document noted and addressed	Policy-makers addressed	Policy impact and evidence
Farella, G., Menegon, S., Fadini, A., Depellegrin, D., Manea, E., Perini, L., Barbanti, A.	Incorporating ecosystem services conservation into a scenario-based MSP framework: An Adriatic case study	2020	Italy	Yes	Marine	No	Marine Strategy Framework Directive, Common Fisheries Policy, Birds and Habitats Directives	Regional policy-makers, Environmental agency, Spatial planners	Workshop parti-cipation and involvement in research
Raum S., Hand K.L., Hall C., Edwards D.M., O'Brien L., Doick K.J.	Achieving impact from ecosystem assessment and valuation of urban greenspace	2019	UK	Yes	Forests	No	Local plans	Local policy-makers	Policy documents referring to the tool and the results of the assessment
Burdon D., Potts T., McKinley E., Lew S., Shilland R., Gormley K., Thomson S., Forster R.	Expanding the role of participatory mapping to assess ecosystem service provision in local coastal environments	2019	UK	Yes	Marine	No	Environmental Impact Assessment, Strategic Environmental Assessment, local environmental planning, local coastal planning	Local policy-makers	Follow up information from workshop participants on the use of research
Ray D., Petr M., Mullett M., Bathgate S., Marchi M., Beauchamp K.	A simulation-based approach to assess forest policy options under biotic and abiotic climate change impacts: A case study on Scotland's National Forest Estate	2019	UK	Unknown	Forest	No	EU Forest Strategy, national forest policy	National level on forest policy, and at the forest district level	Informing policy about alternate land management and incorporation of results at national level policy discussion
Corrigan E., Nieuwenhuis M.	Evaluating Goal Programming as a Backcasting Tool to Assess the Impact of Local Stakeholder Determined Policies on the Future Provision of Ecosystem Services in Forested Landscapes	2019	Ireland	Yes	Focus on all ecosystems on a given area	Yes	National forest policy	Local County Council, Environmental Protection Agency, National Forest Authority, National Parks and Wildlife, Inland Fisheries Ireland	Informing national level stakeholders and engaging in discussions and testing policy options
Clemente P., Calvache M., Antunes P., Santos R., Cerdeira J.O., Martins M.J.	Combining social media photographs and species distribution models to map cultural ecosystem services: The case of a Natural Park in Portugal	2019	Portugal	Unknown	Focus on all ecosystems on a given area	No	Natural Park's management plan	Natural Park management, tourism association	Changing routes, incorporating ecosystem services approach to the Natural Park's management plan
Corrigan E., Nieuwenhuis M.	Using goal-programming to model the effect of stakeholder determined policy and industry changes on the future management of and ecosystem services provision by Ireland's western peatland forests	2017	Ireland	Yes	Forest	No	Water Framework Directive, forest company policies	Business decision-makers	Participating business was reported to be interested in incorporatingES consideration to management planning procedures
Holzinger O., van der Horst D., Sadler J.	City-wide Ecosystem Assessments-Lessons from Birmingham	2014	UK	Yes	Urban	Yes	Ecosystem Services Evaluation for Birmingham's	Local policy-makers	Local level policy document, planning tool developed to follow impacts

Table 2 (*continued*)

