Collective Action Theory and Urban Gardens

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vorgelegt von
Nicole Rogge

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Gutachterinnen:

1. Prof. Dr. Insa Theesfeld

Martin-Luther-Universität Halle-Wittenberg, Naturwissenschaftliche Fakultät III, Institut Agrar- u. Ernährungswissenschaften, Professur Agrar-, Umwelt- und Ernährungspolitik, Halle (Saale)

2. Prof. Dr. Carola Strassner

Fachhochschule Münster, Fachbereich Oecotrophologie - Facility Management, Münster

3. Prof. Dr. Marianne Penker

Universität für Bodenkultur Wien, Institut für Nachhaltige Wirtschaftsentwicklung, Wien

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Summary

In the last decades, urban agriculture has become an international movement with simultaneously growing scientific interest. Community gardens are a specific type of urban agriculture that are unique because of their collective characteristics, self-organization, and self-management of urban green spaces. Based on these characteristics, community gardens are often referred to as commons in the scientific community.

Community gardens provide various economic, ecological, and social benefits for urban dwellers with the potential to lead to more sustainable cities. In higher-income countries like Germany, social factors are typically the main motivator for the establishment of gardens and for residents to participate. Community gardens provide access to social networks that fulfil various social functions, like social interaction, community cohesion, or education and learning. Although research on community gardens has grown, their role as commons and their social processes are little explored. Hence, the objective of this thesis is to extend current knowledge of their collective and social processes. More precisely, this research aims to examine and categorize community gardens as commons, as well as measuring and assessing their social processes as social sustainability and social learning potential. Further, based on collective action theory, this research seeks to investigate factors influencing gardens' social processes. Therefore, the commons are used as a framework to develop a large number of criteria. Based on the criteria development an online questionnaire and a quantitative study is conducted. This is done first, as a pilot-study to demonstrate the utility of the criteria, and second, as a study throughout Germany.

Chapter 1 provides a general theoretical background on urban agriculture and community gardens, describes the problem statement, the specific research objective, and research questions of the present thesis. Further, Chapter 1 sheds light on the overall research design and method.

Chapter 2 presents criteria to explore and categorize community gardens as commons. Based on the pilot study, the results disclose a variety of property right regimes, the importance of sharing material and immaterial resources, and various degrees of collective use in community gardens. Consequently, these findings confirm community gardens function as commons and their ability to collectively manage, change, and sustain urban resources as commons. Additionally, the chapter reveals that community gardens can be categorized as commons based on various degrees of

collectivity. Moreover, the chapter shows that based on various degrees of collectivity, gardens differ in their function as commons, as well.

Chapter 3 further investigates community gardens' social processes as social sustainability. Therefore, the criteria *social interaction*, *participation*, and *perceived success* are developed and used as a concept to measure and assess social sustainability. Based on the data of the national survey, the results demonstrate gardens' social sustainability, while also revealing differences among the gardens. Additionally, a multiple linear regression analysis helps to examine factors influencing gardens social processes. The findings disclose no statistical significant effect on the independent variables *size of the community*, *size of the area*, *degree of rule design*, *degree of monitoring and sanctioning* to the dependent variable *social sustainability*. Rather a positive statistical significant effect on *trust within the community* and the *management group* could be determined, while *heterogeneity of the community* has a negative statistical significant effect.

Chapter 4 additionally investigates learning as a complex collective and social activity taking place in community gardens. By referring to the social learning concept, the study empirically examines who is learning, what is learned, and how learning is taking place. The results reveal diverse learning communities in the individual gardens. Similarly, the results disclose a diversity in the learning content. Moreover, Chapter 4 scrutinizes on how learning is taking place, by building upon the methodological approach presented in Chapter 3. Thus, the criteria *social interaction*, *participation,* and *knowledge sharing* are used to operationalize community gardens' social learning potential. In this respect, the findings show varying degrees of social learning potential in community gardens, based on diverse social interactions. Additionally, the impact of group heterogeneity to the social learning potential is examined. In this regard, results on the Spearman correlation coefficient indicates a negative statistical significant relationship between the variables *cultural heterogeneity* and *social learning potential*, as well as between the variables *educational heterogeneity* and *social learning potential*. *Heterogeneity in age* and *income* did not disclose a statistical significant relationship to the *social learning potential*.

The overall results of this research show that a wide range of criteria are necessary to investigate gardens' collective and social processes and that the commons are an appropriate framework that can underlie such a comprehensive criteria development. Thus, the thesis provides detailed insights on gardens' collective and social processes, emphasizes their social functions, and shows that especially trust, group heterogeneity, and management are influencing factors of gardens' social processes. Findings like this

are very helpful to structure the management of community gardens and to support gardeners foster collective action. Moreover, this research highlights community gardens function as commons, which has so far been little discussed within academia. Therefore, the research has the potential to lead the way to a better understanding of collective action in community gardens. By studying community gardens as commons, the ability of communities to self-organize and self-manage urban green spaces is particularly emphasized. Hence, community gardens are an alternative to private and state regulation of public urban spaces, while they provide various economic, ecological, and social benefits. Thus, this research has the potential to lead the way to a better understanding of collective action and the commons, in general. However, to exploit the potential of community gardens and the commons to contribute to sustainable cities, they need to be integrated in urban planning, as well as appreciated and supported by policy makers and city planners.

Zusammenfassung

Urbane Landwirtschaft hat sich in den letzten Jahrzehnten zu einer internationalen Bewegung mit gleichzeitig wachsendem wissenschaftlichen Interesse entwickelt. Eine besondere Form der urbanen Landwirtschaft sind Gemeinschaftsgärten, welche sich aufgrund ihrer kollektiven Merkmale von anderen Formen der urbanen Landwirtschaft abgrenzen. Basierend auf ihren kollektiven Eigenschaften sowie ihrer Selbstorganisation und Selbstverwaltung werden Gemeinschaftsgärten in der Literatur auch zunehmend als Commons bezeichnet.

Gemeinschaftsgärten bieten den Stadtbewohnern*innen verschiedene wirtschaftliche, ökologische und soziale Vorteile und können einen Beitrag für die Entwicklung nachhaltiger Städte leisten. In einkommensstärkeren Ländern wie Deutschland sind es vor allem soziale Faktoren die zur Gründung der Gärten und der Beteiligung der Bürger*innen in den Gärten führen. Gemeinschaftsgärten bieten den Bürger*innen Zugang zu sozialen Netzwerken, welche verschiedene soziale Funktionen, wie sozialen Austausch, sozialen Zusammenhalt sowie Bildungs- und Lernmöglichkeiten, erfüllen. Trotz wachsender Forschung im Bereich der Gemeinschaftsgärten sind Gärten als Commons sowie ihre sozialen Prozesse bisher nur wenig erforscht und wissenschaftlich belegt. Ziel dieser Arbeit ist es daher, ein tieferes Verständnis der kollektiven und sozialen Prozesse von Gärten zu erlangen. Im Detail zielt diese Forschungsarbeit darauf ab, Gemeinschaftsgärten als Commons zu untersuchen und zu kategorisieren sowie ihre sozialen Prozesse in Form von sozialer Nachhaltigkeit und soziales Lernpotenzial zu messen und zu bewerten. Zusätzlich wird, basierend auf Theorien kollektiven Handelns, untersucht, welche Einflussfaktoren Auswirkung auf die sozialen Prozesse der Gemeinschaftsgärten, hier gemessen als soziale Nachhaltigkeit und soziales Lernpotential, haben. Dafür werden die Commons als Untersuchungsrahmen herangezogen und darauf aufbauend ein umfassender Kriterienkatalog entwickelt. Basierend auf den Kriterien wird ein online-Fragebogen entwickelt und eine quantitative Studie durchgeführt. Dies erfolgt vorerst als Pilotstudie, um die Anwendungsfähigkeit der Kriterien zu testen und anschließend im Rahmen einer deutschlandweiten Erhebung.

Kapitel 1 bietet vorerst eine theoretische Einführung zum Thema urbane Landwirtschaft und Gemeinschaftsgärten, beschreibt die Problemstellung und definiert die Zielsetzung sowie die genauen Forschungsfragen dieser Arbeit. Weiterhin wird in diesem Kapitel das allgemeine Forschungsdesign und die Methode vorgestellt.

In Kapitel 2 werden Kriterien vorgestellt, welcher der Erforschung und Kategorisierung von Gemeinschaftsgärten als Commons dienen. Basierend auf den Daten der Pilotstudie wird gezeigt, dass in den Gemeinschaftsgärten eine Vielfalt von Verfügungsrechten und Formen kollektiver Nutzung vorliegen und ein hoher Grad der kollektiven Nutzung materieller sowie immaterieller Ressourcen besteht. Infolgedessen bestätigen die Ergebnisse die Rolle der Gemeinschaftsgärten als Commons und ihre Fähigkeit städtische Ressourcen auf vielfältige Weise gemeinschaftlich zu verwalten, zu verändern und zu erhalten. Die verschiedenen Formen kollektiver Nutzung dienen zusätzlich dazu, Gemeinschaftsgärten anhand ihrer Kollektivität als Commons zu kategorisieren. Die Ergebnisse zeigen somit auch, dass sich die Gärten in Bezug auf ihre Kollektivität als Commons unterscheiden.

In Kapitel 3 werden die sozialen und kollektiven Prozesse von Gemeinschaftsgärten in Form von sozialer Nachhaltigkeit untersucht. Dafür werden die Kriterien *soziale Interaktion*, *Partizipation* und *wahrgenommener Erfolg* entwickelt und zur Messung und Bewertung der sozialen Nachhaltigkeit in Gemeinschaftsgärten herangezogen. Basierend auf den Daten der deutschlandweiten Erhebung zeigen die Ergebnisse insgesamt hohe Werte an sozialer Nachhaltigkeit in Gemeinschaftsgärten. Weiterhin wird mit Hilfe einer multiplen linearen Regressionsanalyse untersucht, welche Faktoren die soziale Nachhaltigkeit in den Gärten beeinflussen. Die Ergebnisse zeigen einen positiven statistisch signifikanten Einfluss der Variablen *Vertrauen innerhalb der Gemeinschaft* und *Managementgruppe* auf die soziale Nachhaltigkeit. Für die Variable *Heterogenität in der Gemeinschaft* wurde ein negativer statistisch signifikanter Zusammenhang ermittelt. Für die weiteren entwickelten Variablen *Größe der Gemeinschaft*, *Größe der Gartenfläche*, *Grad des Regelentwurfs*, *Grad der Überwachung und Sanktionierung*, konnte kein statistisch signifikanter Einfluss auf die soziale Nachhaltigkeit nachgewiesen werden.

In Kapitel 4 wird zusätzlich Lernen als kollektiver und sozialer Prozess in Gemeinschaftsgärten untersucht. Mit Hilfe des Konzepts des sozialen Lernens wird empirisch erforscht, wer lernt, was gelernt wird und wie das Lernen stattfindet. Die Ergebnisse zeigen, dass in den einzelnen Gärten vielfältige Lerngemeinschaften sowie eine Vielfalt an Lerninhalten anzutreffen sind. Um weiterhin zu untersuchen und zu bewerten, wie das soziale Lernen stattfindet, wird auf den Kriterien aus Kapitel 3 aufgebaut. In diesem Zusammenhang werden die Kriterien *soziale Interaktion* und *Partizipation* um das Kriterium *Wissensaustausch* erweitert und zur Operationalisierung

des sozialen Lernpotenzials herangezogen. Die Ergebnisse zeigen, dass sich beruhend auf verschiedenen sozialen Interaktionen innerhalb der Gartengemeinschaft, unterschiedliche soziale Lernpotentiale in den Gemeinschaftsgärten ermitteln lassen. Diese unterschiedlichen Werte für das soziale Lernpotential werden zusätzlich genutzt um den Zusammenhang von Gruppenheterogenität auf die sozialen Prozesse der Gemeinschaftsgärten zu untersuchen. In dieser Hinsicht weisen die Ergebnisse des Spearman-Korrelationskoeffizienten auf eine statistisch signifikante negative Beziehung zwischen den Variablen *kulturelle Heterogenität* und *soziales Lernpotential*, sowie zwischen den Variablen *Bildungsheterogenität* und *soziales Lernpotential*, hin. Die Heterogenität von Alter und Einkommen ergab keinen statistisch signifikanten Zusammenhang mit dem sozialen Lernpotential der Gemeinschaftsgärten.

Die Gesamtergebnisse dieser Forschung zeigen, dass eine Vielfalt an Kriterien erforderlich ist, um die kollektiven und sozialen Prozesse von Gärten zu untersuchen. Die vorliegende Arbeit zeigt dabei insbesondere, dass die Commons eine geeignete Grundlage einer umfassenden Kriterienentwicklung darstellen. Durch die Vielzahl an Kriterien liefert die Arbeit detaillierte Einblicke in die kollektiven und sozialen Prozesse von Gärten, hebt deren soziale Funktionen hervor und zeigt, dass insbesondere Vertrauen, Gruppenheterogenität und das Management die sozialen und kollektiven Prozesse der Gärten beeinflussen. Diese Erkenntnisse sind sehr hilfreich, um das Management der Gemeinschaftsgärten zu strukturieren und die Gärtner*innen dabei zu unterstützen, kollektives Handeln zu fördern. Darüber hinaus hebt diese Untersuchung die Rolle von Gärten als Commons hervor und bietet Einblicke in die Funktionsweisen der Gärten als Commons, welche in der Wissenschaft bisher nur unzureichend erforscht und diskutiert wurden. Durch die Untersuchung von Gemeinschaftsgärten als Commons wird die Fähigkeit von Gemeinschaften verdeutlicht, städtische Ressourcen selbst zu organisieren und zu verwalten. Gemeinschaftsgärten sind somit eine Alternative zur privaten und staatlichen Regulierung urbaner Räume und bieten auf diese Weise verschiedene wirtschaftliche, ökologische und soziale Vorteile. Damit hat diese Forschung auch das Potential insgesamt zu einem besseren Verständnis des kollektiven Handelns und der Commons zu führen. Um das Potential von Gemeinschaftsgärten und Commons zur Gestaltung nachhaltiger Städte auszuschöpfen, müssen diese jedoch als Teil des öffentlichen Raums in die Stadtplanung einbezogen sowie von politischen Entscheidungsträgern und Stadtplanern anerkannt und unterstützt werden.

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Abbreviations

ACGA	American Community Gardening Association
BBR	Bundesamt für Bauwesen und Raumordnung *(The Federal Office for Building and Regional Planning)*
BDG	Bundesverband Deutscher Gartenfreunde e.V. (*Federal Association of German Garden Friends e.V.*)
BKleinG	Bundeskleingartengesetz *(Federal Law on Allotment Gardens)*
BMUB	Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit *(Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety)* (currently BMU)
BMVBS	Bundesministerium für Verkehr, Bau und Stadtentwicklung (*Federal Ministry of Transport, Building and Urban Development)* (currently BMVI)
FAO	Food and Agriculture Organization of the United Nations
IAD	Institutional Analysis and Development
IKM	Initiativkreis Europäische Metropolregionen in Deutschland *(Initiative Group European Metropolitan Regions in Germany)*
NRW	Nordrhein-Westfalen *(North Rhine-Westphalia)*
MUNLV	Ministerium für Umwelt, Landwirtschaft, Natur- und Verbraucherschutz des Landes Nordrhein-Westfalen (*Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety)*
PAC-gardens	Public-access community gardens
SDG	Sustainable Development Goal
SES	Social-ecological System
UA	Urban Agriculture
UG	Urban Gardens
UN	United Nations
UNCED	United Nation Conference on Environment and Development
UNCSD	United Nations Commission on Sustainable Development
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
USA	United States of America
WCED	World Commission on Environment and Development

1 General Introduction

Community gardening has become an international growing movement, expressing various needs of urban populations. Particularly in higher-income countries such as Germany, urban dwellers come together not only to grow food together, but also to grow communities. Thus, community gardens' social functions are a notable motivation as to why they are founded and why residents are participating. Moreover, as collectively managed urban spaces, community gardens serve as an example of the commons, showing communities ability to self-govern the use of their resources. This research investigates community gardens collective action and social interaction bay exploring them as commons.

The first part of this introduction provides a general theoretical background on urban agriculture and community gardens, while Chapter 2 to 4 provide detailed insights on the key theories and concepts within the field in question. The second and third part of this introduction describes the problem statement, plus the specific research objective and research questions of the present thesis. The fourth part sheds light on the overall research design and method. Finally, the fifth part of this chapter presents a detailed outline of the thesis.

1.1 Theoretical Background

1.1.1 Urban Agriculture, Community Gardens, and its Contribution to Sustainable Development

Urban agriculture has become a pertinent global issue with an increasing scientific interest. While scientific literature provides various definitions of urban agriculture, a general acknowledged definition is missing (Opitz, Berges, et al. 2016). According to Mougeot (2006), urban agriculture is *"[…] the growing, processing, and distribution of food and nonfood plant and tree crops and the raising of livestock, directly for the urban market, both within and on the fringe of an urban area."*(p. 4). Other definitions point to the diversity of urban agriculture that can involve any agricultural activity including private and community gardens (FAO 2010). Therefore, community gardens in this research are understood as a subset of urban agriculture (Figure 2, p. 23) and are defined as collectively used and self-organized open spaces situated in urban areas, where food, non-food plants, and a sense of community is grown to address diverse local needs and to generate personal and joint benefits (see Chapter 2, p. 23). As a complement to rural agriculture, urban agriculture and its diverse types such as community gardens are

offering additional resources, like green spaces, education or recreation, to urban dwellers (Lovell 2010; Mougeot 2006).

Nowadays, urban agriculture seems to be a new phenomenon of modern society, but throughout history, food cultivation in urban areas has always played a significant role in ensuring food supplies for urban residents. Worldwide, civilizations developed urban agriculture systems and created innovative methods of food production, land management, efficient use of water, and other resources (Smit et al. 2001b). Indeed, urban agriculture was a precondition for the creation of many cities, but the characteristic of this phenomenon has changed over time (Vejre and Simon-Rojo 2016).

With industrialization and urbanization, agricultural production tended to become part of the countryside, while cities focused on production of industrial goods (Smit et al. 2001c; Vejre and Simon-Rojo 2016). With this functional separation, cities saw a dramatic increase in population, housing density, and social problems due to poverty or lack of recreational opportunities. These historical developments led to movements for "small gardens for the poor" and "allotments for workers" (Johannes 1955; Smit et al. 2001c). Especially in Germany, we still find the typical "Schrebergärten" (the German equivalent of allotment gardens), pioneered by the ideas of Dr. Schreber in the latter part of the 19th century (Smit et al. 2001c). These small gardens were founded by citizens and emphasized creating spaces for recreation, relaxation or health care (Johannes 1955). They continue to form part of the urban landscape in Germany today.

During and after the two World Wars, the importance of allotment gardens and urban agriculture in general, increased worldwide, as they played a crucial role in food security in urban areas (Armstrong 2000; McClintock 2010; Smit et al. 2001c). With the economic growth in the 1950s and 1960s (post-World War II economic boom), the necessity to grow food in the city and thus the interest in urban agriculture declined (Saldivar-Tanaka and Krasny 2004; Smit et al. 2001c). However, in the last three decades, the importance of urban agriculture and all forms of it, has increased again to become a growing international movement developing new forms and types of urban agriculture (Ferris et al. 2001; Smit et al. 2001b). A new and collective type of urban agriculture are community gardens that emerged during 1970´s in North America (Lawson 2005). In Germany, the first community gardens were founded in the 1990´s (Müller 2011). Until now, community gardening is becoming more and more popular in cities all over the world.

The reason for the growing interest in urban agriculture and community gardening are manifold but can especially be seen in their multidimensional benefits (Bonow and

Normark 2018; Pearson et al. 2010). Urban agriculture activities improve local economies, offers jobs and recreational opportunities, preserves ecological and cultural resources, provides green infrastructures, improves air quality, supplies healthy food for urban residents, and contributes to food sovereignty and food security, health, and well-being. It further addresses environmental justice, education and knowledge, community development and cohesion, and provides new experiences inherent to democratic forms of governance (Bendt et al. 2013; Ferris et al. 2001; Lovell 2010; Pearson et al. 2010; Pourias et al. 2016; Saldivar-Tanaka and Krasny 2004; Smit et al. 2001b). Based on this multidimensional advantages, urban agriculture, and community gardening, contributes in many ways to sustainable development, frequently defined as a *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* (WCED 1987, p. 41). Moreover, urban agriculture gained increasing attention because of cities' decisive role in moving toward sustainable development, also expressed in the sustainable development goal (SDG) "Sustainable Cities and Communities", as one of 17 SDGs passed by the international community within the Agenda 2030. The role of cities is becoming more and more pertinent, as today, on average, 55 percent of the world population is living in cities. While high-income countries are already facing an urbanization of about 80 percent, such as in Germany where 77 percent of the population is already settled in cities, low and middle-income countries are currently experiencing a rapid shift towards urbanization (UN 2018). This concentration of population causes various ecological and social problems. A share of 75 percent of the global carbon emission is taking place in cities and worsening air quality, which, as a result, currently determines the political debate in many municipalities in Germany. Additionally, many cities face insufficient urban services and infrastructures (UN 2018; UNDP 2019). However, these and other deficiencies are the source of inspiration for urban innovations, transition processes, and movements like the urban agriculture and community garden movement, where residents take action to improve social, environmental, and economic problems (McClintock 2010; Saldivar-Tanaka and Krasny 2004).

Yet, the motivations and benefits of urban agriculture activities, and also their contribution to sustainable development, differ in their intensity between lower and higher-income countries and between the specific type of urban agriculture observed (Krikser et al. 2016; Opitz, Berges, et al. 2016). Namely, the potential of urban agriculture for food security and reducing poverty is mainly, but not exclusively seen in lower-income countries (Guitart et al. 2012; Mougeot 2006) and can particularly be fulfilled on

a larger scale through professional peri-urban agriculture[1] (Opitz, Berges, et al. 2016). However, food security, has also become an issue in high-income countries, e.g. in cities of the United States of America (USA) (Block et al. 2012; Opitz, Berges, et al. 2016), where micro to smaller-scaled urban agriculture activities, like community gardening, have the potential to meet food needs predominantly at the household-level, as well (Opitz, Berges, et al. 2016). Indeed, community gardens in the USA emerged as a response to high food prices, health concerns of commercially produced food, or increasing concerns about environmental conditions (Lawson 2005). Nonetheless, in high-income countries community gardening and their social benefits like community cohesion, social interaction, and education are more often emphasized than food production (Bonow and Normark 2018; Guitart et al. 2012; Martin et al. 2016; Mougeot 2006; van der Schans and Wiskerke 2012). This is also shown by the German community garden movement. In Germany the first gardens were founded as intercultural gardens[2] (Müller 2011), not with the aim of food production but to integrate migrants and build communities (Moulin-Doos 2014; Müller 2007). Yet, community gardens emerge for various reasons, e.g. as a counter-movement against globalization and capitalism, privatization of urban land, deterioration of public green spaces, reduced contact between city dwellers and nature, the impoverishment of ecological habitats and their functions, and because of social isolation and exclusion (Colding et al. 2013; Follmann and Viehoff 2015; Nettle 2014; Rasper 2012; van der Schans and Wiskerke 2012). Hence, community gardening has been adopted by various movements and can therefore be expressed as a political activity as well (Follmann and Viehoff 2015; Nettle 2014; Rosol 2010). However, particularly gardens' collective and social processes as social interaction, social exchange, and learning are a motivation to establish and join a garden (Nettle 2014; Pourias et al. 2016; Spilková 2017; Winkler et al. 2019). Additionally, community gardens are established as bottom-up initiatives, organized and managed collectively by various communities. These social and collective characteristics are essential and distinguish community gardens from other urban agricultural activities. The present thesis aims to

[1] Peri-urban agriculture occurs at the fringes of growing cities and can be described as the transition zone between urban and rural areas (Opitz, Berges, et al. 2016). While some scholars understand peri-urban agriculture as part of urban agriculture, Opitz, Berges, et al. (2016) distinguish both forms. Beside the location, an additional difference can be seen in professionalism and motivation. In peri-urban agriculture mainly professional farmers that are predominantly economically motivated are to be found. Additionally, compared to urban agriculture (e.g. community gardening), peri-urban agriculture even more allows the raising of livestock and the production of animal products (Opitz, Berges, et al. 2016). An example of peri-urban agriculture can be seen in Community Supported Agriculture (CSA).

[2] Intercultural gardens especially address migrants from different countries of origin (Moulin-Doos 2014). As social spaces, they deliberately pursue intercultural communication and integration (Müller 2007).

investigate gardens collective and social actions and examines community gardens in Germany, where social functions, through collective action, social interaction, and learning take priority over food production. The following chapters describe community gardens' collective characteristic in more detail, through distinguishing community gardens from allotment gardens and viewing them as commons, as well.

1.1.2 Distinguishing Community Gardens and Allotment Gardens

In Germany, allotment gardens, also known as "Kleingärten" or "Schrebergärten", exist in parallel with community gardens, which is why there is sometimes confusion about the difference of both garden types. Hence, this chapter offers a clear distinction of community gardens and traditional allotment gardens, that are not part of this research.

In general, both, allotment and community gardens are a specific type of urban gardens (Opitz, Berges, et al. 2016) (see also Chapter 2, Figure 2, p. 23). While they have some similar features, particularly their motivation and the collective aspects sets them apart (Bendt et al. 2013; Drake and Lawson 2015; Hancock 2001). Historically, allotments in Germany, like community gardens, were initiated by citizens in response to various urban needs. Unlike community gardens, which are often short-term and unstable constructs, nowadays allotments in Germany have long-term protection through federal law *(BKleinG, Bundeskleingartengesetz)*. The *BKleinG* precisely defines an allotment garden as a garden available for non-commercial, horticultural use, in particular for the production of horticultural products for own use and for relaxation (§1, Absatz 1). There are about 910,000 allotment gardens in Germany with an total area of about 40,000 hectares (BDG 2018). Allotment gardens have a long tradition, although their purpose has shifted over time from subsistence to leisure (Vejre et al. 2016). While allotment gardeners tend to seek a retreat from city life, community gardeners prefer to garden directly in the city, where urban politics takes place (Follmann and Viehoff 2015). In further contrast, allotment gardens are more formal in their organizational structures and have more formal regulations, for instance formal applications to join an allotment garden or rules for a minimum area for food production (Bendt et al. 2013; Cabral et al. 2017; Opitz, Berges, et al. 2016; Vejre et al. 2016). In contrast, community gardens are very diverse in their structure and type of organization ranging from self-organization by loose groups with low or no formal obstacles to formal management by an association (Bonow and Normark 2018; Colding et al. 2013; Rosol 2010).

Notably, allotment gardeners have fenced, private used garden plots (*Gartenparzellen*) with ranges of about 400 square meters, in average cultivated by 2.2 persons (BDG 2018; BMVBS and BBR 2008). The overall allotment colony *(Kleingartenanlage)* consists of a number of garden plots (partly more than 100) and can have several hectares (BDG 2018). Community gardens, in comparison, have an average size of about 2.300 square meters mostly cultivated by 10 (own data). Gardeners tend to not have individual plots, but sometimes individual small beds, as well as shared beds. The single bed can be a planted box with less than one square meter, as well as beds on the ground with sizes up to 18 square meters (Müller 2007). Those beds are mostly not fenced, and if so, mainly as protection against animals or vermin (Müller 2007). The overall community garden can be fenced or unfenced, while nonetheless gardens are mostly open in access (Colding and Barthel 2013; Müller 2007; Nettle 2014; Spilková 2017).

Furthermore, community gardens and allotment gardens involve different social milieus (Bigell 2015). Urban community gardeners are often described as young, more female and mostly in the age of 30 to 40, educated, colorful, and socially heterogeneous (Müller 2012; Schmelzkopf 1995; Smit et al. 2001d; Winkler et al. 2019). In comparison, allotment gardeners are more often male (at least in relation to the work done in the association, "Vereinsarbeit"), mostly in the age of 65 to 75, and belong to the low-income to middle-income population group (Appel et al. 2011; BMVBS and BBR 2008; MUNLV 2009).

Decisively, community gardens have a variety of collectively used resources while in allotment colonies only a few goods are used collectively, like path-ways, a clubhouse or playgrounds. These common goods are sometimes – but not always - open for the public while the individual garden plots are not (Bendt et al. 2013). While allotment gardens are currently undergoing a change, which is in part influenced by the urban agriculture movement (Appel et al. 2011; Bigell 2015; Vejre et al. 2016), they will not be part of this scientific work, due to the key structural differences that were discussed above.

1.1.3 Community Gardens as Commons

Due to community gardens' collective characteristics they are often referred to as an example of the commons movement (Eizenberg 2012; Foster 2011). Commons can be defined as complex institutions in which land and other resources are used collectively by self-governance and rules that are self-restrictive and self-sanctioning (de Moor 2015).

According to Hardin's article "The tragedy of the commons" (Hardin 1968), resources shared by individuals are inevitably exposed to overharvesting. Hardin argued that this is because individuals' rational interests is to take as much as possible, the challenge to restrict access to the resources, and the lack of self-restrictive rules for sustainable use (Feeny et al. 1990; Hardin 1968). A free-riding situation like this, which occurs if individuals benefit from the commons without contributing to its maintenance, was already also described by Olson (1965) in his work "The logic of collective action: Public goods and the theory of groups". However, this "conventional" collective action theory has been disproved by various scholars, who showed that the commons are not an open access situation where individuals are acting out of self-interest and without any communication, but where collective action is taking place to maintain the resources (Hess and Ostrom 2007). It is important to mention here particularly the work of Nobel laureate Elinor Ostrom, who predominantly investigates traditional commons (natural resources as common-pool resources) such as fisheries, forests or irrigation systems, and who demonstrated the ability of communities to self-govern their collective used resources to overcome collective action problems (Ostrom 1990). In line with other scholars she developed collective action theories such as her "Design Principles" to examine and explain successful collective action. As such, her work contradicts the conventional collective action theory and shows that the commons can be maintained not only by the market or by the state, as Hardin proposed, but through self-organization of collective action by communities.

Recently, commons are discussed not only by economists and political scholars, but also in (critical) social science and urban studies as "urban commons" and "new commons" (Follmann and Viehoff 2015; Lee and Webster 2006; Morrow 2019).

In general, urban commons can be defined as urban shared resources while experts of this field often include the idea of the city as a commons, as well (Foster 2011). Additionally, Campbell and Wiesen (2011) describe urban commons as spaces that are ''publically accessible, nonexcludable, and managed through shared governance'' (p. 11). The study of urban commons gained growing interest due to current developments that are to be found in many cities all over the world: rapid urbanization, increasing

privatization of public land, overused as well as underused (abandoned) urban spaces (Foster 2011; Lee and Webster 2006). However, configuration of property rights are still an often ignored aspect in urban planning and design of sustainable cities (Colding et al. 2013).

Next to urban commons, recent academic work also refers to new commons, as publicly shared resources that have recently evolved or reconceptualized as commons (Hess 2008). Both concepts overlap and several urban commons can be considered as new commons, as well. As such, community gardens often serve as examples within both, the urban and the new commons literature (e.g. Foster 2011; Hess 2008) (see also Chapter 2). In addition to that, community gardens are also referred to as urban green commons or food commons (Colding and Barthel 2013; Morrow 2019).

Community gardens as commons allow city dwellers to collectively manage urban resources, jointly take care of urban land, design urban nature, and participate/ intervene in urban politics (Colding et al. 2013; Follmann and Viehoff 2015). They thus show that urban public spaces are managed without government or private intervention, by communities who craft their own rules to sustain the commons. While the government or private sector is absent in the management, they may support community gardens and are mostly the owner of the urban land (Colding and Barthel 2013; Winkler et al. 2019) (see also Chapter 2). Thus, gardens are also *"an expression of a changing relationship between public and private*" (Müller 2012, p. 219).

Moreover, when applying collective action theory to community gardens it becomes evident that they are special in their role as commons. As such, community gardens are special as to why they are established and why residents are participating. As already mentioned, the collective and social processes social interaction, social exchange, and learning are even more a motivation to establish and join a garden, than the harvest are (Nettle 2014; Pourias et al. 2016; Spilková 2017; Winkler et al. 2019). In addition, gardens' physical form and characteristics that qualify them as commons are highly diverse. Namely, community gardens differ in their role as commons according their structures and types of organization ranging from self-organization by the gardeners with low or no formal obstacles to formal management by an association (Colding et al. 2013). Furthermore, gardens vary in ownership and how they assign property rights, meaning who is allowed to access, harvest, or manage the garden (Colding et al. 2013). This is also expressed in gardens collective use of diverse subtractive and non-subtractive urban

resources[3], like the urban space, the harvest, work, but also knowledge. Sharing their knowledge further make community gardens special in their role as commons, since they produce other types of commons, i.e. the knowledge commons (Eizenberg 2012; Hess 2008; Müller 2012)[4]. In community gardens, participants usually don't have substantial knowledge about agriculture or gardening, but depend on sharing knowledge and learning from each other (Müller 2012; Opitz, Berges, et al. 2016). Learning and sharing knowledge in community gardens is thus an additional collective action of the gardens, and indeed one of the prevailing social benefits (Eizenberg 2012; Krasny and Tidball 2009b; Martin et al. 2016). To summarize, community gardens are examples of the complexity of the commons. Moreover, collective action theories and the commons can be used as a framework to analyze gardens' social and collective practices (De Angelis 2003; Eizenberg 2012) (see Chapter 1.3).

1.1.4 Outreach of Community Gardens

The fact that community gardening is relatively new, fast-growing, and mainly an informal activity, may account for the notable absence of systematic data on community gardens, whether on a national or international level (Guitart et al. 2012; Lohrberg 2016; Vejre and Simon-Rojo 2016).

For the USA and Canada, there is an estimated number of 18,000 community gardens (ACGA n.d.). Alone in New York City, a number of more than 550 community gardens are listed (population: 8.5 million) (GreenThumb n.d.; United States Census Bureau n.d.). In contrast, Germany (population of 83 million) (Statistisches Bundesamt 2019), has a total number of 648 community gardens listed in the most comprehensive available database of anstiftung (2019). This considerable low number of gardens can be tied e.g. to the fact that they arose much later in Germany than in the USA and allotment

[3] In the prior study of the commons Ostrom and other scientist referred to the characteristic of rivalry/ subtractability and exclusion as features to describe common-pool resources (Feeny et al. 1990; Ostrom 1990). This means that exclusion to the resource is difficult, and that the individual use of the resources reduces the benefits available to other users. However, later on Hess and Ostrom (2007) distinguished between subtractive and non-subtractive resources while examine knowledge as a commons. Additionally, a distinction has been made through the common-pool resources (resource/ resources system) and property rights regimes under which the resource is hold (open access, private property, state property, communal property) (Feeny et al. 1990; Hess and Ostrom 2007). Because of this complexity, nowadays the more general term "*commons"* is used, to refer to complex institutions and a system in which exclusion is difficult, but resources are not necessarily rivalrous (Hess and Ostrom 2007; Ostrom 2008).

[4] Knowledge has long been cited as a primary example of a public good, because there is no rivalry and it is free to all. Yet, privatization of knowledge through intellectual property rights like patent law and copyright, shows a different kind of view. Even non-rivalrous resources get protected, as well (Hess 2008; Hess and Ostrom 2007).

gardens that existed in parallel to community gardens. However, as can be derived from Figure 1, community gardening in Germany is a growing movement and the number of gardens has doubled in the last five years. Most of these community gardens can be found in the federal states of North Rhine-Westphalia (NRW) (109) and Bavaria (106). In the city-state Berlin, 83 community gardens exist (anstiftung 2019).

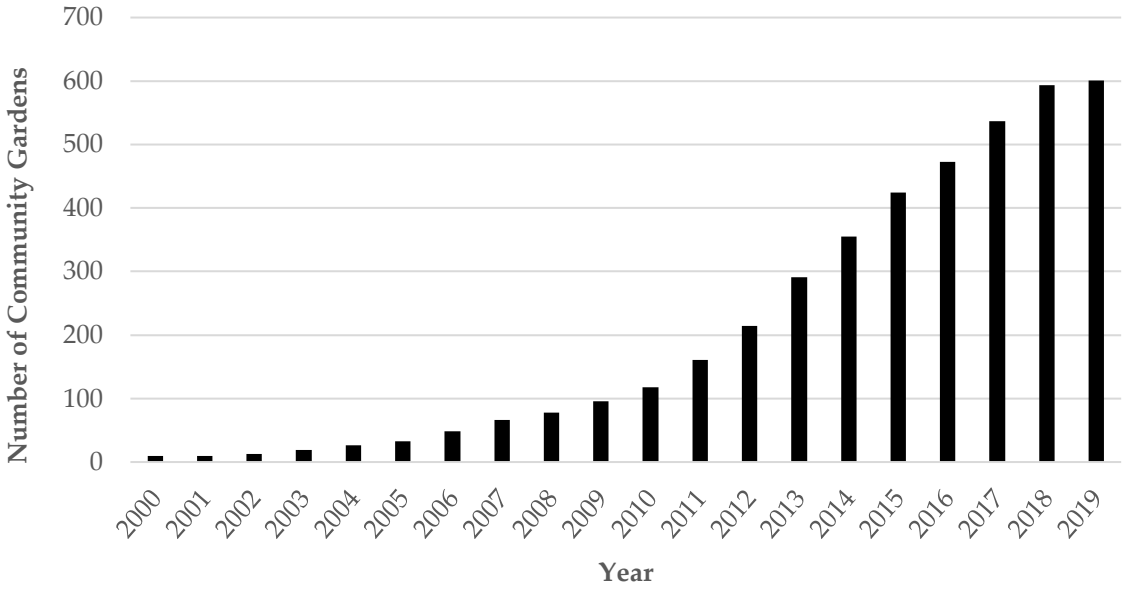

Figure 1: Community gardens in Germany, 2000-2019 (status June 2019, without gardens in the planning stage)
Source: Determined according to anstiftung (2019)

1.2 Problem Statement and State of Art

By 2050, 68 percent of the world population, will live in cities, and in high income regions such as Germany an urbanization of even 84 percent is expected (UN 2018). These developments will even more influence urban living conditions and sustainable development, particularly in cities.

The opportunity for urban agriculture to contribute to sustainable cities has long been ignored, but recently gained increasing recognition (Bonow and Normark 2018; Pearson et al. 2010). Community gardens, through their self-management and self-organization can be a new solution to urban development and an efficient approach to protect and manage urban green spaces as urban commons (Follmann and Viehoff 2015). The discussion particularly shows that sustainable cities do not only need green spaces and green infrastructure, but access to land for local community purposes (Ferris et al. 2001).

Rosol (2010) points to a new acceptance by the city administration to collectively run urban green spaces, particularly through community gardening. However, this acceptance is not a general recognition of the collective management of green spaces, but rather a toleration for interim uses. Frequently, gardens have to give way as soon as other, more profitable uses e.g. interest of private investors, arise (Follmann and Viehoff 2015; Rosol 2010). As such, many gardens are threatened, miss legal status and have only temporary and insecure contracts (Drake and Lawson 2015; Rosol 2010). As a result, there is the challenge to sustain and protect community gardens as commons in regard to ownership and legal status (long-term and secure contracts), but also in respect to the community itself, their visions and struggles (Bigell 2015; Drake and Lawson 2015). The study of Drake and Lawson (2015) for instance showed that particularly declining participation is a main reason while gardens ceased to exist. In addition, the emergence of new community gardens needs to be facilitated. The importance of community gardening to promote sustainable cities needs an even stronger acceptance within city planning, particularly in regard to the SDGs, that a number of countries, such as Germany, are committed to. Additionally, Tornaghi (2012) criticizes that the commons debate is missing in the architecture and planning of urban public spaces. Hence, community gardens and urban commons need further research to gain a more profound understanding and acceptance to change current city planning and design for more sustainable cities.

While community gardening has gained international relevance and increasing scientific importance, there are still various areas within academia that need exploring. First and foremost, there is a recognized general lack of statistics and data on international but also on national levels (Bendt et al. 2013; Guitart et al. 2012; Lohrberg 2016). In addition, data on community gardens are mainly qualitative (Christensen 2017; Guitart et al. 2012). An exception to this is the survey of Drake and Lawson (2015), that provides quantitative data from 445 community gardens in the USA and Canada. While a lot of research is conducted in the USA, there is a limited amount of scholarly work available from other high-income countries, as well as from non-English speaking countries (Christensen 2017; Guitart et al. 2012). Important research outside the USA can be seen in Nettle (2014) who performed a qualitative study of community gardens in Australia. With view on Europe Pourias et al. (2016) examined the food function in community gardens in Paris and Montreal. Spilková (2017) studied community gardens in Prague and Bonow and Normark (2018) conducted a study on community gardening in Stockholm. There is additionally some scientific work focusing on community

gardens in Germany, where particularly the city of Berlin has gained huge recognition (Follmann and Viehoff 2015). Namely, Rosol (2010) and Bendt et al. (2013) provide qualitative data by investigating four community gardens projects in Berlin. In addition, Colding et al. (2013) and Bigell (2015) refer to community gardens in Berlin. Outside of Berlin, Follmann and Viehoff (2015) investigated a community garden project in Cologne, Lindemann-Matthies and Brieger (2016) analyzed the contribution of urban gardening to the attractiveness of urban areas in Karlsruhe, and Cabral et al. (2017) scrutinized allotment and community gardens in Leipzig. Also, there is lot more, mainly unpublished, German-speaking academic work provided by *anstiftung*[5]. At the onset of this study, no research referring to a comprehensive quantitative dataset of community gardens in Germany had been published yet, but recently Winkler et al. (2019) contributed to a quantitative study of community gardens on a national level in Germany.

Besides the lack of statistical data, just a few scholars investigate community gardens as commons. To mention here is Linn (1999) and Eizenberg (2012) who examine community gardens in the USA. In addition, Colding and Barthel (2013) and Colding et al. (2013) deal with urban green commons by referring to community gardens. Likewise, Bigell (2015) as well as Follmann and Viehoff (2015) describe community gardens as commons. Moreover, Nettle (2014) examines community gardens as social and collective action, while Hou (2017) studies the social and collective dimensions of urban gardens by referring to literature of gardens around the world. Recently, Palau-Salvador et al. (2019) published an article where collectivity of community gardens in Valencia are analyzed. However, there is little known about gardens' role as commons, their aspect of collective action and social inter action, or the processes of gardens' management and self-organization (Colding et al. 2013; Drake and Lawson 2015; Follmann and Viehoff 2015; Nettle 2014). Furthermore, a detailed analysis of community gardens social and collective actions by referring to a comprehensive quantitative dataset is missing.

1.3 Research Objectives and Research Questions

Community gardens provide economic, environmental, and particularly social benefits through collective action, social interaction, and collective learning. Yet, community gardens' collective actions and social interaction are little explored. Drawing on this, the objective of the present thesis is to gain a greater understanding on gardens'

[5] see: https://anstiftung.de/downloads/category/15-forschungsarbeiten-urbane-gaerten

collective and social processes by referring to the commons as a framework for social and collective practices (De Angelis 2003; Eizenberg 2012)[6]. The research aims to examine and categorize community gardens as commons and to analyze and operationalize their social processes, as social sustainability[7] and social learning potential[8]. The research further aims to disclose relationships that influence these processes.

Based on the research objective, the following main research questions are raised in this paper:

1) What defines community gardens as commons and how can they be categorized? (Chapter 2)
2) How are community gardens organized as commons and spaces for social interaction? (Chapter 2)
3) How can community gardens' social processes be analyzed and made operational? (Chapter 3 and 4)
4) What influences the social processes in community gardens? (Chapter 3 and 4)
5) What is the role of learning and sharing knowledge in community gardens and how is learning taking place? (Chapter 4)

Examining community gardens in this respect enables a more profound understanding of the community garden movement as well as provides an understanding of other social and urban movements (e.g. transition movement), or civic activism. Moreover, this research offers insights on urban society's needs and desires. This investigation further enables us to gain general insights on the operating principles of (urban and new) commons, and helps to develop new solutions for sustainable resource management. Especially by exploring learning processes and knowledge sharing in community gardens, this research further gives insights into knowledge commons that have gained increasing interest in the study of the commons. By referring to the social learning concept the study provides initial results on gardens' potential to foster social change (see Chapter 4). The results on influencing factors is valuable to

[6] In this research, collective action is also always understood as social interaction (see also Chapter 2). Social interactions are also always social processes.

[7] A clear and widely acknowledged definition for social sustainability is missing. However, social interaction plays a crucial role in the concept of social sustainability. E.g. Dempsey et al. (2009) explore the concept of urban social sustainability by two main dimensions: equitable access and sustainability of the community, while the latter involves social interaction (see also Chapter 3).

[8] Social learning locates learning in social interaction and is here defined as *"[...] a change in understanding that goes beyond the individual to become situated within wider social units or communities of practice through social interactions [...]" (Reed et al. 2010, p. 6) (see Chapter 4).*

support gardeners to foster collective and social interaction. It can further help to foster or develop alternative urban movements, collective food systems, and give advices for city planners, municipality, and community gardeners. Above all it shows the diverse potential of cities and their dwellers to move toward sustainable development.

1.4 Research Design and Method

To address the research gaps, and to answer the raised research questions (see Chapter above) the research design consists of three steps which are described in detail in the following subchapters: 1) Literature review, 2) Criteria development, 3) Survey. The individual steps build upon the findings of the prior steps.

According to Neuman (2014) this study follows an exploratory, descriptive, and explanatory research purpose. The study is exploratory in nature, since it discusses a new topic where little is known about. The study is also descriptive, as it provides detailed insights and creates a set of categories. The study is further explanatory, since it looks for causes and relationships while referring to theories of collective action, and test it within the community garden movement (Neuman 2014). The reliability of the measurements is verified using Cronbach´s alpha and factor analysis. Validity is increased through face validity by the exchange with other scientist and through construct validity by deducing hypothesis from theory. In addition, factor analysis is used to confirm the measurement (Bryman 2016; Neuman 2014).

1.4.1 Literature Review

The in-depth literature review comprises scientific work about urban agriculture, community gardens, commons, sustainability, and social learning. To gain comprehensive insights, the review was extended to the overall urban agriculture movement, where community gardens are mainly described as a subgroup with similar benefits. Additionally, the research focused on high-income countries, because of differences in the purpose and motivations of community gardening. The research was further extended to community gardens in high-income countries, since academic literature on community gardens in Europe and Germany is still rare. Pertinent literature in the field of urban agriculture and community gardens are for example Smit et al. (2001a), Draper and Freedman (2010), or Spilková (2017). Moreover, literature on common-pool resources, commons, urban commons, new commons, and collective action is reviewed. It is important to mention here various work of Elinor Ostrom (1990,

2010a), as well as Hess (2008), and Foster (2011). With regards to literature on sustainability, scientific work in the context of urban and social sustainability was predominantly studied by Dempsey et al. (2009) or Eizenberg and Jabareen (2017). Further, literature that combines the various topics was studied. While, there is much research on sustainability of community gardens, e.g. by Martin et al. (2016) or Opitz, Specht, et al. (2016), there is less literature that copes with community gardens as commons, or social learning in community gardens (see Chapter 1.2 Problem Statement). Nonetheless, particularly the work of Colding et al. (2013), Nettle (2014), and Krasny and Tidball (2009b) was helpful in this respect. Various web search engines that indexes scholarly literature, suitable journals, as well as the library of *Martin-Luther-University Halle-Wittenberg*, and *Münster University of Applied Science*, served to find pertinent literature.