Authors	Article title	Year	Country	Stake-holder partici-pation	Ecosystem assessed	Monetary valuation	Specific policy document noted and addressed	Policy-makers addressed	Policy impact and evidence
Hermann A., Kuttner M., Hainz-Renetzeder C., Konkoly-Gyuró É., Tirászi Á., Brandenburg C., Allex B., Ziener K., Wrbka T.	Assessment framework for landscape services in European cultural landscapes: An Austrian Hungarian case study	2014	Austria, Hungary	Yes	Focus on all ecosystems on a given area	No	Green Infrastructure Birds and Habitats Directives	Spatial planners	Discussions with stakeholders, integration of landscape framework into the nature conservation and regional development project: 'Biosphere Reserve Neusiedler See'
Broekx S., Liekens I., Peelaerts W., De Nocker L., Landuyt D., Staes J., Meire P., Schaafsma M., Van Reeth W., Van den Kerckhove O., Cerulus T.	A web application to support the quantification and valuation of ecosystem services	2013	Belgium	Yes	Focus on all ecosystems on a given area	Yes	Masterplan Antwerp 2020; flood risk management plan	Local policy-makers	Developed tool by local authorities
Oikonomou V., Dimitrakopoulos P.G., Troumbis A. Y.	Incorporating ecosystem function concept in environmental planning and decision making by means of multi-criteria evaluation: The case-study of Kalloni, Lesbos, Greece	2011	Greece	Yes	Focus on all ecosystems on a given area	No	Birds and Habitats Directives	Local decision-makers	Resolve Natura 2000 designation conflicts

highlights balancing scientific reliability against user-friendliness as the biggest challenge. Models and calculations need to be understandable and transparent and end-user interaction needs to be increased via better tools applicability, along with more impactful results (Broekx et al., 2013).

5.12. Policy impact explained largely by effective stakeholder involvement

Some clear tendency can be observed among the few articles (8%) that reported policy impacts. Apart from one exception (an Austrian-Hungarian assessment) they are all from Western Europe. With the exception of two cases where stakeholders are unknown, nine articles involve stakeholders in the research (Table 2). From these cases, eight include more than one stakeholder group. In terms of economic valuation used, only three of the 11 cases report on using such methods (in two cases willingness to pay, value transfers and market prices as well as avoided cost, while for one assessment, damage cost and hedonic pricing). Spatial and regional planning and related policies are addressed in eight articles, while the other cases focus on conservation, marine, water and forest policies. All cases are either local or regional addressing either a specific institution or local decision-makers. In two cases (concerning forestry) decision makers are identified and addressed at both national and district levels. Of those that reported policy impacts, however, only in seven cases (5%) were the enabling factors described and only in three cases (2%) the hindering factors.

5.13. Broader reach out to stakeholders and mixed ESA methods drive desired policy impact

A couple of obvious common characteristics were identified in the case of those assessments that report driving factors of policy impacts. With the exception of one article that only builds on one specific expert group, the assessments all include more than one stakeholder group in the research process. As noted above, only a fraction of these articles apply economic valuation methods; these articles also build on additional methods on top of economic valuation, including scenarios, application of GIS and land use data, interviews, modelling, focus groups and surveys. In terms of ecosystems, ecosystem services assessed, and policies addressed, these case studies vary widely, and a clear pattern could not be detected. On the other hand, there is a clear local and regional focus concerning the policy scope. Consequently, target groups are named as local decision makers, regional and spatial planners and business decision makers.

6. Discussion

As ESAs have been suggested to help with prioritisation of ecosystems and nature in policy making, we have analysed a decade of peer-reviewed research articles with ESAs to understand whether and to what extent these articles themselves considered policy impact. The results are in line with the literature that highlights a lack of knowledge on ESA's policy influence and uptake of their messages to prioritise biodiversity in mainstream policies (Mandle et al., 2021; Posner et al., 2016a; Posner et al., 2016b; Wright et al., 2017). While some examples exist that demonstrate engaging with the questions of policy impact beyond provision of assessment results and valuation, such studies remain very limited and largely concentrated in few regions of Western Europe. It is important to keep in mind, however, the limitations of this research, with the main one being that we only looked at the research articles to seek reported policy impacts of projects or research outputs and therefore, might not be aware of actual policy impact on the ground. Nevertheless, the results provide clear evidence for raising the question of whether ESAs themselves should strengthen their focus on policy impact and report it accordingly. Based on our analysis, below we

provide our key discussion points about how to address this question in terms of (1) what policy impact requires; (2) to what extent engaging with policy impact should be the objective of ESAs; and (3) the importance of addressing underlying policy-institutional and social-behavioural factors and political will.