1.4.2 Criteria Development

The criteria development is based on the in depth-literature review. Prior research on community gardens and own experiences as an active urban gardener of the author supported the development processes and helped the critical review of the selected criteria. A comprehensive criteria development ought to examine community gardens as commons, their collective action and social interaction, as well as the factors influences those collective processes. Thus, the theory of collective action and the commons literature was the most essential basis for this criteria development. To mention here is especially literature that deals with factors that makes success of institutions highly probable such as the collective action theory of the Design Principles, constructed by Ostrom (1990), her Social-ecological System (SES) framework (as a further development of the Design Principles) (Ostrom 2009), and the success factors developed further by Frey and Rusch (2013). Additional considered approaches were the Institutional Analysis and Development (IAD) framework (Ostrom 2011) and the bundles of rights approach of Schlager and Ostrom (1992) (see also Chapter 5). The three main chapters give additional insights on the theories and frameworks, as well as present the developed criteria.

Beside the studies about commons, various scientific work on community gardens (e.g. Armstrong 2000; Colding et al. 2013; Opitz, Berges, et al. 2016), (social) sustainability (e.g. Dempsey et al. 2009; Eizenberg and Jabareen 2017), and social learning (e.g. Bendt et al. 2013; Reed et al. 2010) helped to identify key criteria to investigate community

gardens' collective and social processes. Chapter 2 to 4 give more detailed insights on the criteria development, concepts and measurements used within the single chapters.

1.4.3 Survey

Based on the developed criteria, an extensive questionnaire consisting of 57 questions assigned to seven groups was developed. The seven groups are: the garden area, the garden community, funding, collective action, management and participation, rules, success and failure. The questionnaire consisted of predominantly closed questions (check boxes with some matrix questions) to make data comparable. However, a minor number of semi-open questions were included to discover additional criteria. The questionnaire was coded and a detailed codebook was created, before data was collected (see questionnaire and codebook Appendix A and B).

To conduct a national survey, I opted for a web survey that was sent out as an online link through email. Contacting gardeners via email turned out to be the most effective way, due to being fast and low cost. In addition, it allowed to reach a high number of community gardeners across all of Germany. The online questionnaire was developed and created using *LimeSurvey* (Version 2.05+ Build 140404) provided by the Martin-Luther-University Halle-Wittenberg.

Community gardens were selected drawing on the national listing of *anstiftung*. Additionally, the regional network for NRW *UrbanOasen* was consulted. Both networks are the most comprehensive networks to be found as of today. They also provide some general information on the single community garden project, such as description of the garden projects, year of foundation, email address, homepage, or size of the area. During the time of the survey, 554 community gardens were registered within the listings of *anstiftung* and 63 within the *UrbanOasen* network. The majority of gardens listed on *UrbanOasen* were also listed on the webpage of anstifung, but, 15 gardens were identified on top of that. Verification of a total number of 569 gardens indicated that 50 gardens were still in the planning stage, while a number of nine community gardens have ceased to exist. Further, 28 gardens that appeared to be single public plots with no characteristics of community gardens (e.g. sizes smaller than five square meters, single flower beds tended by neighbors, or gardening activities that do not take place on a permanent area), or gardens that can be characterized as closer to parks than community gardens (sizes of more than 10,000 square meters) were excluded. To focus on urbanized areas, an additional number of 49 community gardens located in cities with less than

20,000 inhabitants were excluded, as well. Overall, 433 community gardens growing flowers, as well as vegetables or fruits, were deemed as suitable for the investigation.

The online questionnaire was directed at leaders or at least members of the core group of a garden, from whom it could be expected to have well-founded knowledge to answer specific questions. The respondents were asked to rank their gardens in terms of the developed criteria. A number of pre-tests ensured that questions were easily understood and that the wording did not suggest any particular answer. Further to test the criteria, modelling, and to increase reliability a pilot-study of eleven cases was conducted from March to April 2016 (see Chapter 2). After improving the criteria, the research was conducted from 15 December 2016 to 31 March 2017 throughout Germany. Data were collected outside the garden season as gardeners are less involved in garden activities and may find the required time to answer the questionnaire. Of 433 questionnaires sent out, 123 completely-filled questionnaires were returned (response rate of 28%).

Each attendee was informed about the purpose and scope of the survey and little personal information as possible was collected (IP address, age, gender). Since the study aimed to receive only one completed questionnaire per garden, respondents had to disclose the name of the garden project. However, this data was not used for publication.

The data were exported from *LimeSurvey* to *Excel* where the accuracy of coding and cleaning of data was first conducted. The completed questionnaires were analyzed using *Excel 2016* and the statistical analysis program IBM SPSS Statistics 24 (IBM, New York, USA) provided by Münster University of Applied Sciences.

1.5 Outline

The following chapters consist of three papers partly submitted in various journals. The individual chapters deal with separate research questions that respond to the research questions presented above. While all three chapters have the same broader topic and stand in close connection to each other, they can also be witnessed separately.

Chapter 2 provides an initial categorization on community gardens as commons. It offers a more detailed distinction of urban agriculture and community gardens as well as offers a definition for the latter. Further, the concept of commons and how gardens function as commons are described. Moreover, criteria to examine and measure collective action in community gardens are presented and their applicability is confirmed by case studies. The case study enabled to examine many features in a

detailed and extensive fashion, and gives comprehensive insights on individual community gardens (Neuman 2014).

Chapter 3 builds upon the findings of Chapter 2 and presents an operationalization approach to analyze and assess community gardens collective and social processes as a measurement of social sustainability in community gardens. Therefore, the concept of social sustainability is described in more detail within this chapter. Based on collective action theory, the chapter further investigates influencing factors as heterogeneity of the community, trust or rule design, that facilitate social sustainability.

Subsequently, Chapter 4 concerns social learning as an additional collective and social processes in community gardens. Therefore, the chapter first offers the theoretical background of the social learning concept. Based on the social learning concept, the chapter further explores detailed information about the learning community - who is actually learning – and about the learning content – what is learned - in community gardens. The chapter additionally builds upon the operationalization approach of Chapter 3 and adjusts the approach to measure the social learning potential in community gardens. The relationship of the social learning potential and various forms of group heterogeneity is demonstrated, as well. Chapter 4 thus gives insights on the knowledge commons produced and shared within the gardens, as well.

Finally, chapter 5 summarizes and discusses the results, places them in the scientific debate, and maps out the research limitations. Moreover, suggestions for future research, as well as implications for policy makers, city planners, and practitioners are made.

2 Categorizing Urban Commons: Community Gardens in the Rhine-Ruhr Agglomeration, Germany [9]

Abstract

Urban gardening has become a growing international movement. Many urban gardens are established, organized, and managed collectively as commons. Particularly in developed countries, these community gardens (a subset of urban gardens) emerge not only in response to a lack of locally produced food, but also in response to a lack of democratic use of public spaces or missing opportunities and time for socializing. They then give rise to social networks that fulfil various social functions. Although community gardens are often listed as examples of commons, they have thus far lacked closer scientific examination. Hence, we present criteria to explore and categorize community gardens as commons by their degree of collectivity. This is based on five components: resource system, infrastructure, resource units, work, social time. We classify these criteria further according to various styles of use, ranging from individual use to sharing. To demonstrate the utility of this model we implement a quantitative study of community gardens located in one of the most urbanized area in Germany, the Rhine-Ruhr Agglomeration. Our results show a high diversity of collective use and the importance of sharing immaterial components in sustaining community gardens, notably social values. We can empirically demonstrate that gardeners develop diverse ways of collective action and social interaction to manage and change their urban environment. To aid in thinking about these issues, we provide an initial typology of community gardens according to their relative degrees of collectivity, reflecting the underlying values of these alternative agricultural system.

2.1 Introduction

Urban Agriculture (UA) has become a dynamic international movement, summarizing a diversity of forms and types. A particular type of UA are urban gardens (UG). Community gardens, the focus of this paper, are in turn a subset of UG. These collectively organized and self-managed gardens, provide not only locally-produced

[9] This chapter has been published as the following article: Rogge, N., & Theesfeld, I. (2018). Categorizing urban commons: Community gardens in the Rhine-Ruhr agglomeration, Germany. International Journal of the Commons, 12(2), 251-274. doi:10.18352/ijc.854

food for urban residents, but rather additional benefits (Armstrong 2000; Guitart et al. 2012; Lohrberg 2016) such as agricultural knowledge and education, community cohesion and development, new experience inherent to democratic forms of governance, well-being, ecosystem services or green infrastructure (Bendt et al. 2013; Foster 2011; McClintock et al. 2016; McIvor and Hale 2015; Nettle 2014; Saldivar-Tanaka and Krasny 2004; Spilková 2017). Regarding these multiple benefits there are various motivations as to why residents participate in community garden projects (Draper and Freedman 2010). While food production is one reason for collective gardening in developing, as well as in developed countries (Opitz, Berges, et al. 2016; Rogus and Dimitri 2014), Pourias et al. (2016), Spilková (2017) and Nettle (2014) mention particularly the social function through collective action as the main motivation for gardeners in Europe and Australia. Despite the international importance of community gardens, there is a recognized lack of statistics and academic research on international and national level (Bendt et al. 2013; Guitart et al. 2012; Lohrberg 2016; Vejre and Simon-Rojo 2016).

Because community gardens are communal provided resources, self-managed mostly without local government intervention in management[10], and established to meet several social needs, they are also referred to as commons (Colding and Barthel 2013; Colding et al. 2013; Foster 2011; Lawson 2005; McClintock 2010). Commons are in general complex institutions in which land and other resources are used collectively by self-governance and rules that are self-restrictive and self-sanctioning (de Moor 2015). Understanding community gardens as commons can be very helpful in structuring garden management, and institutions in the surrounding community, to support gardeners seeking to foster collective use and social interaction. Following Hess (2008), Foster (2011), and Colding et al. (2013), we define community gardens as *new* and *urban commons* that have recently evolved. The core characteristics they share is their joint provision of various economic, ecological, and social goods such as open space, education, intergenerational and intercultural exchange (Foster 2006; Hess 2008). In addition to that, both new commons and community gardens are referred to as a movement, where new forms of self-governance and collaboration are developed (Bendt et al. 2013; Hess 2008; Rosol 2010). Hess (2008, p. 4) additionally, describes new commons like community gardens as "*publicly shared resources that have been reconceptualized as*

[10] This does not mean that there is no governmental involvement at all. While the gardeners itself mostly initiate and manage the community garden project, local governments often support these projects through land use approval or by funding and resource support (Lawson, 2005; Drake and Lawson 2015).

commons". Further, not only the urban space but also various urban resources such as financial means, organic waste, or reused building materials are used collectively which makes community gardens urban commons, too (Foster 2011). The management of new and urban commons, in contrast to the management of traditional common-pool resources, such as fisheries or irrigation systems, have broader objectives and a larger group of beneficiaries (Pieraccini 2015). Although studies on commons is an emerging field, and community gardens are often listed as examples of commons (Colding and Barthel 2013; Eizenberg 2012; Hess 2008; Lawson 2005; Linn 1999; McClintock 2010), only a few studies actually examine community gardens in this respect (Colding et al. 2013; Foster 2011; Nettle 2014). To foster research in this area, key characteristics defining community gardens as commons must first be specified. Furthermore, a typology of community gardens as commons, will inform future investigation.

Drawing on the recent studies of Pourias et al. (2016), Nettle (2014), and Spilková (2017) which point to the relevance of collective action in community gardens, the objective of this paper is to examine further what defines community gardens as commons and particularly how they can be classified in regard to the intensity of their collective actions. Regarding this, we are focusing on the collective use of diverse resources within community gardens and aim to explore what exactly is used and done collectively. Therefore, we are implementing an in-depth case study analysis, done here with a selection of community gardens located in the Rhine-Ruhr Agglomeration. We further aim to provide an initial classification of community gardens as commons regarding various degrees of collectivity. Our hypothesis is that community gardens differ widely in terms of which components are used individually or collectively.

In order to examine community gardens with regard to their collectivity, we consider the material components resource system, infrastructures, inputs and outputs of food production, as well as the immaterial components work and social time. We assume, that the more of the five mentioned components are used or fulfilled collectively, the more cooperation, communication and organization are required to manage these collective uses.

In the following pages, we describe the development and the state of the art of community gardens as a subset of UA. Therefore, Section 2.2 outlines diverse types of UA. In Section 2.3, we first explain the case study selection. Second, we present the criteria that serve to classify various community gardens according to their degree of collectivity. Third, we describe the questionnaire development and survey. Section 2.4 then presents the findings of our survey related to community gardens located in the

Rhine-Ruhr Agglomeration in Germany. In Section 2.5, we discuss our findings and challenges of the study before we conclude in Section 2.6.

2.2 Diversity of Urban Agriculture

This section gives an overview of the multifaceted aspects and different forms of UA, which includes community gardens as a subset. Since there is no specific widely-used definition for the term community gardens, yet (Guitart et al. 2012; Rosol 2010), we will propose one, highlighting the aspect of collective action.

2.2.1 Contrasting Urban Agriculture, Urban Gardens, and Community Gardens

UA is a growing international movement that encompasses various forms and activities, involves various actors, and pursues many objectives. The Food and Agriculture Organization (FAO) acknowledges its diversities and defines UA as

> *"[…] crop and livestock production within cities and towns and surrounding areas. It can involve anything from small vegetable gardens in the backyard to farming activities on community lands by an association or neighbourhood group." (FAO 2010).*

Many other definitions are to be found in the scientific literature, however most of them highlight food production in urban areas as the core concept of UA (Opitz, Berges, et al. 2016). Nevertheless, there is a broad understanding, that UA comprises diverse activities, since it includes all kinds of urban farms, ranging from commercial farmers who grow food for market to small-scale gardening activities.

UG are a subset of UA (Figure 2). It includes gardens with many purposes and various locations, like the backyard or balcony of a house, rooftops, or open vacant spaces, often available only for temporary use (Smit et al. 2001a). Therefore, cultivation is mostly taking place on smaller urban areas sometimes unsuited for food production, while UA in general, ranges to peri-urban plots of agricultural land with 10 or more hectares (Smit et al. 2001a). Numbers of these UG are used individually (house gardens, allotment gardens), while a sizeable subset qualifies as community gardens (Figure 2).

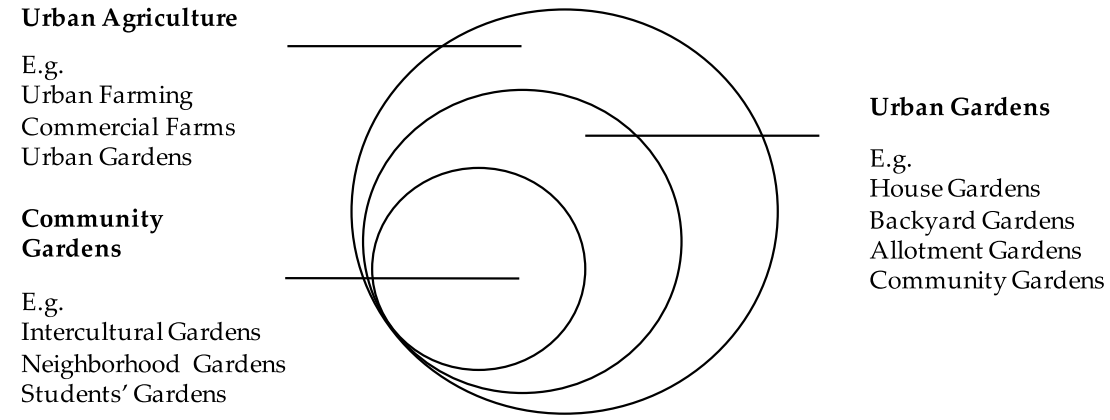

Figure 2: Community gardens as part of urban gardens and urban agriculture
Source: Own figure

Examples of community gardens are neighborhood gardens, intercultural gardens or students' gardens[11]. Community gardens often emerge as bottom-up initiatives and their collective character is essential to their creation (Drake and Lawson 2015; Nettle 2014; Rosol 2010; Simon-Rojo et al. 2016). Opitz, Berges, et al. (2016, 343) further describe that *"[…] members participate in the decision processes and share resources such as space, water and tools."* The focus of community gardens is not simply gardening, but rather developing social networks and establishing a sense of community (Simon-Rojo et al. 2016). In addition, as UG and UA in general, community gardens show various aims, motivations, structures, and forms of organization, and further differ e.g. in size, location, and services they offer to the community. While community gardens are often called public gardens, a closer look reveals that gardens further differ in ownership of the land being used that can likewise be public, private, or collective (Colding et al. 2013; Ferris et al. 2001).

Drawing from Ferris et al. (2001); Mougeot (2006); Rosol (2010); Randolph (2011); and Krikser et al. (2016), we define community gardens as follows: collectively used and self-organized open places situated in urban areas, where food, non-food plants, and a sense of community is grown, to address diverse local needs and to generate personal and common benefits.

Due to their self-governance, their collective use of various resources, and their services offered to the society, community gardens can be considered to represent new and urban commons (Colding et al. 2013; Eizenberg 2012; Foster 2011; Hess 2008; Lawson 2005; Linn 1999). Being aware, that the characteristics of common-property

[11] Various expressions can be used to specify community gardens regarding location or actors. For instance, intercultural gardens especially address migrants from different countries of origin (Moulin-Doos 2014).

regime is much more complex according to e.g. self-monitoring, self-sanctioning, and rule design, this research is focusing on disentangling the collective use of diverse resources.

2.2.2 Current Scope of Community Gardens

The fact that community gardening is relatively new and a fast growing movement may account for the notable absence of systematic data, whether on a national or international level (Bendt et al. 2013; Guitart et al. 2012; Lohrberg 2016; Vejre and Simon-Rojo 2016). In Germany, 624 community gardens are listed in the most comprehensive database available (anstiftung 2017). Most of these community gardens can be found in the federal states of Berlin (75), Bavaria (93), and North Rhine-Westphalia (NRW) (87).

2.3 Research Design and Method

The research design consists of three steps: 1) the case study selection, 2) the criteria development to operationalize the collectivity characteristics, and 3) the questionnaire development and garden survey.

2.3.1 Case Study Selection

We expected to gain knowledge on the complexity of resource use not only through comparing diverse community gardens, but also by scrutinizing into the individual garden projects. To illustrate the diversity of individual community gardens, we chose a multistage selection procedure, starting with an area sampling.

To study community gardens as new and urban commons we opted for the most urbanized area in Germany. We chose the *Rhine-Ruhr Agglomeration*[12] as the examination unit, since this area is one of the most important dense-population areas in Germany and one of the biggest areas of concentrated population in Europe (BBR 2008). The *Rhine-Ruhr Agglomeration* is located in the federal state of North Rhine-Westphalia (NRW), has a total area of 11,738 square kilometers, and a population of 11.6 million (BBR and IKM 2012). Twelve counties and 20 urban municipalities (German: kreisfreie Städte) including major cities such as Cologne, Düsseldorf, Dortmund, or Essen belong to that area[13].

[12] Due to a lack of commonalities between the cities, the limited cooperation, and a lack of self-identification as part of a metropolitan region, the term *Metropolitan Region Rhine-Ruhr* is regarded as very controversial (Bege 2010), thus *Rhine-Ruhr Agglomeration* is preferred.

[13] Altogether, 24 of the 79 major cities in Germany, are located in the *Rhine-Ruhr Agglomeration*.

According to (anstiftung 2016), there are 65 community gardens in the *Rhine-Ruhr Agglomeration*. Thus, 75% of the community gardens in NRW, are listed in that region. Since community gardens in NRW are further networked through the online platform *UrbaneOasen* we identified for the year 2016 a total number of 79 community gardens located in the *Rhine-Ruhr Agglomeration* (Die Urbanisten 2016). Consequently, this selection offered a number of various community gardens located in diverse cities within a very urbanized area.

Verification of the 79 gardens indicated that some gardens are still in the planning stage (13 gardens) while others have ceased to exist (6 gardens). Of the remaining 60 garden projects listed, we further excluded activities of gardening that appeared to be public beds, with no characteristics of community gardens (e.g. <5 square meters, single flower beds tended by neighbors, or gardening activities that do not take place on a permanent area) and projects that can be characterized as closer to parks than community gardens (e.g. >10,000 square meters) (13 gardening activities in total). We further excluded community gardens which were established since 2014 (25 gardens). We can therefore guarantee that the examined gardens passed through at least two garden seasons and can report on detailed rules of sharing as well as success and failure. Overall, we identified 22 community gardens suitable for our investigation.

2.3.2 Criteria Development

Based on the core characteristic of community gardens that centers around their manifold ways and intensity of collective resource use, we developed criteria that allow to investigate the degree of collectivity. The criteria development is based on literature review and on several prior research projects (Armstrong 2000; Bendt et al. 2013; Hess and Ostrom 2006; Opitz, Berges, et al. 2016; Ostrom 2003, 2009; Pourias et al. 2016; Rosol 2010; Schlager and Ostrom 1992), as well as on own experience as an urban gardener. The criteria should examine what exactly is used collectively and to which degree. Therewith we can test our hypothesis that gardens differ depending on whether and how key components in gardens are used individually or collectively. Thus, we examine how these processes work in detail.

The bundles of rights approach (Schlager and Ostrom 1992) appears helpful in that respect. For instance, while authorized people may hold access rights to the gardens, they lack other rights such as withdrawal (Colding et al. 2013). Another classification is done by Hess and Ostrom (2003, 2005, 2006) who look at knowledge as a form of new commons and make a threefold distinction in facilities, artifacts, and ideas to assess what

exactly is shared and how. Further helpful is the distinction in resource system and resource units, done in most traditional common-pool-resource studies to analyze individual cost and benefit streams of use or provision (Hess and Ostrom 2003, 2005, 2006; Ostrom et al. 1999).

We aimed to construct a more detailed distinction and designed a core building block with five components that can be used collectively in community gardens, namely: resource system, infrastructure, resource units (including inputs and outputs), work, and social time (Table 1).

These five components are based on various criteria found in scholarly literature (Bendt et al. 2013; Drake and Lawson 2015; Eizenberg 2012; Ferris et al. 2001; Hess 2008; Nettle 2014; Opitz, Berges, et al. 2016; Spilková 2017) (Table 1).

Table 1: Collectively used components of community gardens

	Components				
	Resource system	**Infrastructure**	**Resource units**	**Work**	**Social time**
Criteria	Area	Kitchen	Tools	Creating beds	Consumption of the harvest
	Plot	Tool shed	Soil	Planting	Garden parties
	Bed	Greenhouse	Compost	Weeding	Cultural events
		Water connection	Seeds	Watering	Excursions
		Toilets	Plants	Cleaning-up	
		Furniture	Harvest	Constructing work	
			Financial means	Organizing	
			Costs		

Source: own compilation

In addition to differentiating five components that can be used collectively, the extent of collective use in each component varies. Similarly to different property-rights systems existing in parallel, e.g. Swiss peasants who divide their agricultural land into separate owned parcels, but use grazing land collectively[14] (Ostrom 2003), we find such characteristics in community gardens, as well. E.g. in some community gardens, gardeners have an individual used garden plot, while a shared garden plot used by all gardeners exists in parallel (Bendt et al. 2013; Drake and Lawson 2015). Regardless of the plot design there is always a minimum of shared areas like pathways or social spaces

[14] The diversity of property-right systems by Swiss peasants was noted by Robert Netting, who observed that the same individuals used different property-right systems side-by-side (Ostrom 2003, Netting 1976, 1981).

to be found (Drake and Lawson 2015). In some gardens, a combination of individual and collective use exist, while in others all components are used collectively (Drake and Lawson 2015; Nettle 2014; Rosol 2010). Notably, components can be used collectively in two ways: through dividing or through sharing. In Figure 3, the term *collective divided* indicates that collective use occurs within the community through joint assignment or division. Under *collective shared*, collective use occurs within the community without a clear assignment.

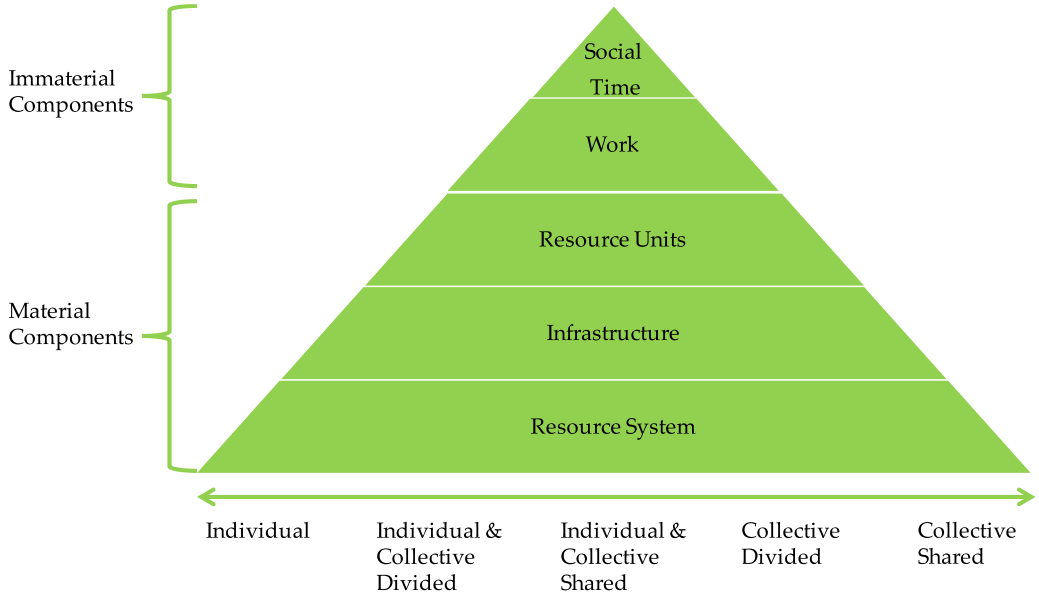

Figure 3: Five components and five styles of use in community gardens
Source: Own figure

We break down the first and most basic component, (at the bottom in Figure 3), the resource system (the total garden or urban area) into the criteria: area, plot, and bed (Table 1). Then, we examine which of those is used individually or collectively through dividing, sharing, or a combination of both individual and collective use (Figure 3). In a collectively used resource system, the community can divide the total system through for example, simple division of areas, plots or beds between different users. In another collectively used resource system, however, there may be a combination of individually and collectively used areas, plots or beds. Still another form of a collectively used resource system is sharing of the entire space. In this case, there are no divided or individually used areas, plots or beds. The community shares the system without a clear assignment.

In addition to the resource system, infrastructure is another collectively used component. Infrastructures may include a kitchen as well as toilets, access to water, outdoor furniture, a tool shed or a greenhouse (Table 1). In some gardens each gardener

has an individual tool shed. In other gardens we find a combination of individually and collectively used tool sheds or tool sheds that are only used collectively. At the subordinate-level of collectively used tool sheds we can differ again between dividing and sharing. A collectively used tool shed can be divided by gardeners, who are allocated a specific space in a tool shed, which they are allowed to use and where they may store their individual tools. If the tool shed is used collectively by sharing, all gardeners can use it without a clear assignment of rights to space.

Furthermore, some gardens may also use certain inputs or outputs (resource units) collectively. These include tools, seeds, plants, soil, compost, water, financial means, costs, and harvest (Table 1). On the one hand, there may be rules to divide the harvest collectively according to working hours spent or according to individual needs of each gardener. On the other hand, the harvest can be shared without any clear withdrawal rule. One example for this default rule may be that all gardeners prepare and eat the harvest together. While the latter constrains an individual in his or her withdrawal rights, it increases the socially shared time.

In contrast to resource system, infrastructure and resource units, which are material components, work and social time are immaterial components (Figure 3). We subdivide the component work under the following criteria: creating beds, planting, weeding, watering, cleaning-up, constructing work, and organizing (Table 1). In some gardens work may be done individually, for example on gardeners' individually used beds. However, work may also be done collectively, again through dividing or sharing. Usually, in community gardens collective work is divided by working time or working activities. For instance, a community may allocate a specific working hour or specific tasks – like watering – to each gardener. The work is divided and that means the work is not done together. Sharing work, by contrast means that there are specific times or meetings for gardening when people work together, e.g. spreading new soil on all beds together. In such cases, gardeners share working time and working activities, and so they share social time, too.

Another immaterial component is social time. Besides working together, social time can be spent together through events such as the consumption of the harvest, garden parties, cultural events or excursions. In contrast to all other components, the benefits of socializing - spending time with other gardeners – can only be shared, not divided. Therefore, we examine which of the four mentioned collective activities (consumption of harvest, garden parties, cultural events, and excursions) take place, which other collective activities happen and how often these collective actions are organized.

In line with Glaeser et al. (2002) and Adger (2003) we assume that there are various positive feedbacks between a high frequency of community social activities and trust, which in turn influences norms and rules of collaboration in a positive way. The better the members know and spend time with each other, the less free riding there should be (Foster 2006, 2011; Ostrom 2010a), making an expansion of collective action more likely and more successful and thus reinforcing social interaction.

We further assume that the more of the five mentioned components are used or fulfilled collectively, the more cooperation, communication and organization are required to manage these collective uses. Furthermore, shared components require a higher degree of collective action and social interaction than divided components. Therefore, the degree of collectivity can be determined by the style of use ranging from 1 (individual use) to 5 (shared use) (Figure 3). By achieving diverse degrees of collectivity, we aimed to develop an initial typology that leads us to prototypical garden projects.

2.3.3 Questionnaire Development and Survey

Based on the above presented criteria, we designed an extensive questionnaire consisting of 57 questions, enabling us to examine the complexity of collective action within community gardens. The online questionnaire was directed to leaders or at least members of the core group of a garden, from whom we expected to have well-founded knowledge to answer specific questions. A number of pre-tests ensured that questions were easily understood and that the wording did not suggest any particular answer.

Of 22 online questionnaires sent out to our case studies, eleven completely-filled questionnaires were returned, a comparatively high response rate for online surveys of such extent. Despite this in total small number of eleven cases, but due to the richness of data for each case, we can analyze the varying degrees of collective use of community gardens within each of the five components, described in the next section. In addition, we can illustrate the specificity of each garden project.

2.4 Results

In this section, we will present the results of our study – i.e. the collective action found for the five components. Diverse degrees of collectivity, meaning measurable degrees of possible social interaction, lead us to an initial typology of community

gardens and confirm the categorization of community gardens as new and urban commons.

2.4.1 Collective Action in Community Gardens in the Rhine-Ruhr Agglomeration, Germany

The research question we aim to answer is: what defines community gardens as commons and how can they be classified in regard to the intensity of their collective actions? The gardens from the *Rhine-Ruhr Agglomeration* in Germany have allowed an initial answer to this question, as they show quite unique patterns of collective action. The following section demonstrates the results of our study. With the help of the five components and the five styles of use, ranging from individual use (Value/Style 1) to sharing (Value/ Style 5), we can show a wide variety of collective action in the eleven community gardens examined.

Table 2: Style of use for component 1: Resource system

Garden	Style of use				
	Individual (1)	**Individual & collective divided (2)**	**Individual & collective shared (3)**	**Collective divided (4)**	**Collective shared (5)**
1	Plot, Bed	Area	-	-	-
2	-	-	-	Bed	Area, Plot
3	-	-	-	Bed	Area
4	-	-	-	-	Bed
5	Plot	-	Area	-	Bed
6	Area, Plot, Bed	-	-	-	-
7	-	-	-	-	Area, Plot, Bed
8	-	-	-	-	Area, Plot, Bed
9	-	Bed	-	-	Area
10	Bed	-	-	-	Area
11	-	-	-	Area	-

Resource system is defined by the criteria area, plot, and bed. If not otherwise stated, missed criteria means that the criterion does not exist in the particular garden.

For the first component, the resource system, we can demonstrate a wide range of styles of use in community gardens. Table 2 shows that in four of the 11 examined community gardens several criteria are used individually (Style 1). For instance, in Garden 6 all criteria are used individually, i.e. gardeners have an own area, plot, and beds. Next to the individual use, we find in three garden projects a combination of individual and collective use (Style 2 and 3). For instance, in Garden 5 the area is utilized in a combination of individual use and sharing (Style 3). In addition, plot is used

individually while a bed is shared. Hence, Garden 5 is a good example where within the resource system a variety of three different styles of use exist.

Moreover, six gardens use the total resource system collectively (without any kind of individual use). Garden 11 uses the resource system collectively through dividing the area (Style 4), Garden 2 and 3 express dividing and sharing (Style 4 and 5), and Garden 4, 7, and 8 share the resource system without a clear assignment (Style 5).

Table 3 shows that none of the criteria which define the infrastructure are strictly used individually (Style 1) in any of the gardens examined. Rather, infrastructure use is a combination of individual and collective use (Style 2 and 3). For instance, in Garden 5 the kitchen is used in a combination of an individual and collective divided style: gardeners have their own kitchen(ette) in their garden house, if available, and a joint kitchen is used with a clear assignment.

Furthermore, nine gardens use the entire infrastructure collectively. Garden 9 divides all criteria (Style 4) and Garden 6 divides the furniture (Style 4), but shares the tool shed and water connection (Style 5). Seven gardens use all infrastructures through sharing (Style 5), only.

Looking at the aggregated data again, Table 4 demonstrates that resource units are more often used individually than infrastructure, shown by the fact that five gardens use certain resource units strictly individually (Style 1). For instance, Garden 1 uses seeds, plants, and the harvest individually. In Garden 8 seeds are used in a combination of individual and shared use (Style 3), while all other resource units are used through sharing (Style 5). Five gardens use their resource units collectively (Style 4 and 5). In Garden 9 all resource units are divided (Style 4) while in Garden 4,7, and 11 all resource units are used through sharing (Style 5) and therefore without a special assignment.

Table 5 indicates the immaterial component work, and shows that in five gardens some work activities are strictly done individually (Style 1). For instance, in Garden 6 creating beds, planting, weeding, watering, and cleaning-up are done individually (Style 1) while construction work and organizing are achieved through sharing (Style 5). In Garden 2, 3, 4, and 9 most of the work is done in a combination of individual and collective style (Style 2 and 3). Only two gardens do all of their work collectively, while in Garden 11 some work is divided (Style 4) and some work is shared (Style 5), in Garden 7 all working activities are shared (Style 5).

Table 3: Style of use for component 2: Infrastructure

Garden	Style of use				
	Individual (1)	**Individual & collective divided (2)**	**Individual & collective shared (3)**	**Collective divided (4)**	**Collective shared (5)**
1	-	-	Furniture	Water connection	Tool shed, Toilets
2	-	-	-	-	Tool shed, Furniture
3	-	-	-	-	Water connection, Furniture
4	-	-	-	-	Kitchen, Tool shed, Greenhouse, Water connection, Furniture
5	-	Kitchen	Tool shed, Water connection	-	Furniture
6	-	-	-	Furniture	Tool shed, Water connection
7	-	-	-	-	Tool shed, Greenhouse, Water connection, Furniture
8	-	-	-	-	Kitchen, Tool shed, Water connection, Toilets, Furniture
9	-	-	-	Kitchen, Tool shed, Greenhouse, Water connection, Toilets, Furniture	-
10	-	-	-	-	Greenhouse, Water connection, Furniture
11	-	-	-	-	Tool shed, Water connection, Furniture

Infrastructure is defined by the criteria kitchen, tool shed, greenhouse, water connection, toilets, and furniture.

Table 4: Style of use for component 3: Resource units

Garden	Style of use				
	Individual (1)	**Individual & collective divided (2)**	**Individual & collective shared (3)**	**Collective divided (4)**	**Collective shared (5)**
1	Seeds, Plants, Harvest	-	-	-	Tools, Compost
2	-	-	-	Seeds, Plants	Tools, Soil, Compost, Harvest, Financial means, Costs
3	Tools, Seeds	-	-	-	Soil, Compost, Plants, Harvest,
4	-	-	-	-	Tools, Soil, Compost, Seeds, Plants, Harvest, Financial means, Costs
5	Compost, Seeds, Harvest	-	Tools	Plants	Soil
6	Seeds, Plants, Harvest, Financial means, Costs	-	-	Soil, Compost	Tools
7	-	-	-	-	Tools, Soil, Compost, Seeds, Plants, Harvest, Financial means, Costs
8	-	-	Seeds	-	Tools, Soil, Compost, Plants, Harvest
9	-	-	-	Tools, Soil, Compost, Seeds, Plants, Harvest, Financial means, Costs	-
10	Seeds, Plants, Harvest	-	-	-	Tools, Compost, Financial means
11	-	-	-	-	Tools, Soil, Compost, Seeds, Plants, Harvest

Resource unit is defined by the criteria tools, soil, compost, seeds, plants, harvest, financial means, and costs.
Garden 5 responded: “I do not know” the style of use of the criteria financial means and costs. Garden 10 responded “I do not know” the style of use of the criteria costs.

Table 5: Style of use for component 4: Work

Garden	Style of se				
	Individual (1)	**Individual & collective divided (2)**	**Individual & collective shared (3)**	**Collective divided (4)**	**Collective shared (5)**
1	Creating beds, Planting, Weeding	-	Cleaning-up	Watering	Construction work, Organizing
2		-	Creating beds, Planting, Weeding, Watering, Cleaning-up, Construction work	Organizing	-
3	-	-	Planting, Weeding, Watering, Cleaning-up, Construction work	Organizing	Creating beds
4	-	-	Creating beds, Planting, Weeding, Watering, Cleaning-up, Construction work	-	Organizing
5	Planting	-	Watering	Creating beds	Weeding, Cleaning-up, Construction work, Organizing
6	Creating beds, Planting, Weeding, Watering, Cleaning-up	-	-	-	Construction work, Organizing
7	-	-	-	-	Creating beds, Weeding, Planting, Watering, Cleaning-up, Construction work, Organizing
8	Weeding	-	-	Watering, Cleaning-up	Creating Beds, Planting, Construction work, Organizing
9	-	Creating beds, Planting, Weeding, Watering, Organizing	-	-	Cleaning-up, Construction work
10	Creating beds, Planting, Weeding, Watering	-	-	-	Cleaning-up, Construction work, Organizing
11	-	-	-	Watering, Cleaning-up	Creating beds, Planting, Weeding, Construction work, Organizing

Work is defined by the criteria creating beds, planting, weeding, watering, cleaning-up, construction work, and organizing.

Besides work, social time is another immaterial component – a style of use that is always shared. In line with scholars in the field (Guitart et al. 2012; Nettle 2014; Pourias et al. 2016; Saldivar-Tanaka and Krasny 2004; Spilková 2017), we found that in modern societies today, social interaction and thus sharing of time represents to a large extent what makes people participate in community gardens. We can empirically support the insights provided from other parts of the developed world (Nettle 2014; Pourias et al. 2016; Saldivar-Tanaka and Krasny 2004; Spilková 2017) that besides gardening, socializing is the most mentioned aim in the garden projects studied and the most mentioned motivation of the gardeners. In addition to that, in ten out of eleven gardens studied, the quality of the garden as a social place was ranked as *quite important* or *very important*. While gardeners share social time through working together, other collective activities involving social time also take place.

Table 6 demonstrates how often, and which kind of, collective activities are taking place. Except for one garden, all gardeners share social time at least once a month. There are diverse types of collective activities, yet as the empirical data show, gardeners share social time especially through garden parties.

Table 6: Socializing in community gardens

Frequency of collective activities, in total	**Garden**	**Kind of collective activity**
Less than once a month	3	Garden parties
Once a month	1	Garden parties, Cultural events
	6	Consumption of the harvest, Garden parties, Cultural events
	10	Garden parties
Once to two times a month	4	Consumption of the harvest, Garden parties, Cultural events, Excursion, Workshops, Events outside the garden
	5	Garden Parties
	7	Consumption of the harvest, Garden parties, Cultural events, Excursion
	11	Consumption of the harvest, Garden parties, Cultural events
Two to four times a month	8	Consumption of the harvest, Garden parties, Cultural events
Four times a month or more	2	Consumption of the harvest, Garden parties
	9	Consumption of the harvest, Garden parties, Excursion

2.4.2 Typology

Our results indicate a variety of styles of use in the individual community gardens. This variety can range on an ordinal scale from 1: the community garden shows only one style of use e.g. all criteria are used individually; to 5: the individual community garden encompasses all 5 styles of use viz. individual, individual and collective divided, individual and collective shared, collective divided, and collective shared.

Depending on the predominant style of use (individual to sharing), community gardens can further reach diverse degrees of collectivity.

Figure 4 demonstrates the variety of styles of use (x-axis) and the degree of collectivity (y-axis) of the 11 community gardens examined.

The results show that gardens mostly combine a variety of styles of use (x-axis). E.g. in Garden 1 and Garden 5 all five styles of use, ranging from individual use to sharing prevail (see Table 2 to Table 5 as well). Therefore, Garden 1 and Garden 5 are prime examples of complex and very diverse property-right systems. Unlike in Garden 7 where the variety of 1 indicates that all criteria are used only through one style. The variety of styles of use indicate the diversity of resource use within an individual garden project. However, it does not indicate if resources are predominantly used individually or collectively.

To further qualify community gardens as commons, the degree of collectivity is the important result of our study. To determine the degree of collectivity (y-axis), we first calculated the median of the style of use of each component and each community garden[15] (see results presented in Table 2 to Table 5). We therefore only considered "filled-in" criteria. Afterwards, we calculated the arithmetic mean of all five components' medians. In this respect, we achieved diversified results of collectivity of the examined gardens, shown as metric data in Figure 4 (y-axis).

Formula: $C(G) = \frac{\overline{x_{E1}}+\overline{x_{E2}}+\overline{x_{E3}}+\overline{x_{E4}}+\overline{x_{E5}}}{5}$

C= Degree of Collectivity; G= Garden; E= Component; $\bar{x}$ = Median

Example calculation Degree of Collectivity Garden 1:

E.g. median of style of use of component 1 (resource system) (see Table 2): Value 1 (individual use of plots), Value 1 (individual use of beds), Value 2 (combination of individual and collective divided use of the total area): $\overline{x_{E1}} = 1$

$$C(G_1) = \left(\frac{1 + 4.5 + 1 + 3 + 5}{5}\right) = 2.90$$

The degree of collectivity can range from the lowest value 1 (criteria are predominantly used individually) to the highest value 5 (criteria are predominantly used through sharing). For instance, in Garden 7 and 8 criteria are predominantly used through sharing. The example calculation above depicts a more diversified case of

[15] We opt for the median due to the ordinal scale of the primary data. Regarding the component 5 (social time) all gardens reach a value of 5, since social time can only be shared and not divided.

Garden 1 reaching a degree of collectivity of 2.9. Because we only examined community gardens, as expected, all gardens have a higher value of the degree of collectivity than one. In fact, all case studies reach degrees of collectivity higher than two (y-axis Figure 4).

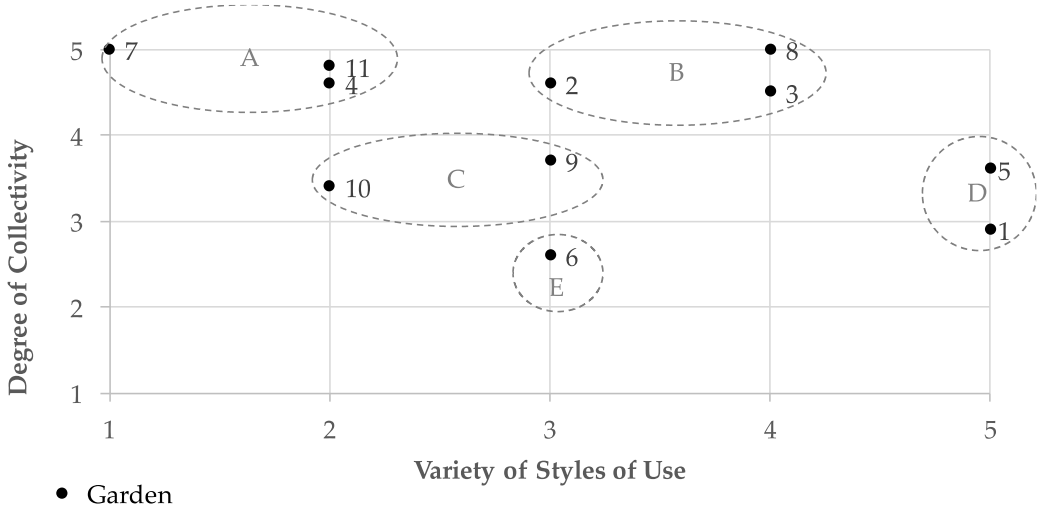

Figure 4: Collectivity of case study gardens

Referring to our model of degree of collectivity and variety of styles of use, we present an initial idea of five types of community gardens (Table 7) which serves to illustrate the importance of the degree of collectivity and the variety of style of use within each individual garden. *High collective gardens with less variety of styles of use* (Type A) are community gardens where criteria are mostly used through sharing. This gives indication that those gardens have a clear orientation towards sharing but less diverse property-right systems. *High collective gardens with high variety of styles of use* (Type B) are community gardens where criteria are mostly used through sharing, while further styles of use exist. In both types, we would have the highest potential for social interaction. *Medium collective gardens* have lower percentage of shared use and higher percentage of individual use, while the variety of style of use ranges from less variety (Type C) to high variety and therefore very diverse property-right systems (Type D). The lower the degree of collectivity of a garden, the less opportunities for social interaction, as shown in Type E, named *lower collective gardens*. Therefore, following our initial idea for a typology, the degree of collectivity on the y-axis should present the major criteria for assigning a garden into a group.

Table 7: Typology of community gardens

Types	Garden
A High collective gardens with less variety of styles of use	4; 7; 11
B High collective gardens with high variety of styles of use	2; 3; 8
C Medium collective gardens with less variety of styles of use	9; 10
D Medium collective gardens with high variety of styles of use	1; 5
E Lower collective gardens	6

2.5 Discussion

With their vast diversity, community gardens are a prime example of the need to explore new and urban commons further. The collective use of resources in community gardens, as in commons in general, is often taken for granted, but our results show an enormous heterogeneity of collective use of diverse components, and thus of collectivity and social interaction, in community gardens. Our results further confirm that the range of components which can be used collectively may go beyond what is usually explored in natural common-pool–resources studies. Here five components - the resource system, the infrastructure, the resource units and immaterial components such as work and social time - can be used collectively at various degrees.

While none of the criteria defining the component infrastructure are strictly used individually (Style 1), the component resource units shows a high share of individual use. We interpret this result as an indication that the collective use of resource units (inputs and outputs) is much more difficult than infrastructure. This can be substantiated by the fact that resource units are substractable: the seeds or harvest one gardener subtracts, cannot be used by another gardener, while infrastructure is not that rivalrous. Nevertheless, five gardens use all resource units collectively (Style 4 or 5) and of that group, three gardens even so without a clear assignment (Style 5).

Looking at the component work, it is conducted in a combination of individual and collective style (Style 2 and 3), and strictly individual style (Style 1), but the predominant style of work is sharing (Style 5). Gardeners often work together and thus also share social time. This expresses their underlying motivation to join community gardens, namely social involvement, and shows their underlying values, ideas but also needs. Furthermore, social time is shared through collective activities, mostly garden parties. Therefore, our empirical results let us argue that community gardens to a large extent give gardeners the benefits of increased immaterial components. We further assume that the more immaterial components are shared, the better the new and urban commons movement can address social needs in urban areas.

Since all gardens reached total values of the degree of collectivity higher than two, our results confirm that collective action and social interaction are essential characteristics of community gardens. For almost all components, sharing is the predominant style of use, i.e. most of the resources and tasks are used and fulfilled without a clear assignment.

The diversity of collective action in community gardens is just one expression of how urban residents find multiple ways of social interaction to manage, adapt, and maintain their urban environment. Thereby urban gardeners give a new meaning to property, provide new ways of life and of a sharing economy that emerge in modern urban societies. Community gardens therefore further underlines the new forms of collaboration, self-management, and collective action of new commons, mentioned by Hess (2008). If community gardens are to thrive, it is of high importance to provide basic resources such as use rights to urban areas, so that societies can test new and diverse ways of interacting and living together. As we have shown, community gardens are defined by individuals who take the initiative to formulate their own rules and manage their surrounding urban landscape in a creative and diverse fashion. This enables a meeting and exchange of ideas.