6.1. Achieving policy impact requires research to go beyond valuation

While the idea of providing a financial figure for a policy-maker, upon which policies start to prioritise nature is alluring (and indeed, it might have worked somewhere), our results point to the need for different approaches. Whereas reportedly economic valuation and monetary terms help emphasise the message of ecosystem services' importance, this may not be the key aspect to impress on the target audience. Concerning the characteristics of the research or relevant ESA tools, user-friendliness, transparency, flexibility, scientific reliability, broader outreach to stakeholders, and use of both qualitative and quantitative as well as engaging methods are key elements for ecosystem services assessment impacting policies. This is in line with recent calls highlighting the unused potential of valuation methods to capture multiple values of biodiversity (IPBES, 2022). In those cases where policy impact is referred to within the article, the message being policy-need driven and specifically targeted were crucial points. Specific targets worked mostly at a local scale and for feeding into particular policies, while the inclusion of relevant stakeholders (including primarily policy-makers) was the main decisive factor – in line with literature that stresses the relevance of a stakeholder-inclusive process (Schleyer et al., 2015; Rose et al., 2018). Inclusion of stakeholders may be driving more policy relevance simply due to the establishment of a direct channel with the target group, raising their interest and addressing their needs. The local scope may be particularly significant because, at a local level, stakeholders may be easier to reach and connect with on a less abstract case where they have interest, knowledge and emotional connection with the direct environment – and thus, might be more eager to take part. Thanks to stakeholders (including policy-makers) involvement, the research is not only built in a manner to address policy-makers' questions, it is also forged in a partnership providing additional ownership and credibility of the scientific work resulting in a higher success rate to steer policy. Thus, while ESAs and valuation certainly add and show value, if one's intention is to make them work in practice, engagement with the context, as well as with the decision-making and affected actors, is what brings these ESAs and valuations closer to their purpose.

6.2. Science-policy trade-off? Time to consider impact of valuation

The analysed articles – perhaps understandably as they are scientific research articles – only narrowly focus on the policy implications of the findings. This of course does not mean that the research activities or associated projects have not produced other policy relevant impacts, outputs or messages and have not reached policy-makers and involved them in dialogues; they might have. However, if they have this is not included in the research article. This raises the question of why such specific policy relevance is not a prerequisite for publishing on a subject that has at its very core the aim of creating such impact. If we consider the original purpose of ecosystem services and ESAs, it is unavoidable to reflect on whether related research adequately focuses on the intended policy impact from start to finish. Considering how few articles note the particular policy documents they address, or the specific policy stakeholders they intend to target, the question can be posed whether ESAs truly serve their purpose on the policy front.

In order to be relevant, ESAs should address policy needs or provide policy relevant messages so policy-makers can build research outcomes into processes. For this, it is essential to engage in a dialogue with these stakeholders from the outset and to design the research adequately to address this dimension. Outcomes should also come in a format that policy-makers can digest and understand without unnecessary scientific jargon. It is indeed an exquisite balancing act for scientists dealing with ecosystems and requires additional skills. However, with the ecosystem services research being multidisciplinary, there is an opportunity to involve those social scientists and practitioners that deal with policy-making and can advise on policy-relevant design from the start. Moreover, herewith we argue that it makes sense that those applied fields of research, which are motivated by the need to address practical and pressing problems on the ground, do dedicate at least an equal amount of attention to the impact of their assessment, as they do to the detail of their assessment. After decades of conversations and at least over a decade of detailed assessments, it seems about time to try to balance this attention. Consideration of additional social science aspects, building dialogues with policy-makers and other stakeholders on an otherwise complex research process is undoubtedly a challenging and time-consuming task. We also note that even if the assessments seem to have peaked, they still remain concentrated in some regions and places where research and action has stronger support. Thus, of course, more assessments are also needed. Yet, perhaps they could be designed in ways that have a better balance between their detail and impact.