2.6 Conclusion

Community gardening is an ongoing international movement. To appreciate their diversity, a large amount of criteria is needed to capture the characteristics of the gardens in a detailed way and to elaborate on their typology. Community gardens are prime examples of collective use and social interaction within urban areas and they have special qualities, illustrating how people in cities start organizing their commons and gain experience in democratic governance. We therefore elaborated on these collective uses of urban resources and examined what exactly is used and done collectively and to which degree. We designed a core building block of five components: the resource system itself, infrastructure, and resource units, as well as the immaterial components work and social time. These five components are defined by diverse criteria (resource units for instance include tools, soil, compost, seeds, plants, harvest, financial means, and costs) which can be used in different styles of use ranging from individual use to sharing.

We initiated a survey in the *Rhine-Ruhr Agglomeration* in Germany, as the most urbanized area, important for community gardening. The results from 50% of all at least

two seasons active community gardens give an initial answer to the questions of what defines community gardens as commons and how they can be classified in regard to their degree of collectivity.

Our results of diverse styles of uses confirm the diversity of resource use and the diversity of property right regimes studied by Huong and Berkes (2011) and Davy (2014). This diversity enables us to systemize gardens according to their degree collectivity. Thereby gardens can reach values ranging from 1 (criteria are predominantly used individually) to 5 (criteria are predominantly used through sharing, without a clear assignment). Although there is a wide variety of styles of use, most of the criteria that define each component are used through sharing. This is underlined by the fact that, according to our model, all examined gardens reach a total value of collectivity higher than 2, confirming that collectivity and social interaction is the main characteristic of community gardens. Based on our study, we suggest to continue to explore a typology of community gardens based on the degree of collectivity and the prevailing variety of style of use in each garden: high collective gardens, medium collective gardens and lower collective gardens. With this, we aim to fill the lack of in-depth studies on the diversity of community gardens and to scrutinize into their key characteristics from a commons perspective.

Community gardening as a civic movement offers new ways of social interaction and collective use of urban resources, provide space for recreation, knowledge exchange, social cohesion, and experience in implementing basic democratic principles. These benefits are not only shared within a closer community but also with *external users* (Drake and Lawson 2015). In this regard, responses to our survey not incorporated in the overall results are significant. These responses point to the importance of sharing knowledge, not only among members of the garden community but also with the general public, constituting a special characteristic of such new commons. The pace and extent of knowledge sharing is so diverse that it cannot be incorporated in one of the other components, and therefore needs to be examined in further research.

The limitation of the study is that although we can categorize gardens according to their degree of collectivity, we cannot draw conclusions on their performance. Higher degrees of collective action do not automatically mean that those initiatives are more successful than others (Frey et al. 2016). To determine the success of community gardens as new and urban commons - however success should first be defined, further research is required. Since we could demonstrate diverse degrees of collective action within community gardens, we plan on extending our research to analyse the relationship

between styles of uses and success factors. We want to consider the size of the resource system, number and composition of the members, rule design, monitoring and sanctioning mechanisms as additional criteria relevant to study community gardens as commons.

3 Social Sustainability through Social Interaction—A National Survey on Community Gardens in Germany [16]

Abstract

Community gardening has become a growing movement in cities all over the world, where these diverse collectively managed spaces provide various economic, ecological, and social benefits for urban residents. Particularly in developed countries such as Germany, social benefits are the motivation to participate in community gardens more so than the harvests. Although research on community gardens has grown, including the question of their benefits to a sustainable development, there is little literature studying the social importance and social sustainability of community gardens. Therefore, the purpose of this paper is to examine social interaction, participation, and perceived success as a concept to assess social sustainability. The paper further aims to examine the conditions influencing social sustainability within community gardens. With the help of an online survey, we collect data from 123 community gardens throughout Germany, with which we assess diverse degrees of social sustainability. Causalities of gardens' social sustainability are analyzed with a multiple linear regression model. Results indicate that there is no significant relationship between size of community and social sustainability, rather aspects of trust and management have a strong effect on social sustainability. Findings like these lead to a better understanding of social interaction in urban communities that contribute to more social sustainability.

3.1 Introduction

In the last three decades, the importance of urban agriculture has increased to become a growing international movement (Ferris et al. 2001; Smit et al. 2001b, 2001c). Driving forces of this movement are global developments, their local consequences and the urgency to shift towards sustainable development. Very generally and most frequently, sustainable development is defined as a "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (WCED 1987, p. 41). The necessity to move towards sustainable development is

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underlined by the global Agenda 2030 and its 17 Sustainable Development Goals (SDGs), adopted by the United Nations in 2015. These 17 SDGs are integrated and consistent with the three dimensions of sustainable development: the environment, focusing on the conservation of natural resources (UNCED 1992); the economy, focusing on prosperity for all human beings (UN 2015); and society, focusing on people's basic needs (UNCED 1992; Vallance et al. 2011). Although more complex concepts of sustainability are developed and discussed, sustainability is predominantly seen in regard to these three dimensions. However, there are no widely acknowledged definitions for these dimensions.

Although the SDGs do not explicitly address urban agriculture, various topics are connected to it, such as end poverty and hunger (SDGs 1 and 2), ensure healthy lives (SDG 3), reduce inequalities (SDG 10), make cities resilient and sustainable (SDG 11), ensure sustainable consumption and production patterns (SDG 12), take action to combat climate change (SDG 13), and protect, restore, and promote sustainable use of terrestrial ecosystems (SDG 15) (Game and Primus 2014; Hernandez and Manu 2018; Landert et al. 2017). Consequently, urban agriculture with its diverse aims, actors, structures and organizations, contributes in various ways to sustainable development and its three dimensions (Ackermann et al. 2014; Pearson et al. 2010).

However, urban agriculture's contribution to the dimensions of sustainability depends on the type of urban agriculture observed (Krikser et al. 2016). While we find professional and sometimes very technical urban agriculture activities focusing on food production and food provision for the urban population, we further find small social-orientated gardening activities as an expression of self-determination, self-experience, social interaction or social change.

In our research, we are particularly focusing on community gardens as a socially-oriented subset of urban agriculture and its contribution to the social dimension of sustainability. Within community gardens, as in urban agriculture in general, we still find a high diversity of actors, motivations, structures, sizes, locations, as well as services offered to the wider community. Community gardens mostly emerge as bottom-up initiatives and are collectively organized and self-managed networks (Bendt et al. 2013; Colding et al. 2013; Foster 2011; Spilková 2017). Commons are defined as complex institutions in which land and other resources are used collectively by self-governance and rules that are self-restrictive and self-sanctioning (de Moor 2015). Thus, community gardens also belong to the commons movement (Foster 2011; Hess 2008).

Commons such as community gardens are furthermore a way to organize material resources, immaterial resources, and social relations (De Angelis 2003; Eizenberg 2012). Hence, they provide not only locally-produced food for urban residents (McIvor and Hale 2015; Pourias et al. 2016), but also benefits such as education, community development, new experiences inherent to democratic forms of governance, ecosystem services, green infrastructure, or space for recreation, just to name a few (Barthel et al. 2010; Bendt et al. 2013; Foster 2011; Lovell 2010; McClintock 2010; McClintock et al. 2016; McIvor and Hale 2015; Nettle 2014; Saldivar-Tanaka and Krasny 2004; Spilková 2017; Vejre and Simon-Rojo 2016). All those benefits play a role in the increasing popularity of community gardens and their potential for sustainable development. Although community gardens fulfill various functions in all three dimensions of sustainability (Lovell 2010; Pearson et al. 2010), the benefits of this type of urban agriculture are more social (Krikser et al. 2016; Martin et al. 2016).

Reflecting this richness and multi-dimensionality of social sustainability, a clear and widely acknowledged definition is missing (Dempsey et al. 2009; McKenzie 2004; Rasouli and Kumarasuriyar 2016). On this account, some authors provide key components, themes or indicators to describe the nature of social sustainability (Rasouli and Kumarasuriyar 2016). The United Nations Commission on Sustainable Development (UNCSD) for instance draws on the themes equity, health, education, security, housing, and population (2001). Additional themes outlined by Rasouli and Kumarasuriyar (2016) are, e.g., diversity, sense of place, or social capital. Furthermore, Dempsey et al. (2009) described social sustainability within the urban context by reference to two main concepts: social equity and sustainability of community. Some but not all of these topics overlap with the urban agriculture and community garden literature.

Issues in urban agriculture, and in particular community gardens, linked to the social dimension of sustainability are health (Angotti 2015; Armstrong 2000; Ferris et al. 2001; Game and Primus 2014; Lovell 2010; Martin et al. 2016; Pourias et al. 2016; Spilková 2017; Wolch et al. 2014), well-being (Lovell 2010; Martin et al. 2016; McIvor and Hale 2015; Nettle 2014; Spilková 2017), education and knowledge (Ackermann et al. 2014; Eizenberg 2012; Ferris et al. 2001; Game and Primus 2014; Lovell 2010; Martin et al. 2016; Saldivar-Tanaka and Krasny 2004), environmental justice (Ferris et al. 2001; Martin et al. 2016; Wolch et al. 2014), food security (Ackermann et al. 2014; Ferris et al. 2001; Game and Primus 2014; Opitz, Berges, et al. 2016; Pourias et al. 2016; Rogus and Dimitri 2014), community cohesion (Angotti 2015; Armstrong 2000; Ferris et al. 2001; Pourias et al.

2016; Saldivar-Tanaka and Krasny 2004), and social capital (Drake and Lawson 2015; Martin et al. 2016; Nettle 2014). The potential of food security is therefore not only relevant for developing countries but also for developed countries (Ackermann et al. 2014; Caputo 2012; Rogus and Dimitri 2014), however, the motivations for farming in the city are more diverse (Rogus and Dimitri 2014; Rosol 2010). While food production can be a motivation of gardeners to participate, Pourias et al. (2016), Spilková (2017) and Nettle (2014) mentioned social interaction (e.g., collective activities, socializing, and belonging to community) as a main motivation to participate in community gardens in Europe and Australia. We understand this motivation as an expression of the citizens' social needs and use social interaction—often referred to as social capital—as a key criterion to assess social sustainability in community gardens.

We assume that the more central the social interactions are, the more community gardens contribute to various social needs and have thus a widespread impact on social sustainability. In doing so, they also provide space for learning, education, trial and error, not only regarding food production but also regarding the production of social networks, social skills, and different ways of how we can live together. Even if community gardens (and other urban agriculture activities) are not able to replace the industrial food system or education system, they provide a "flavor" of various alternatives (Nettle 2014; Wright 1993). Community gardens can therefore also be seen as a social economy, where production is not taking place for profit, but collectively and to satisfy human urban needs (Gibson Graham 2006; Wright 2006). Social economies like community gardens are a "new model for restoring community and democratic participation" (Amin et al. 2003, p. 27). Martin et al. (2016) described this set of features as social sustainability services. Over and above this, social interaction is described by many authors as an indicator that contributes to social sustainability (Dempsey et al. 2009; Martin et al. 2016; Opitz, Specht, et al. 2016; Pearson et al. 2010; Rasouli and Kumarasuriyar 2016; Yoo and Lee 2016).

Although there are many studies dealing with the social benefits of community gardens, there is only a limited number of studies deeply analyzing gardens' social function and assessing their social sustainability, especially on a larger scale (Lovell 2010; Nettle 2014). Moreover, there is a recognized general lack of academic research and concomitant statistics at national and international levels (Bendt et al. 2013; Guitart et al. 2012) that explore the social functions empirically.

We intend to fill this gap by providing a concept that assesses social sustainability and elaborating on the social processes within community gardens. Further, we want to

consider the chances to partake in social activities taking place in community gardens, and draw conclusions on community gardens' performance. Therefore, *social interaction*, *participation*, and *perceived success* are criteria we use to define and measure diverse degrees of social sustainability. Additionally, we are interested in finding out what characteristics of community gardens such as size, social heterogeneity, or trust, facilitate social interaction.

To do this, we conduct a quantitative survey that asks respondents to rank their gardens in terms of the criteria that we are determining to be measures of social sustainability. With the help of an online questionnaire, we collect data from 123 community gardens throughout Germany. We therefore contribute to scholarly empirically driven research in developed countries, especially in Europe, and non-English speaking countries where studies on community gardens are still rare (Spilková 2017).

In the following, we present how we developed and designed criteria and variables to assess social sustainability, the data collection, and data analysis. Results of the study disclose various degrees of social sustainability in the community gardens examined, and demonstrate that aspects of trust within the community have a strong effect on gardens' social sustainability. Finally, we discuss the findings and challenges of the study and give future research directions.

3.2 Method

The research design consists of three steps: (1) development of criteria and variables that measure and influence social sustainability; (2) survey design; and (3) data analysis.

3.2.1 Criteria and Variable Development

To develop criteria and variables that measure and influence social sustainability of community gardens, our study was based on a literature review on community gardens, sustainable development, social sustainability, commons, and success (Armstrong 2000; Bendt et al. 2013; de Haan et al. 2017; Eizenberg and Jabareen 2017; Foster 2011; Hess and Ostrom 2006; Opitz, Berges, et al. 2016; Ostrom 2003, 2009; Pourias et al. 2016; Rosol 2010; Schlager and Ostrom 1992; Yoo and Lee 2016). Drawing on the systematic set-up of the database SESMAD (2014), we likewise classified variables as dependent variable (to measure social sustainability) or independent variable (variables that have an impact on social sustainability). The variables development was mainly based on commons

theory, and were adapted to community gardens characteristic. We first needed to start with some rather general statements to grasp the diversity and the complexity of the gardens.

The criteria and variables developed to measure social sustainability are presented in Section 3.2.1.1. Section 3.2.1.2 outlines the independent variables, which have an impact on garden's contribution to social sustainability.

3.2.1.1. Social Sustainability Criteria

Since community gardens are socially-orientated initiatives, we refer to social and collective processes taking place within community gardens to assess their social sustainability. We developed the criterion *social interaction* to examine what is used and done collectively in community gardens, the criterion *participation* to examine the possibility to partake within these social interactions, and the criterion *perceived success* to further assess the performance of these social processes. All three criteria are based on several variables presented in Table 8.

Table 8: Criteria and variables to measure social sustainability

Criteria	Variables	Sub variables
Social interaction	Collective use	Style of use of 23 resources
	Frequency of social activities	
	Perceived importance of social exchange	
Participation	Access right	
	Management right	
	Amount of preconditions to participate	
Perceived success	Rules compliance	
	Fairness	
	Participants' perspective on success	Personal success
		Success of the garden project
	Complaints	Frequency of complaints regarding community interaction
		Frequency of complaints regarding joint resource use
		Conflicts within the community

We chose *social interaction* as a main criterion to assess social sustainability of community gardens. To define the criterion *social interaction*, we referred to the collective characteristic, which is essential for community gardens (Drake and Lawson 2015; Nettle 2014; Rosol 2010) and sets them apart from other urban agriculture and urban gardening activities. The collective characteristic included the collective use of diverse resources, social activities within the community, and the importance of social exchange (Bendt et

al. 2013; Drake and Lawson 2015; Nettle 2014; Opitz, Berges, et al. 2016; Rosol 2010; Spilková 2017).

Based on the literature review, we identified 23 resources that can be used collectively (Bendt et al. 2013; Drake and Lawson 2015; Eizenberg 2012; Ferris et al. 2001; Hess 2008; Nettle 2014; Spilková 2017). These resources include material resources such as a tool shed, water connection, compost, soil or the harvest. It further includes immaterial resources such as diverse work activities. *Collective use* can take place to varying degrees. For instance, some community gardens offer individual plots, some offer collectively used plots (collectively divided by a division of resources or collectively shared), and some offer a combination of individual and collectively used plots (Bendt et al. 2013; Drake and Lawson 2015; Nettle 2014; Rosol 2010). Therefore, we developed different styles of use ranging from 1 individual use to 5 shared use. Regardless of the plot design, there is always a minimum of shared areas like social spaces to be found (Drake and Lawson 2015). The 5 styles of use are applied to all 23 resources (see Appendix C, Table S1 for all 23 resources and the five styles of use). As an example, watering plants can be done individually on the private plot, or collectively through dividing or sharing. In this example, collective dividing means that watering is done through a collective allocation of the working task. If watering the plants is done through sharing, that means gardeners also do the watering together at specific garden meetings. We assume that the more resources are used collectively, the more social interaction is required to manage this collective use. We further assume that sharing requires even more social interaction since the absence of clearly allocated resources and allocated working tasks needs an ongoing exchange within the garden group. Indeed, the resource use in community gardens differs widely, and we assume that, to perform well, it needs to be adjusted to the particular members and their needs. However, our current study has not been able to identify a relationship between resource use and performance.

Next to work, an additional immaterial resource is social time. Social time can be spent together through diverse social activities such as barbeques or garden parties. Since social activities can only be done together and not individually, we opt for the variable *frequency of social activities*, coded from 1 (less than once a month) to 5 (four times a month and more).

The third variable that characterizes *social interaction* is the *perceived importance of social exchange* within the community garden project. This variable can reach values from 1 (very unimportant) to 5 (very important). By calculating the average of all three

variables the degree of *social interaction* is defined. Since the value of each variable covers a range of values from 1 to 5, *social interaction* can reach values from 1 to 5 as well. We are aware of using the arithmetic mean for an ordinal scale. We assume that our items are quasi-metric and opt for the arithmetic mean instead of the median, to consider values deviating from others (Bryman 2016; Cleff 2015).

The next criterion we developed to measure social sustainability is *participation*. Participation seems relevant, since it is a broadly acknowledged mechanism to promote sustainable development, and therefore also to be found in scientific literature to define the concept of social sustainability (Dempsey et al. 2009; Eizenberg and Jabareen 2017; McKenzie 2004; Yoo and Lee 2016). Bendt et al. (2013) pointed out the possibility of immediate participation in "public-access community gardens" (PAC-gardens), which they define as gardens that are open for all citizens at all times, are collectively managed by various groups, and have absent to low formal obstacles (e.g., contract regulation, license or queue system), and thus a high degree of openness to participation. Following Bendt et al. (2013) we referred to *access right*, *management right,* and the *amount of precondition to participate* as variables defining participation.

Access right signifies the right to enter the resource and enjoy non-subtractive benefits (Hess and Ostrom 2006; Schlager and Ostrom 1992), such as enjoying the garden without taking fruits. Individuals who have access rights may or may not have rights permitting participation in particular activities and collective-choice action (Dempsey et al. 2009; Schlager and Ostrom 1992). Although community gardens are often called public gardens regarding access, ownership, and the degree of democratic control (Ferris et al. 2001), some gardens are fenced and have access restrictions, for instance limited access hours, and only members or plot holders may have keys (Nettle 2014; Schmelzkopf 1995; Spilková 2017). We therefore examine *access rights* in community gardens coded from 1 to 5 and distinguish if the right is held by a third party (1), by the leader group (2), by the core group (3), by all gardeners (4), or all citizens (5). The latter matches to the above-mentioned PAC-gardens. The leader group may consist of the board members of an association or the garden founders. The core group is defined as the group that regularly partakes within the garden project, including the leader group. By "all gardeners" we mean the total gardeners group consisting of the leader group, the core group, and gardeners that do not participate regularly. In public access community gardens, we further find residents who are using the garden for e.g., recreational purposes but do not participate in gardening activities. We understand this group as external users and categorize them as "all citizens".

With the variable *management right*, we examined what kind of user group is holding the management right and therefore holds power in decision-making processes (Bendt et al. 2013; Colding et al. 2013; Schlager and Ostrom 1992). We use the same values as for the variable *access right*, ranging from 1 (third party) to 5 (all citizens).

The variable *precondition to participate* leads to prevailing obstacles to participate in community gardens. We identified 4 preconditions: membership of the formal association, available garden plots, regular participation, and others. Depending on how many preconditions exist the variable ranges from 1 (four preconditions exist) to 5 (no preconditions exist).

Again, we used the average of all three variables to calculate the degree of the criterion *participation*. Same as the criterion *social interaction*, the criterion *participation* can reach values ranging from 1 to 5. Higher values indicate that residents can participate or benefit from the garden, easily. However, there may be many reasons why gardens are more or less open to the broader community, e.g., gardens do not allow public access or have to be fenced due to their specific location. Since the degree of participation does not enable us to predict a garden's success, a third criterion is required.

With the third criterion, we wanted to investigate on the successful performance of community gardens as an essential criterion to determine social sustainability. Success can be defined in many ways, however, studies investigating success within social initiatives, such as community gardens, are still at an initial stage and the social dynamic processes are difficult to identify and assess (de Haan et al. 2017; Eizenberg and Jabareen 2017). According to de Haan et al. (2017), the aspect of an active citizen and the production of a sense of community is more important than reaching the original goals of the initiative (de Haan et al. 2017). Oppositely, if citizens are not participating in social interaction and do not feel responsible for the initiative, it can be defined as failed.

Regarding community gardens, we opted for the following variables to assess their success: *rules compliance*, *fairness*, *participants' perspective on success*, and *complaints*. These variables are measured based on gardener's perception.

The importance of *rules compliance* by garden members for effective and sustainable resource systems is well explored within commons theory (Baerlein et al. 2015; Cox et al. 2016; Frey and Rusch 2014; Jenny et al. 2007; Ostrom 1990; Ostrom 2009). We defined this variable to range from very low (1) to very high (5).

Fairness is an additional variable used as a success factor within commons theory that has an impact on rules compliance (Baerlein et al. 2015; Frey and Rusch 2014; Jenny et al. 2007; Ostrom 1992). In regard to the social sustainability literature, fairness is a

further part of the concept of equity (Eizenberg and Jabareen 2017; UNCSD 2001). We measured the perceived *fairness* within the community group by values ranging from 1 (very low) to 5 (very high).

The third variable examined how gardeners perceive success, first related to their personal success and, second, related to their judgement on the success of the garden project as a whole. Thus, we could incorporate diverse understandings of success from the participants' perspective. It is measured by values ranging from 1 (very low) to 5 (very high). The average of both sub variables corresponds to the value for the variable *participants' perspective on success*.

The last variable that we used as a converse to success (de Haan et al. 2017) is *complaints.* The variable is built on the average of the sub-variables *frequency of complaints regarding community interaction*, *frequency of complaints regarding the collective use of resources*, and *conflicts within the community* on a scale from 1 (very often/very high) to 5 (very rarely/very low).

Similarly, as for the criterion *social interaction and participation*, the average of all four variables are used to calculate the degree of the criterion *perceived success*, ranging from 1 to 5.

By calculating the average of all three criteria we thus determine the degree of social sustainability, ranging from 1 (very low) to 5 (very high).

The variable and criteria combinations were adjusted and reviewed with the help of factor analysis (principal component analysis and varimax rotation, SPSS 24).

3.2.1.2. Variables Affecting Social Sustainability

In the next step, we wanted to examine determinants of diverse degrees of social sustainability. Drawing on variables appearing in the Social-Ecological System Framework (Frey and Rusch 2014; Ostrom 2009), we opted for 7 variables as most important for community gardens and social sustainability (Table 9). The number of variables was adjusted to the sample size.

Table 9: Variables affecting social sustainability (independent variables)

Variables	Value	Scale of measure
Size of the community	Number	Metric
Heterogeneity of the community	1–5	Ordinal
Perceived trust within the community	1–5	Ordinal
Area size	Number	Metric
Management group	1–5	Ordinal
Rule set and design	0–12	Ordinal
Monitoring and sanctioning	0–8	Ordinal

While in commons theory relationships between dependent and independent variables are likely to be nonlinear (Frey and Rusch 2014), we assumed linearity between the variables. We tested the linear relationship of variables by scatterplots and residuals as an assumption of multiple linear regression analysis (see Section 3.2.3).

We opted for the variable *size of the community* and *heterogeneity of the community* since both encourage the garden initiatives and their successful performance over time (Ostrom 1992, 2002; Ostrom 2003).

Concerning the variable *size of the community*, we assume a negative relationship to social sustainability, since within bigger initiatives more skills and investments are required, and the risk of failure increases (de Haan et al. 2017). We measure the size of the community by referring to the size of the core group, defined as the group that regularly participate in the garden project.

In regard to communities' heterogeneity and its effect on social sustainability, the literature seems more complex. In community gardens literature, scholars often pointed out that the cultural heterogeneity is valuable for the society, e.g., due to express and experience culture collectively, or due to generating knowledge (Colding and Barthel 2013; Eizenberg 2012; UNESCO 2008). Eizenberg (2012) for instance described community gardens as spaces that emphasize diversity. In addition to that, Jabareen (2006) mentioned diversity as a process that ensures social sustainability. On the contrary, in commons theory, very homogenous and very heterogeneous communities are both assumed to have negative effect on social interaction (non-linearity) (Frey and Rusch 2014). However, the relationship of heterogeneity and successful performance is also often discussed in the commons literature (Mansuri and Rao 2004; Ostrom 2002). In our research, we considered various forms of social diversity and refer to differences in age, education, income, and culture each measured from 1 (very low) to 5 (very high). The *heterogeneity of the community* is measured by the average of all these values. Therefore, a "very high" value of heterogeneity means a "very high" diversity according to all of these social differences. We understood diversity of garden communities as an important characteristic and assumed that communities are in general heterogeneous, at

least to some degree. Thus, we argued that rather too heterogeneous communities, make cooperation and social interaction more difficult. Therefore, we assume a negative effect of the variable *heterogeneity of the community* and our concept of social sustainability. However, this negative relation should rather be understood as the difficulty of social interaction and cooperation according to too many diverse interest groups (see Section 3.4).

Besides the size of the community and its heterogeneity, trust contributes to the emergence and maintenance of social interaction (Frey and Rusch 2014; Ostrom 2003; Ostrom 2010a). However, trust can also emerge through social interaction (Foster 2006) and thus can be understood as an outcome, too. Nevertheless, we understood trust in the first place, as input to gardens social sustainability, necessary to establish cooperation in the management of urban resources (Ostrom 2010a) *(*see Section 3.4*)*. Trust is measured as general *perceived trust within the garden community* ranging from 1 (very low) to 5 (very high).

Concerning the variable *size of the garden area*, we assumed a positive effect on social sustainability. Commons theory refers to medium sizes to be most conducive, while large sizes (e.g., because of high costs to sustain them), as well as too small sizes (e.g., because of little valuable products) face negative effects on sustaining them (Hess and Ostrom 2005; Ostrom 2009; Ostrom et al. 1999). Since community gardening takes place in smaller urban areas (Smit et al. 2001b) and gardens are in general limited in size regarding the urban conditions, we assumed that negative effects due to too large sizes will not affect community gardens.

An additional variable which we wanted to assess in its effect on social sustainability is the *management group*, as this group actually manages, organizes and coordinates the gardening processes. We referred to the already mentioned characteristic value ranging from management is performed by a third party (and therefore not by the gardeners themselves) (1), to management is performed by all citizens (5).

With the final two variables, we wanted to examine the impact of existing rules and the degree to which they are monitored and sanctioned. Inspired by Ostrom (2010b) and Schlager and Ostrom (1992), we identified the following group of rules important for community gardens: rules to restrict community size, rules to restrict access to the garden area, rules that govern roles or position within the community, rules that govern harvest rights, rules that govern gardening and food production, and rules that govern the sharing of information. Depending on how many of these rules exist and whether

they are defined roughly or in detail in the respective community gardens, they can reach values of *rule set and design* ranging from 0 (no rules exist) to 12 (detailed rules for all of these groups exist) (see Appendix C, Table S2). Related to theory we expect a positive relationship between well-defined rules and social sustainability. The variable *monitoring and sanctioning* is measured by the already mentioned characteristic value ranging from "a third party" to "all citizens" in combination with sanctioning is taking place or not. For this, gardens can reach values ranging from 0 (no monitoring and no sanctioning is taking place) to 8 (monitoring is taking place by the broader community and sanctions were imposed in the case of rules non-compliance) (see Appendix C, Table S3).

3.2.2 Survey and Data Collection

Community gardens have been selected drawing on the most comprehensive available listing of *anstiftung* that currently contains 643 community gardens in Germany (anstiftung 2018). The database offers information on garden location, year of foundation, homepage, contact email, size of the area, and additional information about the garden project. We searched for further information such as size of the city where the project is located or timeliness, to check if the community is still active.

We excluded gardening activities that were still in the planning stage or that appeared to be single public plots with no characteristics of community gardens. Since we also focus on urbanized areas, we excluded gardens in cities with less than 20,000 inhabitants. We further selected productive urban gardens where vegetables and fruits are grown. Overall, we identified 433 gardens suitable for our investigation.

Based on the criteria, we designed a questionnaire consisting 57 questions assigned to seven groups of questions: the garden area, the garden community, funding (not part of this paper), collective action, management and participation, rules, success and failure. We used a questionnaire with predominantly closed questions with a minor number of semi-open questions; the latter were included to discover additional criteria. The online questionnaire was directed to leaders or at least members of the core group of a garden, from whom we expected to have well-founded knowledge to answer specific questions. The respondents were asked to rank their gardens in terms of the presented criteria and variables. Prior examination ensured that questions were easily understood and that the wording did not suggest any particular answer.

The research was conducted from 15 December 2016 to 31 March 2017. We opted for collecting data outside the garden season to allow gardeners to find the required time to

answer the questionnaire. Of 433 questionnaires sent out, 123 completely-filled questionnaires were returned (response rate of 28%).

3.2.3 Data Analysis

The completed questionnaires were analyzed using IBM SPSS Statistics 24 (IBM, New York, USA). The multiple linear regression analysis with a threshold of $p = 0.05$ was used to determine the effect of seven independent variables: *size of the community, heterogeneity of the community, perceived trust within the community, size of the area, management group, rule set and design,* and *monitoring and sanctioning* on the dependent, likewise empirically composed variable social sustainability. We examined the residuals and tested independent variables of multicollinearity, and found results to be acceptable.

3.3 Results

The following section presents the results of our study: firstly, the assessment of social sustainability in community gardens, and, secondly, the determinants influencing social sustainability.

3.3.1 Social Sustainability in Community Gardens

We developed the criteria *social interaction, participation,* and *perceived success* to assess social sustainability. The criteria are, in turn, each based on a set of measurable variables. The criterion *social interaction* is based on the variables *collective use*, *frequency of collective action*, and *perceived importance of social exchange*. The criterion *participation* is based on the variables *access right*, *management right*, and *amount of precondition to participate*. The criterion *perceived success* draws on variables that depict the *rules compliance*, *fairness*, *participants' perspective on success*, and *complaints*.

The first step was the analysis of the above mentioned ten variables concerning the 123 community gardens examined (Figure 5) (see Appendix C, Table S4 for all data presented in this section).

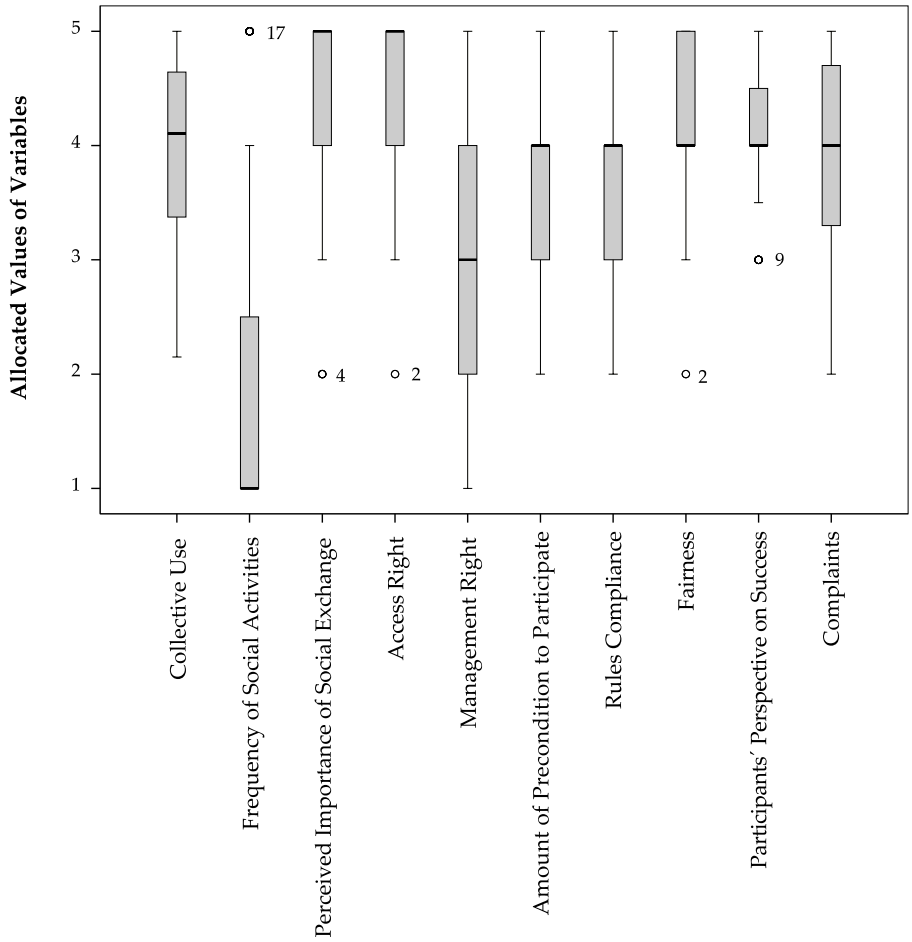

Figure 5: Boxplot of variables to determine the criteria social interaction, participation, and perceived success

Note: *n*= 123, except for perceived importance of social exchange, access right, and complaints n= 122; fairness *n*= 121; management right *n*= 117; and rules compliance *n*= 112. The dots in the boxplot represent outliers.

The boxplots indicate various ranges within each variable, however overall gardens mostly reach values higher than 3.

The variable *collective use* demonstrates a range from 2.15 to 5 of the 123 community gardens examined. This result points to a wide range of collective use of resources within community gardens. While there is no community garden using all resources individually (Value 1), we find gardens where all resources are used through sharing without a clear allocation (Value 5). The position of the box between Value 3 and Value 5 indicates that collective use of resources is in general of a high degree.

Frequency of social activities is a variable for which community gardens mostly reach values below 3. The median for the *frequency of social activities* is right-skewed and reached a value of 1. That means that the variable is not normally distributed and social activities are taking place less than once a month in most of the examined community

gardens. Looking at the data in detail, 59.3% of the 123 examined community gardens reach values of 1. Community gardens that reach values of 5 (i.e., social activities are taking place four times a month and more), are shown as outliers in the boxplot. In total, we have 17 outliers (13.8% of the community gardens) for this variable.

Compared to the variable *frequency of social activities*, the median for the variable *management right* is 3, while all other variables reach values of 4, and the variable *importance of social exchange* and *access right* even a value of 5.

By looking at the data in detail, taking as an example the variable *perceived importance of social exchange*, 30.1% of the examined gardeners mentioned importance of social exchange within the garden as "important" (Value 4) and 60.2% as "very important" (Value 5). In total, 5.7% mentioned the importance of social exchange as "neither unimportant nor important" (Value 3), while 3.2% mentioned social exchange as "unimportant" (Value 2). The latter are illustrated as outliers in the box plot in Figure 5. We further have one missing value for this variable (one gardener answered "I do not know"; n = 122).

Taking another example, in 54.5% of the examined community gardens all citizens have *access rights* to the garden area (Value 5), in 41.5% of the gardens all gardeners have access rights (value 4), while in 1.6% of the examined gardens only the core group (Value 3), and in 1.6% of the examined community gardens only the leader group has access right to the garden area (Value 2; illustrated as outliers). Again, we have one missing value for this variable (n = 122).

Participants' perspective on success is yet a further example where most of the gardens reach values of 4 and higher. By looking at the data in detail, we see that in 75.5% of the examined gardens participants perspective on success is "high" (Value >3.5) to "very high" (Value 5), and in 24.5% "neither high nor low" (Value 3 - 3.5). The latter are again illustrated as outliers. However, none of the outliers shown in Figure 5 are excluded from further calculations.

Based on the results of the variables, the criteria *social interaction*, *participation*, and *perceived success* are calculated. As can be seen in Figure 6, for *perceived success*, community gardens reach higher values, compared to the criteria *social interactions* and *participation*. The median for the criterion *perceived success* is 4.1 (Arithmetic mean = 4.0). The median for the criteria *social interaction* and *participation* are 3.4 (Arithmetic mean = 3.5) and 3.7 (Arithmetic mean = 3.7), respectively.

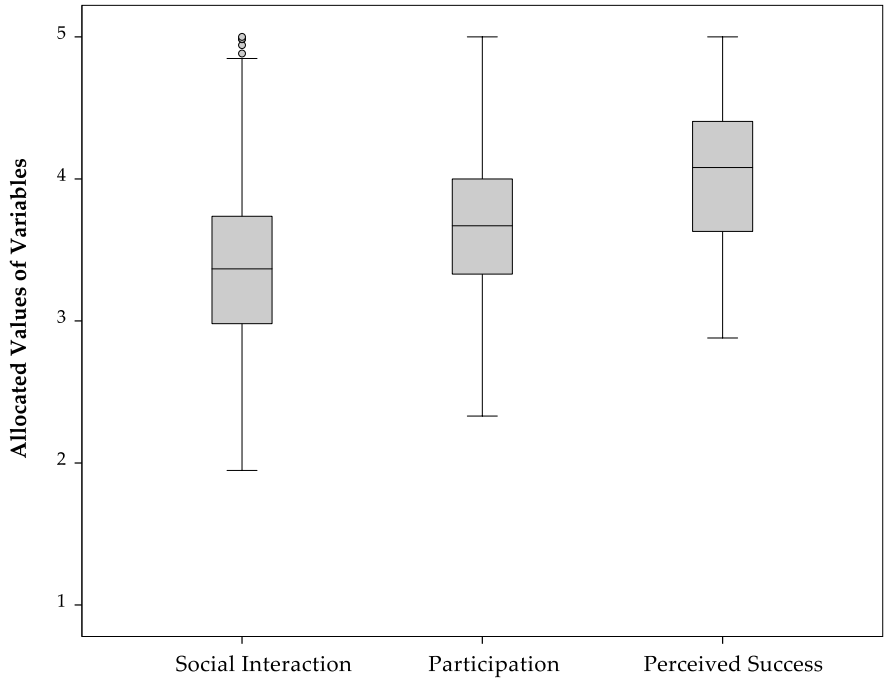

Figure 6: Boxplot of criteria determining social sustainability
Note: The dots in the boxplot represent outliers.

The arithmetic mean of the three criteria is used to calculate the degrees of social sustainability of individual garden projects. The results indicate diverse degrees of social sustainability and suggest a normal distribution (Figure 7), confirmed by the skewness (0.267) and kurtosis (−0.146). The values of social sustainability range from 2.80 to 4.94, with an arithmetic mean of 3.74. While we have only two gardens (1.6%) reaching a value of social sustainability lower than 3.0, 35 community gardens (28.4%) reach values from 3.0 to 3.5, and 55 (44.7%) from 3.5 to 4.0. Of the examined community gardens, 26 (21.2%) reach values ranging from 4.0 to 4.5, while five gardens (4.1%) reach a degree of social sustainability higher than 4.5.

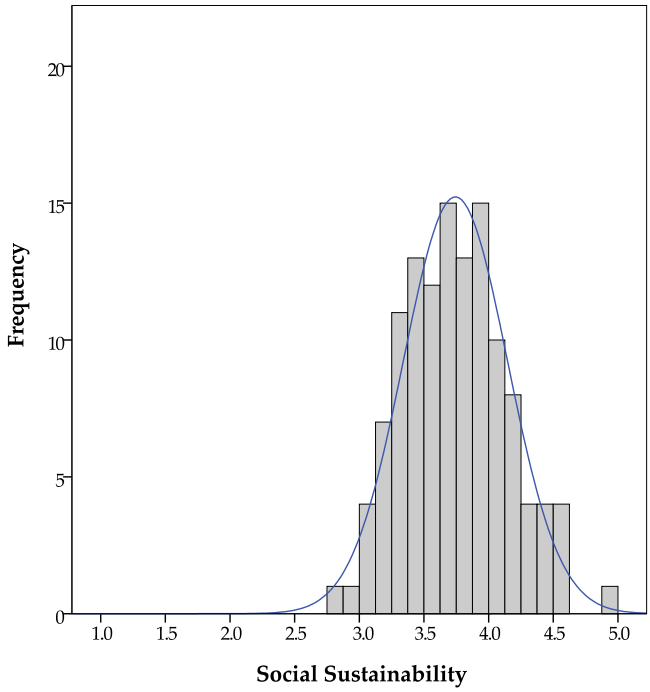

Figure 7: Normal distribution of social sustainability

3.3.2 Determinants of Social Sustainability

This section demonstrates the causality of social sustainability as our dependent variable to the defined independent variables: *community size, heterogeneity of the community, perceived trust within the community, size of the area, management group, rule set and design*, and *monitoring and sanctioning*. Table 10 presents the results of the seven independent variables and the 123 community gardens examined. Table 11 presents the results of the multiple linear regression analysis (see Appendix C, Table S5 for all data presented in this section).

As can be seen in Table 10, the *size of the community* ranges from 2 to 82 participants and confirms the diversity of group sizes within community gardens found in literature. The arithmetic mean of the community core size is 13.19. The mode indicates that 10 is the core group size that appears most often in the 123 community gardens examined. Regarding the *heterogeneity of the community*, values range from 1.5 to 5, with an arithmetic mean of 3.41. In addition to the mode of 3, this result indicates that the heterogeneity in community gardens is mostly "neither low nor high". The results for *perceived trust within the community* range from 2 to 5, the median and mode of 4 indicate a "high" perception of trust.

Looking at the *sizes of the area*, the smallest is 25 square meters, while the largest is 12,000 square meters. The arithmetic mean of the area size is 2323 square meters. These results again confirm the diversity of community gardens.

Regarding the variable *management group*, values range from 1 to 4. The median and mode of 3 indicate that mostly the core group is actually managing the garden. We further find a spread of values for the variable *rule set and design*, covering a range from 0 (no rules exist) to 12 (detailed rules for the six identified groups exist). The result of the arithmetic mean of 3.6 (median and mode of 4) indicates that, within community gardens, detailed rules are not of high importance.

In addition, the results for *monitoring and sanctioning* range from 0 (no monitoring and no sanctioning is taking place) to 8 (monitoring is taking place by the broader community and sanctions were imposed in the case of rules non-compliance). However, the mode of 3 indicates that, in the community gardens examined, monitoring is mostly taking place by all gardeners, while no sanctions were imposed if gardeners do not follow the rules (see Appendix C, Table S3).

Table 10: Variables affecting social sustainability.

Independent variables	Arithmetic mean	Median	Mode	Minimum	Maximum
Size of the community (n = 123)	13.19	10.00	10	2	82
Heterogeneity of the community (n = 123)	3.41	3.30	3	1.5	5
Perceived trust within the community (n = 122)	4.05	4.00	4	2	5
Size of the area (n = 121)	2323.88	1300.00	2000	25	12,000
Management group (n = 123)	2.64	3.00	3	1	4
Rule set and design (n = 123)	3.6	4.00	4	0	12
Monitoring and sanctioning (n = 120)	3.68	3.00	3	0	8

We carried out a multiple linear regression to analyze the relation of the independent variables and the dependent variable social sustainability. Table 11 shows an r^2 of 0.396 and an adjusted r^2 of 0.358. The p-value < 0.001 indicates the statistical significance of the regression. The regression coefficients indicate a positive statistical significant influence of the variables *perceived trust within the community* and *management group* on the dependent variable social sustainability. The results further indicate a negative statistical significant influence of the variable *heterogeneity of the community* on the dependent variable social sustainability. Our empirical data show that the variables *size of the community*, *size of the area*, and *rule set and design* have a negative effect on social sustainability, however, these results are not statistically significant. The variable *monitoring and sanctioning* point to a positive impact on social sustainability, even though not statistically significant.

Looking at the Beta values, *perceived trust within the community* has the highest effect on social sustainability. The second highest effect comes from the *management group*,

followed by *the heterogeneity of the community*, *size of the community*, the *rule set and design*, and the *size of the area*. The variable *monitoring and sanctioning* has the weakest effect on social sustainability.

Table 11: Results of multiple linear regression of social sustainability and independent variables

r^2 = 0.396; Adjusted r^2 = 0.358					
F (7, 111) = 10.408; p < 0.001, n = 119					
Independent variables	**Regression coefficient**	**Beta**	***p***	**CI Lower 95%**	**CI Upper 95%**
Size of the community	−0.005	−0.147	0.063	−0.010	0.000266
Heterogeneity of the community	−0.090	−0.171	0.032*	−0.172	−0.008
Perceived trust within the community	0.238	0.439	<0.001**	0.157	0.319
Size of the area	-5.395×10^{-6}	−0.034	0.658	−0.000029	0.000019
Management group	0.170	0.284	<0.001**	0.080	0.260
Degree of rule design	−0.018	−0.093	0.247	−0.048	0.012
Degree of monitoring and sanctioning	0.003	0.020	0.815	−0.24	0.031

Note: * = p < 0.05; ** = p < 0.001.

3.4 Discussion on Social Sustainability of Community Gardens

Community gardens are socially-oriented and collectively managed urban agriculture activities that provide economical, ecological, and, in particular, social benefits. Referring to the increasing number of studies discussing the social benefits of community gardens, this paper provides a new methodological approach to evaluate the social sustainability of community gardens according to their social interaction, often referred to as social capital. We thus aim to empirically analyze the social functions and make social sustainability operational. Hence, we refer to *social interaction* as an important criterion contributing to social sustainability (Dempsey et al. 2009; Opitz, Specht, et al. 2016; Pearson et al. 2010; Yoo and Lee 2016), a main motivation, and essential characteristic of community gardens, particularly in developed countries. We further consider the possibility for urban residents to participate in community gardens and the success of these social arrangements. Therefore, the criteria *social interaction*, *participation*, and *perceived success* are developed and defined by respective variables. Calculating social sustainability by using the arithmetic mean of criteria and variables instead of the median appears helpful to achieve more differentiated results. The range of gardens' social sustainability varying from 2.80 to 4.94 seems sufficient to illustrate various degrees of social sustainability and express the importance of community-serving functions of the gardens (Figure 7). While we find similarities within the community gardens, the results further indicate differences by comparing the single

variables, as well by looking at one single variable. Consequently, the results confirm the diversity of community gardens as well.

Through the various degrees of social sustainability, we are able to examine causalities to further garden characteristics. We opted for seven independent variables mainly based on commons theory, of which we wanted to measure their effect on social sustainability. The results of the multiple linear regression analysis indicate that social sustainability is positively influenced by *perceived trust within the community*. Therefore, our results confirm the positive effect of trust on social interaction described in literature and commons theory. It seems obvious that higher perception of trust leads to higher interaction, more collective action, as well as to less conflicts and higher rules compliance, and thus higher social sustainability. While we understand trust as an independent variable that affects the outcome social sustainability, trust can also emerge through social interaction and thus can be understood as an outcome, too—a circular process naturally occurring in dynamic systems such as community gardens. In a long-term perspective, social interactions may lead to higher levels of trust. Trust can, therefore, be more important as a product of social sustainability than as a contributor. However, this requires repeated interaction among the same members of the communities, i.e., communities that are stable over longer periods with less fluctuation. As we have to take a partly static view—at least for the moment of analysis—we considered trust relations as an input to the system. We further opted to consider trust as an independent variable since it enables the establishment of the new urban communities.

Besides trust, our results demonstrate that the *management group* has a positive statistical significant impact on social sustainability. There seems to be a higher potential of social sustainability if not a small party (a third party or the leader group) is managing the garden, but rather a broader community group is in charge of the initiative.

Another variable that shows a statistically significant impact on social sustainability is the *heterogeneity of the community*. Our results of the linear regression analysis indicate a negative relation of too *heterogeneous communities* and social sustainability, and therefore confirms our assumption at the high and of the scale. However, we have to state out, that our concept of social sustainability bases on social interaction, and cooperation. These negative relations should rather be understood as the difficulty of social interaction and cooperation according to too many diverse interest groups, than a value of social sustainability. Too heterogeneous hereby means a high diversity in many aspects: age, education, income, and culture. Further, research could investigate on these

diverse aspects (e.g., education, culture, age, and income) and its contribution to social sustainability separately. Additionally, according to the literature, the impact of heterogeneity on collective action is likely to be non-linear, however, the scatterplots did not indicate a curvilinear relationship. A reason might be that for its justification we would need larger datasets. However, Mansuri and Rao (2004) and Ostrom (Ostrom 2002; Ostrom 2003) pointed to the complexity of social heterogeneity and the fact that the variable is also affected by other variables.