6.3. Understanding decision-making and decision-makers - importance of underlying policy-institutional factors and political will

There is a principal and somewhat naïve assumption that both research and policy-making are linear and rational processes. Here, researchers conduct studies based on asking the "right" policy relevant questions, and disseminate the outcomes, which are then read by the relevant decision-makers. They in turn make their informed decisions based on the presented implications. However, in the real world, scientific information does not necessary reach decision-makers directly and become the basis of the decision-making process so evidently. Scientific evidence rather penetrates to the policy-making arena in a diffuse manner and accumulates, waiting for the right moment to influence the course of policy, which additionally depends on the context, policy-institutional traditions, exchanges, socio-economic background, social-behavioural factors, and political circumstances at any specific point in time, among other factors besides (Zolyomi, 2022). Additional factors, that define how scientific knowledge such as assessment or valuation results can affect the policy formulation both at the individual and institutional levels, include ideological constraints, lack of political will and ability to form integrated policies, perceptions (uncertainty and different risk preferences), separation between policy-makers and researchers and differing forms of communication and media uptake (Almeida and Báscolo, 2006; Bardach, 2012).

Accordingly, halting biodiversity loss requires understanding about how values, norms and behaviour are interlinked with how decision making takes place (Nielsen et al., 2021). We need to comprehend better how institutional arrangements evolve and individuals are influenced by these changing arrangements and change them. This will enable us to adjust both our methods and messages to impact policy, and ultimately practice at a more elevated rate (Kusmanoff et al., 2020). And there is ample to learn. While recent attempts (e.g. IPBES' Values assessment (2022)) and Transformative change assessment (planned for 2024) and the European Environmental Agency (EEA)'s Sustainability transitions work) to bridge gaps in knowledge and effective decision making between social and environmental processes are promising, there is an apparent need for further knowledge gathering and application. Systematic investigation of these aspects from multiple perspectives, scales and starting points (e.g., individual and institutional; various sectors and geographic levels) is pivotal to provide more targeted recommendations for transformational pathways for biodiversity policy prioritisation.

7. Conclusions

The present article only scratches the surface of ecosystem services

and ESA research, with a somewhat narrow focus on specific articles that state policy relevance in particular terms according to search engines. It is probable that a review of non-peer reviewed literature might have built more around policy relevance and might have yielded additional or other results. It is also evident that IPBES, international research projects and initiatives produce more and more knowledge that is slowly infiltrating into society and being considered by policy. Nevertheless, our results indicate that the large majority of ecosystem services research, including specific assessments and referring to policy, either did not impact policy, did not know it impacted policy, or was not required to report on it in a scientific forum. In any case, this does not reflect well on the term of ecosystem services that was invented for the very reason of impacting policy. Seemingly, gathering and providing scientific information on ecosystem services by explaining the complex and diverse values of nature alone may not be sufficient to achieve its underlying intention. In order for ecosystem services and ESA to move closer towards being the silver bullet, we also need an adequate policy-institutional, social-behavioural and not least, research weaponry to launch it from. Ecosystem services or ESA is a term and a tool, but to make it successful we have to consider to whom and how to deliver it. We may scrutinise if and how emerging terms (e.g., nature-based solutions or nature's contribution to people) have made a bigger impact, and whether it makes sense to strategically move towards a more unified and inclusive language. We also have to consider the other factors that influence decisions, behaviour, values, practices and norms both at the individual level and at the institutional levels, along with policy processes and policy needs. For this, we need additional knowledge and a wider discourse, both within the realm of ecosystem services and ESA and beyond. We need to involve political and other social scientists that can shed more light on the relevant specifics so we can form more targeted and planned messages. Such a joined-up approach is essential in order to achieve better prioritisation of nature and biodiversity at a level that matches their magnitude and role for humans and all other species.

Annexes

Annex 1 of this article is available at https://doi.org/10.5281/zenodo.7855340.

CRediT author statement

Agnes Zolyomi: Conceptualization, Methodology, Original draft preparation, Writing Alex Franklin and Barbara Smith: Supervision, Writing, Reviewing and Editing Ilkhom Soliev: Conceptualization, Methodology, Writing, Reviewing, Visualisation, Supervision, Validation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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