Our results on *size of the community* show a negative but not statistically significant effect on social sustainability, which confirms results in other studies, showing that too large communities may negatively affect social interaction among community members, since too many diverse interests need to be considered and more complex negotiation processes would be necessary (de Haan et al. 2017; Ostrom 2009). However, Ostrom (2002) also pointed to several studies that do not confirm the effect on community size on successful management of shared resources. Nevertheless, according to our results, sizes of 10–15 gardeners participating regularly seems to be a moderate group size. In addition, group size may depend on the size of the garden area. However, our results indicate only a weak correlation of sizes of the community and size of the garden area ($r = 0.216$; $p = 0.016$; Pearson's correlation coefficient) (Bryman 2016).

An interesting point for the scholarly debate in commons theory is that the variable *rule set and design* shows a negative effect on social sustainability of gardens. Although we could not show this with statistical significance, the indication of such a relation deserves a closer look. We expected a positive connection of social sustainability by the presence of well-developed, detailed rules (Ostrom 2010b; Schlager and Ostrom 1992). The apparent discrepancy to theoretically based assumptions might be due to the very open and dynamic structure of community gardens, confirmed by a detailed look at the data. Of all of the examined rules, access rules and community size rules are those for which most of the gardens do not even have rules (71.5% of the gardens do not have access rules and 78.0% do not have community size rules). This fact suggests the openness of community gardens and their welcoming culture, even though they have to face conflicts due to a high number of users. Most rules, as well as most detailed rules, are developed regarding gardening and food production, however withdrawal rules (e.g., who can harvest and how much) are less developed. Since community gardens do mainly serve social functions and as this main purpose is obvious to the gardeners joining, not all rules have to be spelled out in a detailed manner, or if so, this might even affect the social sustainability negatively.

Our results further indicate no relationship of the *size of the area* on social sustainability. On the one hand, we expected a positive causality due to more physical space for social interaction and more possibilities to test new forms of interaction. On the other hand, this result confirms the importance of the openness and welcoming culture, even if just little space is available. This is proven by an additional analysis of correlations between the size of the area and access rights ($r = -0.055$; $p = 0.544$; Spearman's correlation coefficient), and the size of the area and community rules ($r = 0.037$; $p = 0.684$; Spearman's correlation coefficient) that indicates no correlation. Based on our empirical data, this result proves that even small community gardens are open to the public and do not implement rules to restrict the community size.

The weakest effect on social sustainability shows the variable *monitoring and sanctioning,* likewise not statistically significant. According to the result that rule design is not of high importance, it is not surprising that monitoring rules compliance and performing sanctioning has such a weak effect. A detailed look at the data disclose that monitoring is mainly taking place by "all gardeners". In addition, only in 37.4% of the gardens de-facto sanctioning is taking place, while in 52.0% no sanctioning is taking place in the case of non-compliance to rules (10.6% of the gardeners did not know if sanctioning is taking place).

Finally, even though not all results are statistically significant we are able to explain 35.8% (adjusted r^2) of the variance in the dependent variable by the determinants we developed in the presented methodological approach. Since we examine social processes which depend on many diverse factors, the r^2 of 0.358 can be considered as good. An even higher r^2 might be achieved if additional factors were to be considered, however, an even larger sample size would be necessary.

Although our study measures social sustainability by focusing on social interaction, we see a connection to additional subjects of social sustainability. Social interaction in community gardens leads to social cohesion and social ties, which can contribute to citizens' well-being and health, since they can bring positive health effects and community involvement. Therefore, our model can also be included in further research studies to measure social sustainability, or more particular additional aspects of social sustainability.

A weakness of our empirical data collection is that only one member of the leader or the core group was involved in the study. Regarding the variables, e.g., *social importance of the community garden*, *participants' perspective on success* or *complaints*, we thus only received the perception of one community member. In addition, leaders or

core group members are most aware of collective aspects of the gardens or are most interested in them and thus provide positive biased answers. Further research could lead to adapt our model assumptions and may find further determinants of social sustainability in community gardens. Additional social benefits, e.g., health, environmental justice, or food security, can be relevant to assess social sustainability in developed as well as developing countries. Analyses with our data were not carried out on the broader social functions of community gardens as a form of urban agriculture that answers a few key challenges of current urban settings. They provide a way to integrate immigrants better into existing communities, on account of cultural exchange possibilities and just working next to each other without further specifically designed integration attempts. Furthermore, being active in "successful" self-organization in a public space could confront the widely recognized democratic fatigue and discontent with political power holders expressed in the recent election results all over Europe. In addition to that, it is of great interest to analyze community gardens impact on social change and social transformation leading to sustainable lifestyles in the long-term perspective.

4 The Potential of Social Learning in Community Gardens and the Impact of Community Heterogeneity[17]

Abstract

Community gardening has become an international movement with a simultaneously growing scientific interest. This is due to the community gardens` multiple contribution to sustainable development, among other characteristics, through their educational role and potential for social learning. While there are several research papers expressing that social learning occurs in community gardens, there is a lack of examination covering how this social learning is taken place in detail. We investigate empirically who is learning, what is learned, and how learning is taking place, based on a German-wide survey of 123 community gardens. We built a set of respective criteria that helped to prove the high diversity in the learning community, the learning content, and the learning process. The latter is here understood as a process of social interaction, participation, and knowledge sharing, indicating gardens' social learning potential. We therewith provide systematization for the gardens' learning potential, which can be operationalized. In addition, we studied the effect of group heterogeneity on gardens´ social learning potential. Results indicate a negative significant effect of communities' cultural and educational heterogeneity on gardens social learning potential.

4.1 Introduction

In the context of sustainability, learning and in particular social learning have received increased scholarly attention. Social learning is often conceptualized as a process of social change with the potential to lead to more sustainability, even though there is no guarantee on that (Pahl-Wostl 2006; Reed et al. 2010). Current theories of social learning are connected to the concept of "communities of practice" developed by Wenger (1998), who highlights learning as participation in groups of people who engage in a process of collective learning, actions and interactions (Garmendia and Stagl 2010; Pahl-Wostl 2006; Pahl-Wostl et al. 2008). Thus, learning is recognized as something that does not inevitably take place within formal instructions (Ramsten and Säljö 2012).

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Due to urbanization and the fact that more than 50 percent of the world population - and in developed countries even more than 75 percent - is living in cities (UN et al. 2018), social learning is likewise important for sustainable urban development (Bendt et al. 2013). As such, it seems rewarding to throw light on civic practices like the growing community garden movement and their collective learning processes (Krasny and Tidball 2009b).

Community gardens are of increasing interest not only because of their urban context but rather because of their widely accepted contribution to sustainable development and their educational role (Martin et al. 2016). What is decisive is that multiple types and activities of learning are to be found, e.g. formal learning through educational programs, as well as informal learning through social interaction and learning by doing (Bendt et al. 2013; Krasny and Tidball 2009b). Additionally, learning occurs among the internal community as well as among a broader community e.g. by offering educational programs to the general public (Bendt et al. 2013; Krasny and Tidball 2009b). Accordingly, community gardens offer various social learning opportunities among diverse user groups (Krasny and Tidball 2009b; Pourias et al. 2016).

There is quite some scholarly work on the garden's potential towards sustainable development, all emphasizing the related aspects of learning and education in community gardens in a general way (e.g. Ackermann et al. 2014; Boukharaeva and Marloie 2006; Martin et al. 2016; Opitz, Specht, et al. 2016; Spilková 2017). Only a minor share of those studies point to the particular role of social learning in community gardens (Bendt et al. 2013; Krasny and Tidball 2009b). Moreover, despite the international importance of community gardens, there is a recognized lack of corresponding statistics (Bendt et al. 2013; Lohrberg 2016). Thus, besides some qualitative insights, no one to the best of our knowledge, has empirically examined the extent, forms, and characteristics of social learning in community gardens by referring to a larger quantitative data set.

Motivated by literature expressing that there is social learning in community gardens, we aim to provide a comprehensive study on this social learning process. We therefore conducted a German-wide quantitative survey in 2017. Data of 123 community gardens confirm the importance of education and learning in those gardens: about a third of the examined gardens stated education as a main purpose of the garden project and a main motivation to participate (respondents could choose 3 of 11 response options). The importance of learning in community gardens is also confirmed by the study of Winkler et al. (2019).

Our paper has thus two objectives: 1) We shed light on who is learning and what is learned. We further investigate on how social learning is taking place by operationalizing social learning as a process of social interaction, participation, and knowledge sharing that gives evidence to gardens' social learning potential. 2) We will scrutinize communities' heterogeneity as a factor strongly debated in its impact on collective action, social interaction, and learning within groups. We aim to consider heterogeneity effects on the social learning potential, by differentiating between heterogeneity in age, education, culture, and income.

The paper is organized as follows: Section 4.2 gives a brief overview of the concepts of social learning and communities of practice, and describes the role of social learning in community gardens. Section 4.3 presents the data collection and data analysis. Section 4.4 outlines the criteria and descriptive results of who is learning and what is learned in community gardens. Section 4.5 focuses on how learning is taking place and how these learning processes are influenced by communities' heterogeneity. Finally, Section 4.6 discusses the findings and concludes by highlighting gardens' social learning potential affected by communities' heterogeneity.

4.2 Background

4.2.1 The Concepts of Social Learning and of Communities of Practice

Although the notion of social learning has become popular, its meaning is still very broad (Reed et al. 2010; Wals and Leij 2009). The early work of social learning emphasizes individual learning within social contexts (Bandura 1977). However, Reed et al. (2010), Pahl-Wostl (2006), and Pahl-Wostl et al. (2008) point out that this approach seems to be insufficient, since it focuses on the individual and does not consider the richness of all learning processes. Lately developed concepts (e.g. Ison and Watson 2007; Pahl-Wostl et al. 2007) define social learning as a process of social change and social participation in communities of practice (Reed et al. 2010). The concept of communities of practice is part of a comprehensive conceptual framework to think about learning and its social dimensions. Thus, communities of practice can be viewed as social learning systems, where learning is considered as the relationship between the person and the social world (Wenger 2010).

Reed et al. (2010) highlight some limits of these recently developed concepts of social learning. First, even though participation facilitates social learning it does not inevitably lead to social learning (Bull et al. 2008). Thus, there is a need to clearly distinguish

between social learning and participation, as different concepts. Second, there is a general dissent between the concept of social learning and its outcome. While social learning can be considered as both, a process of people that learn and, as an outcome of social interaction, additional potential outcomes such as behavioral change can be assumed, but not guaranteed. The third problem Reed et al. (2010) state, is an often missed distinction between individual and broader social learning (Davidson-Hunt and Berkes 2003). While learning takes place in an individual, it most often arises through social interaction with other individuals. Hence, learning can be at surface level or lead to conceptual change at groups, communities, or societal levels (Reed et al. 2010). Therefore, Reed et al. (2010) define social learning as *"a change in understanding that goes beyond the individual to become situated within wider social units or communities of practice through social interactions between actors within social networks"* (p. 6). To examine and to really understand the function of social learning it is necessary to assess whether social learning is taking place, and if so, what kind of learning is taking place, to what degree, and how, as well as between whom and when (Armitage et al. 2008; Reed et al. 2010). We will expand on the definition of Reed et al. (2000), by supplementing our empirically grounded systematization.

4.2.2 Scrutinizing Social Learning in Community Gardens

Bendt et al. (2013) and Krasny and Tidball (2009b) already give evidence on social learning in community gardens. Other authors may not always explicitly mention the notion of social learning, but stress community gardens' educative role and describe learning in community gardens as a social activity with the potential for societal change (Eizenberg 2012; Martin et al. 2016; Nettle 2014; Opitz, Specht, et al. 2016; Pourias et al. 2016). To examine and understand social learning in community gardens, it is pertinent to examine who is learning, what is learned, and how learning is taking place (Armitage et al. 2008; Reed et al. 2010).

Since urban garden projects mostly boast diverse communities, diverse learning groups are to be found. Additionally, there is a broad variety of what is learned: new know-how, social qualification, social skills, practical skills, political, critical, and alternative knowledge, or knowledge about urban space and its production (Bendt et al. 2013; Eizenberg 2012; Pourias et al. 2016). Many gardens teach about e.g. gardening, plants, animals, local food production, food canning, or offer programs to facilitate environmental awareness or neighborhood empowerment, while others also offer cultural programs or workshops in knitting as well (Eizenberg 2012; Martin et al. 2016).

Next to a variety of who is learning and what is learned, gardens further differ in how learning is taking place. Learning mainly occurs as informal learning, e.g. as spontaneous and experimental learning, through social interaction, during daily gardening practices, and by sharing memories, values, or feelings (Boukharaeva and Marloie 2006; Eizenberg 2012; Martin et al. 2016). However, learning also appears as formal learning organized through education programs, such as workshops or lectures, related to specific topics or concerns (Bendt et al. 2013; Eizenberg 2012; Nettle 2014). As such learning and teaching mainly occurs in parallel and through social interaction among all participants (Pourias et al. 2016). According to these multiple activities and types of learning, community gardens can be recognized as rich communities of practice (Krasny and Tidball 2009b). In the following, we examine this richness by analyzing the data of a national study.

4.3 Data Collection and Analysis

We refer to data we collected through a national study on community gardens in Germany, conducted in early 2017. Community gardens have been selected drawing on the most comprehensive available listing of *anstiftung* foundation that currently contains 639 community gardens in Germany (anstiftung 2019). We excluded gardening activities that were still in the planning stage, have ceased to exist, or that appeared to be single public plots with no characteristics of community gardens. Since we also focus on urbanized areas, we excluded gardens in cities with less than 20,000 inhabitants. We further selected productive gardens where vegetables or fruits are grown. Overall, we identified 433 gardens suitable for our investigation.

We developed a questionnaire consisting of 57 predominantly closed questions. The questionnaire was directed to leaders or at least members of the core group of a garden (see Section 4.4 for more details on group structures), from whom we expected to have well-founded knowledge to answer specific questions. Prior examination ensured that questions were easily understood and that the wording did not suggest any particular answer. Of 433 online questionnaires sent out, 123 completely-filled questionnaires were returned (response rate of 28%). Based on our study, Löckener (2018) conducted an additional analysis and examined garden educational programs. All data is analyzed using IBM SPSS Statistics 24 (IBM, New York, USA).

4.4 Criteria and Descriptive Statistical Results on Who is Learning and What is Learned in Community Gardens

In this section, we present the elaborated criteria and provide the descriptive statistical results on who is learning and what is learned in community gardens. We assume that the diversity of people participating in community gardens provide a rich opportunity for learning and sharing (Tidball and Krasny 2009). To give insights on communities' diversity we examine the size and structure of the communities, the user groups, and community heterogeneity.

Information on the learning community can be gained from the size of the community and the community structure that is composed of a leader group, a core group and the total group (Rogge et al. 2018). The leader group coordinates the garden activities. The core group is defined as the group that regularly partakes in the garden project, including the leader group. The total group consists of the leader group, the core group, and gardeners that do not participate regularly (Rogge et al. 2018). Within these structural groups diverse numbers of participants are to be found (Table 12). While the size of the leader group mostly consists of three gardeners, the core group mainly consists of ten, and the total gardeners group of 25 gardeners (see Mode-Value in Table 12). Thus, just a few members of the total gardeners group do also belong to the core group or leader group. However, the number of participants also differs amongst the various garden projects. For instance, the smallest total group size of a community garden is seven while the largest is 400. It can be assumed that the size of the community affects the social learning processes, as the size affect the efficiency and social interaction of communities (Enqvist et al. 2014; Provan and Kenis 2008; Rogge et al. 2018).

Table 12: Who is learning? Size and structure of the community

Structural group	Arithmetic mean	Median	Mode	Minimum	Maximum
Leader group (n=122)	3.7	3	3	0	12
Core group (n=123)	13.2	10	10	2	82
Total group (n=122)	42.6	25	25	7	400

Furthermore, the following user groups of community gardens have been identified: families, children, students, working persons, jobseekers, refugees or migrants, as well as pensioners, and others (Bendt et al. 2013; Martin et al. 2016; Okvat and Zautra 2011; Smit et al. 2001d; Winkler et al. 2019). Out of this list, respondents of our questionnaire could select three main user groups. The empirical data shows that various user groups are present in the individual garden project: 66.7 percent of the

examined gardens chose three response options while 8.1 percent of the gardens chose only one response option. Table 13 shows that working persons (67.5 percent) and families (58.5 percent) are the prevailing user groups in most of the community gardens surveyed.

Based on the prevailing user groups, communities are more or less heterogeneous e.g. in age, culture and ethnic, gender, income, or educational background (Ferris et al. 2001; Martin et al. 2016; Okvat and Zautra 2011). This heterogeneity affects social learning in community gardens: young gardeners learn from the experience of the older gardeners, while e.g. gardeners with diverse cultural background have diverse knowledge about different plants and planting routines, and can likewise transmit specific knowledge on culture (Boukharaeva and Marloie 2006). Further, the involvement of higher educated persons can bring scientific and practical knowledge together (Krasny and Tidball 2009a). As we are interested in the particular role of heterogeneity for social learning we will provide more insights on that in Section 4.5.4.

As shown in Table 13 results on the heterogeneity indicate that communities seem to be more heterogeneous in income and age: more than 50 percent of the respondents stated a "high" or "very high" heterogeneity in income (median = 4) and age (median = 4). A share of 47.1 percent stated a "high" or "very high" heterogeneity in culture (median = 3) and 39.7 percent stated a "high" or "very high" heterogeneity in education (median = 3). Indeed, there is a relationship between garden main user groups and their heterogeneity. We can for instance show a relationship between the user group "students" and heterogeneity in education (Cramer's V= 0.306, p= 0.023), and heterogeneity in age (Cramer's V= 0.343, p= < 0.001), as well as a relationship between the user group "refugees and migrants" and heterogeneity in culture (Cramer's V= 0.407, p= <0.01). Jointly with the contingency table, these statistically significant results give indications that gardens which mentioned students as a main user group are less heterogeneous in education and age, whereas gardens where refugees and migrants are participating are more heterogeneous in culture. These, at first glance, plausible results show a good model fit of the relations between the selected criteria.

As the community garden movement is often stated as a female practice (Schmelzkopf 1995), the learning community can be assumed to be more female as well. This is confirmed by our results on gender distribution. 48.4 percent of the examined gardens stated that more females than males are active, whereas 4.9 percent of the gardens have a higher proportion of men. However, in 46.7 percent of the examined gardens an equal gender distribution was reported.

Table 13**:** Who is learning? User groups of community gardens

Criteria	Variable	Range	Number of respondents (%)*	
User group (n=123)	Working persons	-	83	(67.5)
	Families		72	(58.5)
	Students		43	(35.0)
	Pensioners		41	(33.3)
	Refugees & migrants		26	(21.1)
	Children		21	(17.1)
	Jobseeker		19	(15.5)
	Others[a]		13	(10.6)
Heterogeneity	Age (n=123)	Very low	2	(1.6)
		Low	20	(16.3)
		Neither low nor high	38	(30.9)
		High	42	(34.1)
		Very high	21	(17.1)
	Education (n=121)	Very low	1	(0.8)
		Low	34	(28.1)
		Neither low nor high	38	(31.4)
		High	31	(25.6)
		Very high	17	(14.1)
	Income (n=110)	Very low	1	(0.9)
		Low	10	(9.1)
		Neither low nor high	39	(35.5)
		High	45	(40.9)
		Very high	15	(13.6)
	Culture (n=121)	Very low	7	(5.8)
		Low	27	(22.3)
		Neither low nor high	30	(24.8)
		High	35	(28.9)
		Very High	22	(18.2)
Gender distribution (n=122)		Equal	57	(46.7)
		More females	59	(48.4)
		More males	6	(4.9)

Note: *: percentages based on valid values. **a**= Responses for "others" were: neighborhood (2), apprentice (2), all (2), people with disabilities (2), school kids, people in need, artists, people who are interested, people who have time.

Next, we investigate on what is learned in community gardens. Although the depicted criteria do not present a completed list, they provide a comprehensive overview. We refer to the learning streams developed by Bendt et al. (2013), which we operationalize with our survey: 1) learning about gardening and ecological conditions; 2) learning about the politics of space; 3) learning about self-organization; 4) learning about social entrepreneurship. We additionally examine garden educational programs, as part of formal learning in community gardens, often offered to the general public.

Within the first criterion, *learning about gardening and ecological conditions* we consider that learning occurs mainly through the general garden practice and thus predominantly informally. As such urban gardeners learn about the quality of soil, its relation to the growth of plants as well as where their food is coming from (Bendt et al. 2013; Krasny and Tidball 2009b; Levkoe 2006). Regarding this, many gardeners know e.g. how to compost and to treat plants with organic fertilizer (Boukharaeva and Marloie 2006). We examine what is cultivated in community gardens and assume that a diversity in cultivation positively influences learning about gardening and leads to recognition of ecological conditions. Table 14 presents the variety of cultivation in community gardens. In most of the examined gardens, herbs, vegetables and flowers are grown. Almost all gardens have compost. A share of 43.1 percent of the examined gardens keep bees and more than ten percent of the gardens keep small animals like rabbits or chickens. In 99.2 percent of the gardens more than one and in even 43.1 percent of the gardens even more than five of the presented crops in Table 14 are cultivated, and thus a variety of learning about horticultural practices can be assumed.

The second criterion, *learning about the politics of space* arises through negotiation and dissents concerning the use and development of urban space (Bendt et al. 2013). Since the community tends not to be the owner of the garden area, negotiation between government, private sector, and the public are usual. If the garden is established without any contract, more negotiation seems necessary, and learning about the politics of urban space is assumed to be more extensive (Bendt et al. 2013). Thus, ownership and legal status of the area give insights on this learning stream. As presented in Table 14, the area mainly belongs to the local government. Sometimes irrespective of the formal owner it is considered as de-facto open access by the gardeners. In 42.0 percent of the examined gardens, use rights are temporary (less than 5 years) and in 22.7 percent even insecure. There seems to be no pertinent difference between ownership type and the perception that lease contracts are short and insecure: 17.4 percent of the gardens in private ownership, 23.1 percent of the gardens in government ownership, and 24.5 percent of the gardens in public ownership consider their contracts to be short and insecure.

Third, we investigate the criterion *learning about self-organization* i.e. to learn about the management of the resources, division of labor, or effectiveness of various decision-making structures (Bendt et al. 2013; Colding et al. 2013). Gardens that are formally organized e.g. as a registered association may have a democratic decision structure and thus learn about democratic principles. Otherwise, according to Bendt et al. (2013) gardens that are informally organized as loose groups learn more how to improvise and

to make ad hoc decisions. As such we are interested whether gardens are organized formally or informally and whether their decision-making structure is hierarchically, democratically, or laissez faire organized. As shown in Table 14, a share of 70.7 percent of the examined gardens are organized formally e.g. as registered associations and decisions are mostly made democratically. In contrast to Bendt et al. (2013), our results indicate little differences in garden type of organization and their decision structure: 73.8 percent of the gardens that are formally organized and 71.9 percent of the gardens that are informally organized boast a democratic decision structure. Above this, Levkoe (2006) opines that being active in social movements in general encourages democratic learning.

Fourth, gardeners may learn about *social enterprising* e.g. when garden projects create jobs, financially work out through selling products, or when workshops and other kinds of paid services are offered (Bendt et al. 2013). Thus, the profit orientation and financing of gardens can give insights on learning about social enterprising. Results in Table 14 demonstrate that almost all surveyed gardens are non-profit organizations. Information on financing further indicates that most of the projects are mainly funded through donations and sponsoring. Gardens who mentioned "others" mainly stated public funding as their main financial source while one garden also mentioned running workshops, and two gardens mentioned the sale of products as their financial source.

For the last criterion *educational topics,* we aim to investigate the diversity of topics offered within garden educational programs. The results are based on the study of Löckener (2018). Table 14 shows that besides the fact that educational programs mostly cover topics on cultivation and botany, a broad spectrum of subjects are covered in a typical garden year. For instance, 22.8 percent offer programs concerning political issues and 3.3 percent on natural cosmetics. A variety of educational topics are also to be found within activities of the individual gardens: 14.6 percent offer more than five varied topics, 28.5 offer two to five varied topics, and 4.9 percent of the examined gardens offer just one educational topic. According to Löckener (2018), 52.0 percent of the examined gardens do not have any educational program, or none to be found without conducting follow-up interviews.

Table 14: What is learned?

Criteria	Variable	Sub variable	Number of respondents (%)*	
Gardening and ecological conditions (n=123)	Production	Herbs	121	(98.4)
		Vegetables	120	(97.6)
		Compost	120	(97.6)
		Flowers	110	(89.4)
		Fruits	100	(81.3)
		Bees	53	(43.1)
		Worm farms	21	(17.1)
		Chickens	7	(5.7)
		Rabbits	6	(4.9)
		Others	8	(6.5)
Politics of space	Ownership (n=122)	Public/ Open Access	56	(45.9)
		Government	39	(32.0)
		Private	23	(18.9)
		Community	4	(3.3)
	Legal status (n=119)	Temporary and insecure	27	(22.7)
		Temporary and secure	23	(19.3)
		Middle-term, insecure	10	(8.4)
		Middle-term, secure	26	(21.8)
		Long-term, insecure	13	(10.9)
		Long-term, secure	20	(16.8)
Self-organization	Organizational form (n=123)	Formally organized	87	(70.7)
		Informally organized	36	(29.3)
	Decision Structure (n=116)	Hierarchically	6	(5.2)
		Democratic	85	(73.3)
		Laissez faire	25	(21.5)
Social enterprising	Profit orientation (n=122)	Profit-oriented	0	(0)
		Low profit-oriented	3	(2.5)
		Nonprofit-oriented	119	(97.5)
	Financing (n=123)	Donation and sponsoring	55	(44.7)
		Own financial resources (e.g. membership fees)	35	(28.5)
		Others	33	(26.8)
Educational topics (n=123)	Cultivation	-	43	(35.0)
	Plants		40	(32.5)
	Alternative farming concepts		35	(28.5)
	Livestock and wild animals		30	(24.4)
	Politics		28	(22.8)
	Processing and preserving		26	(21.1)
	Specific groups offers		21	(17.1)
	Others		20	(16.3)
	Craft and design		10	(8.1)
	Integration and culture		7	(5.7)
	Natural cosmetics		4	(3.3)
	None		64	(52.0)

Note: *: percentages based on valid values.

4.5 How Social Learning is Taking Place in Community Gardens

4.5.1 Criteria to Measure How Learning Takes Place

In the following section, we investigate how social learning is taking place. Scholarly attention is devoted to social interaction and participation as decisive elements of social learning (Krasny and Tidball 2009b; Pahl-Wostl et al. 2007; Tran et al. 2018; Wenger 1998). Yet both do not necessarily guarantee social learning (Bos et al. 2013; Bull et al. 2008; Reed et al. 2010), but they are suitable criteria to examine social learning potential in communities of practice. Thus, we assume that higher degrees of social interaction and participation increase communities' potential for social learning processes. We further expand the examination of the learning potential by considering the extent and quality of *knowledge sharing* in community gardens.

For the s*ocial interaction* and *participation* criteria we rely on earlier work of Rogge et al. (2018). The *social interaction* criterion presents an operationalization of social interaction in community gardens through the variables *collective use*, *frequency of social activities*, and *perceived importance of social exchange.* Therein, collective use incorporates both the use of various material (e.g. greenhouse, tools, compost) as well as immaterial resources (work, time). Also Tran et al. (2018) point to social learning in farming households while individuals share their work. Rogge et al. (2018) identified 23 material and immaterial resources that can be *used or done collectively* at five different degrees ranging from individual use (1) to sharing (5) (see Table 15). Social interaction can be further expressed through the variable *frequency of social activities*, meaning sharing social time beyond the gardening activities e.g. through the common consumption of the harvest, or garden parties. This variable ranges from less than once a month (1) to four times a month and more (5). The third variable that characterizes social interaction in community gardens is the *perceived importance of social exchange* ranging from very unimportant to very important.

The second criterion, *participation*, can be understood as a process where e.g. individuals or groups have an active role in decision making (Reed et al. 2010). We understand participation as the opportunity to become part of the learning community. As such, we explore the openness of the gardens to the public and measure *participation* through the variables *access right*, *management right*, and *amount of precondition to participate* (Bendt et al. 2013). Access right implies the right to enter the resource and to enjoy non-subtractive benefits (Hess and Ostrom 2006; Schlager and Ostrom 1992), such

as enjoying the garden or learning and interacting with nature and participants. Individuals who have access rights may or may not have rights permitting participation in particular activities and collective-choice action (Schlager and Ostrom 1992). The management right signifies what kind of user group is holding the right to manage the garden and thus hold power in decision-making processes (Bendt et al. 2013; Schlager and Ostrom 1992). In line with the results presented in Rogge et al. (2018), the access and management rights are operationalized as follows: the right is held by a third party (1); by the leader group (2); by the core group (3); by the total group (4); or all citizens (5) (see structural groups above). The last variable *precondition to participate* gives insights on prevailing obstacles to partake in community gardens. The following preconditions could be identified: membership of the formal association, available garden plots, regular participation, and others. The variable ranges from: four preconditions (1) to no preconditions (5).

We investigate the third criterion, *knowledge sharing,* by focusing on the variable *importance of knowledge exchange*, preferred *transfer type*, and *educational methods*. The variable *importance of knowledge exchange* is further differentiated according to the sub-variables *importance of knowledge exchange - internally,* meaning among the garden community, and *importance of knowledge exchange - externally,* meaning among external garden users (the general public). The sub-variables range from very low (1) to very high (5). The variable *transfer type* is categorized according to the sub-variables communication, information, and knowledge. We understand the transfer of information as sharing facts and information about gardening activities, while knowledge transfer goes beyond transferring information and includes transfer of experience as well as the understanding of information. The three sub-variables are operationalized by the diversity of transfer types used: written or oral (1), mainly written or mainly oral (2), equally in written form and oral (3). Another core element that describes the quality and outreach of sharing knowledge, is the *educational methods* used within community gardens' educational programs. We follow the classification of Löckener (2018) into workshop, lecture, guided tour, film presentation, general information, tutorial, and other. We operationalize the variable in such a way that a higher variety in educational methods (1 to 7) corresponds to a higher variety of options for learning and thus corresponds to more social learning potential.

4.5.2 Quantitative Results on How Learning Takes Place

To determine how learning takes place, first, the criterion *social interaction* is specified. Results on the variable *collective use* indicate that sharing material and immaterial resources is in general of a high degree: almost 75 percent of the examined gardens reach values above 3.5 (Table 15). Social interaction does further occur by sharing time through *social activities*. In most of the examined gardens, social activities take place less than once a month, while in 13.8 percent of the gardens social activities take place 4 times a month or even more. The third variable, *importance of social exchange*, indicates that social exchange is of very high importance in most of the gardens.

Second, participation is determined by the variables *access right*, *management right*, and *precondition to participate*. Results for the variable *access right* indicate that in more than half of the examined gardens, access is open to the general public. However, in only 3.3 percent of the examined gardens, the general public also has the right to participate in management processes. Thus, the results confirm that the right to enter the resource system does not inevitably include the right to participate in management processes. In 34.2 percent of the gardens, individuals have at least to be a member of the core group to participate in management processes. The variable *precondition to participate* gives information about the obstacles to participate in community gardens. Preconditions are e.g. to join the garden association or to participate regularly. Results indicate that in more than 70 percent of the examined gardens only one or even no precondition (value 4 and 5) exist.

Third, for the criterion *knowledge sharing* Table 15 shows the overall importance of knowledge exchange among the garden community, as well as with external garden users. A share of 67.2 percent of the examined gardens assess the knowledge exchange within the garden community as "important" or "very important". A share of 29.2 percent of the examined gardens state the knowledge exchange with external garden users as "important" or "very important", as well. Additionally, results of the variable *transfer type* indicate that communication, information, and knowledge almost always occurs in a combination of written and oral transfer type (value 2 and 3). Zooming specifically into knowledge transfer, we can show that most gardens transfer knowledge "mainly written or mainly oral" (63,4 percent). Particularly 59.3 percent of the gardens share knowledge mainly orally, and only 4.1 percent share knowledge mainly in written form. Thus, in contrast to information and general communication, knowledge, i.e. expertise and experience is more often orally shared. Considering garden educational programs, empirical material shows that workshops, lectures, and guided tours are the

prevailing methods. We can further calculate from this data, that 12.1 percent of the gardens depend on five to seven different educational methods (see Table 15). In 26.0 percent of the gardens more than one but less than five diverse methods are revealed. A share of 9.8 percent of the examined gardens refer to one educational method. In 52.0 percent of the examined gardens no educational program could be identified.

Table 15: How learning is taking place? Social learning variables

Criteria	Variable	Value	Number of respondents	(%)*
Social interaction	Collective use: ranging from individual use to sharing (n=123)[a]	>= 1.0; < 1.5	0	(0.0)
		>= 1.5; < 2.5	4	(3.3)
		>= 2.5; < 3.5	30	(24.4)
		>= 3.5; < 4.5	50	(40.7)
		>= 4.5; <= 5.0	39	(31.7)
	Frequency of social activities (n=123)[b]	1	73	(59.3)
		2	19	(15.4)
		3	10	(8.1)
		4	4	(3.3)
		5	17	(13.8)
	Importance of social exchange (n=122)[c]	1	0	(0.0)
		2	4	(3.3)
		3	7	(5.7)
		4	37	(30.3)
		5	74	(60.7)
Participation	Access right (n=123)[d]	1	0	(0.0)
		2	2	(1.6)
		3	2	(1.6)
		4	51	(41.5)
		5	68	(55.3)
	Management right (n=117)[d]	1	1	(0.9)
		2	41	(35.0)
		3	40	(34.2)
		4	31	(26.5)
		5	4	(3.3)

(continued)

Criteria	Variable	Value	Number of respondents	(%)*
	Precondition to participate (n=123)[e]	1	**0**	(0.0)
		2	9	(7.3)
		3	25	(20.3)
		4	84	(68.3)
		5	5	(4.1)
Knowledge sharing	Importance of knowledge exchange - internally (n=122)[f]	1	0	(0.0)
		2	8	(6.6)
		3	32	(26.2)
		4	56	(45.9)
		5	26	(21.3)
	Importance of knowledge exchange - externally (n=120)[f]	1	3	(2.5)
		2	38	(31.7)
		3	44	(36.7)
		4	27	(22.5)
		5	8	(6.7)
	Communication transfer (n=123)[g]	1	1	(0.8)
		2	61	(49.6)
		3	61	(49.6)
	Information transfer (n=123)[g]	1	1	(0.8)
		2	63	(51.2)
		3	59	(48.0)
	Knowledge transfer (n=123)[g]	1	7	(5.7)
		2	78	(63.4)
		3	38	(30.9)
	Educational methods (n=123)[h]	0	64	(52.0)
		1	12	(9.8)
		2	16	(13.0)
		3	9	(7.3)
		4	7	(5.7)
		5	10	(8.1)
		6	3	(2.4)
		7	2	(1.6)

Note: *: percentages based on valid values. a: Collective use is examined by using the arithmetic mean of 23 resources and activities that can be used or done collectively at degrees ranging from 1= individual; 2= combination of individual and collective divided; 3= combination of individual and collective shared; 4= collective divided (clear allocation); to 5= collective shared (no clear allocation). b: 1= less than once a month; 2= once a month to less than two times a month; 3= two times a month to less than three times a month; 4= three times a month to less than four times a month; 5= four times a month and more. c: 1= very unimportant to 5= very important; d: 1= third party; 2= only the leader group; 3= only the core group; 4= the total group; 5= all citizens. e: 1= four preconditions exist; 2= three preconditions exists, 3= two preconditions exist; 4= one precondition exist; 5= no precondition exist. f: Importance of knowledge exchange is examined by using the arithmetic mean of the sub-variables ranging from 1= very unimportant to 5= very important. g: Transfer type is examined by using the arithmetic mean of the three sub-variables ranging from 1= written or oral, only; 2= mainly written or mainly oral; 3= equally in written or oral form. h: 1= one to 7= seven methods exist. We are aware of using the arithmetic mean for an ordinal scale. We assume that our items are quasi-metric and opt for the arithmetic mean instead of the median, to consider values deviating from others (Bryman, 2016).

4.5.3 Revealing Social Learning Potential

We composed the above presented criteria *social interaction*, *participation*, and *knowledge sharing* to social learning potential, the factor of key interest in this paper. The variable and criteria combinations were adjusted and reviewed with the help of factor analysis (principal component analysis and varimax rotation). The obtained factor score (regression method) of the variables determines the respective criterion. The obtained factor score of the criteria in turn reveals the social learning potential (Neuman 2014).

The results allow us to hint at diverse degrees of social learning potential which are empirically grounded and suggest a normal distribution (Figure 8). The degree of social learning potential reaches values from -2.19 to 1.94. Values close to zero mean that gardens' social learning potential is close to average compared to the other gardens. Negative values mean a social learning potential lower than the average. Positive values mean a social learning potential above the average i.e. high social learning potential. While we have only one garden (0.8 percent) reaching a value of social learning potential lower than -2.0, a number of 22 community gardens (18.0 percent) reach values from -2.0 to -1.0, and 42 gardens (34.4 percent) reach values from -1.0 to 0.0. On the positive side, a number of 33 (27.1 percent) community gardens reach values ranging from 0.0 to 1.0, a number of 24 gardens (19.7 percent) reach a degree of social learning potential from 1.0 to 2.0.

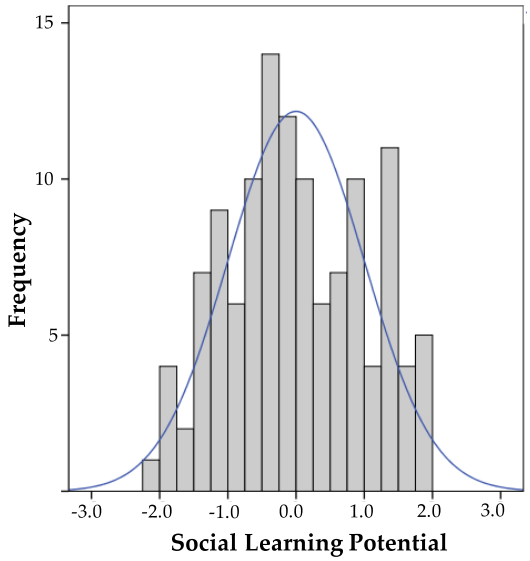

Figure 8 : Social learning potential distribution (n= 122)
Note: skewness = 0.040; z-skewness=0.183; kurtosis =-0.830; z-kurtosis= -1.908

4.5.4 The Influence of Heterogeneity on the Social Learning Potential

An often discussed factor in collective action theory and social learning is that on the homogeneity or heterogeneity of actor groups (Agrawal and Gibson 1999; Capra 2009). Since some time now, the links between actors' heterogeneity and collective action are regarded as complex (Heckathorn 1993) and a relationship between actors' heterogeneity and success in collective action is considered to be difficult to grasp (Vedeld 2000). In general, heterogeneity can either facilitate or impede the process of social cooperation. Although Agrawal and Gibson (1999) opines that for homogenous communities it might be more easy to make decisions collectively, in a different setting, homogenous groups may have more difficulties e.g. to withstand external threats (Agrawal and Gibson 1999). In sum, collective action scholars mostly argue for a relation but emphasize that heterogeneity does not have a uniform effect on collective action (Frey and Rusch 2014; Mansuri and Rao 2004; Varughese and Ostrom 2001).

Particularly regarding social learning theory, Capra (2009) points to learning capabilities and the creative power of heterogeneous communities. However, a dynamic network of relationships as well as a free flow of information is required otherwise heterogeneity rather becomes an obstacle than an advantage. Additionally, Glasser (2009) emphasizes that social learning can involve diverse actors even with competing or conflicting values and interests, and that conflicts may even positively influence the learning processes. Positive effects of group heterogeneity and learning is further discussed in the general education literature and more recently in the inclusion discussion as well (e.g. Ainscow et al. 2006; Mamas and Avramidis 2013; Razmerita and Brun 2011).

Similarly, advantages of heterogeneous groups are described in the community garden literature, e.g. to experience culture collectively, or to generate knowledge (Colding and Barthel 2013; Eizenberg 2012; Tidball and Krasny 2009). Nevertheless, group diversity may enhance conflicts as well as exclusion (Okvat and Zautra 2011). As such Schmelzkopf (1995) points to conflicts because of different ethnic and gender backgrounds e.g. what should be grown, or who belongs to the community. We want to empirically investigate the assumption that too heterogeneous communities make cooperation, social interaction, and thus the social learning process difficult, because of too many diverse interests and conflicts. In line with Poteete and Ostrom (2004) – who also opt for differentiating between various forms of heterogeneity, we differentiate four types of heterogeneity in garden communities, i.e. age, education, income, and culture, as presented above.

Already, our descriptive data show that heterogeneity in garden communities ranges between "neither low nor high" (3) to "high" (4), while communities show more heterogeneity in income and age (Section 4.4). In particular, results of the Spearman correlation coefficient indicate a significant negative weak correlation between heterogeneity in culture and social learning potential (r_s= -0,215; p= 0.018) as well as between heterogeneity in education and social learning potential (r_s= -0.252; p= 0.005). There seems to be no statistically significant effect of heterogeneity in income (r_s= -0.077; p= 0.424) or in age (r_s= -0.095; p= 0.296) on social learning potential. Based on the graphic illustration (Figure 9) a uniform effect of heterogeneity on social learning potential cannot be assumed. Additional results on curve estimation indicates significant results for a linear and a cubic model, while the r^2 is low.

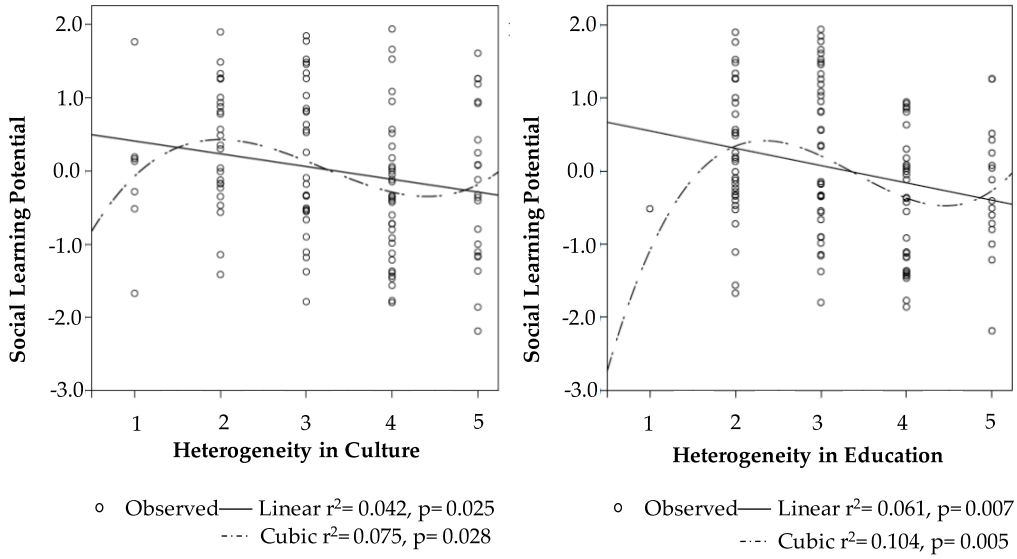

Figure 9: Scatterplots for social learning potential and heterogeneity in culture and education

4.6 Discussion and Conclusion

Community gardens are often emphasized as social-oriented activities contributing in various ways to sustainable cities, particularly based on their role in social learning, amongst others through social interaction. Yet detailed empirical data and particularly quantitative analysis on those assumed impacts are missing. We filled this gap by examining who is learning, what is learned, and how social learning is taking place. Through comprehensive criteria development, we not only explore on systematizing the somewhat encompassing concept of social learning, we also attempt to proof the concept by using empirical data and additionally provide an explicit measurement of social

learning potential. With this we can contribute to a better understanding of social learning in communities of practice.

It turned out that with regard to the composition of the communities, the division by structural groups and user groups helps to classify social learning in community gardens. First, based on belonging to a specific structural group, the learning content will differ among the individual gardeners. Data show that it is mainly the core group or leader group which hold the right to participate in management processes. Thus, it can be assumed that only a small number of the community will learn about leadership, however a larger group will learn about gardening activities. Second, there are various user groups, presenting working persons, families, and students. On average, at least three different user groups participate and learn together in community gardens. Depending on gardens' main user groups, communities differ in their heterogeneity as well. As such, e.g. in gardens where refugees or migrants prevail, heterogeneity in culture is high. This leads to the assumption that in these gardens, social learning occurs among diverse cultural groups and confirms gardens' potential regarding integration and the reduction of prejudice.

Besides who is learning, results on what is learned in community gardens also indicate a diversity. We have shown that learning mainly occurs as informal learning about gardening and ecological conditions, politics of space, and self-organization. Thus, our results confirm these three learning streams developed by Bendt et al. (2013), and support them through comprehensive data. Participants learn about various subjects such as composting or beekeeping through their garden practice, whereby they experience natural conditions and thus gain greater understanding of ecological relationships. Additionally, gardens are self-managed areas, mainly organized formally and through drawing on democratic decision structures. Thus, participants learn how to become and run a formal institution and how democratic processes work in practice. Since community gardens often only possess short-term lease contracts, negotiations about the garden area, mainly with the public authorities, are necessary. As such, urban gardeners are confronted with questions of ownership, the right to the city, and learn about political decision-making structures, too. However, related to the structural groups of community gardens, we expect that this learning stream will occur particularly within the leader and core group of the community.

Following Bendt et al. (2013) urban gardeners also learn about social enterprising. Yet based on our results on profit orientation and financing, this learning stream plays a subordinate role. Moreover, hints on what is learned in community gardens can be

gained through classifying topics offered within educational programs. Although horticultural themes prevail, there is a richness of topics. We have already mentioned that not all participants will learn the same content. However, social learning does not have to be the same for all individuals to facilitate social change (Bos et al. 2013).

We further gained insights about how learning is taking place. While social interaction and participation does not inevitably lead to social learning it seems indispensable to consider a single mechanism and features that indicate social learning in community gardens. As such we examined the three criteria *social interaction*, *participation*, and *knowledge sharing*. Earlier results indicate that social interaction and participation are in general of a high degree in community gardens (Rogge et al. 2018). Social interaction can be expressed by the collective use of various resources whereby gardeners learn, mainly informally, how to self-organize and manage their resources. Gardeners further interact and learn through social activities taking place in gardens, e.g. cultural activities. In general, social exchange is stated as very important in most of the gardens and socializing is often a motivation to participate in garden projects.

Scrutinizing into participation, it is interesting to study garden openness to the public, and thus garden openness as a learning space which is not planned but happens naturally and coincidentally. Since 55 percent of the gardens are open in access, even residents who do not participate as gardeners (external garden users) are able to learn by walking through the garden, by talking to the gardeners, by discovering unfamiliar plants, animals, and new ways of agricultural production, or just by seeing how food is grown. Experiences like these particular plays a crucial role in cities, where citizens often miss contact with agriculture and nature. In addition, results indicate that there are small obstacles to become a member of the community and thus become part of the closer learning group.

Results on the final criterion on how learning takes place, i.e. *knowledge sharing*, indicate the importance of knowledge exchange within the garden community, as well as with external garden users. In gardens where knowledge exchange with the external users is more important, gardens more often mentioned that educational programs are offered (Cramer's V= 0,286, p= 0,044). In total, we could substantiate that more than half of the gardens provide educational programs based on a variety of educational methods, but primarily workshops and lectures. Additionally, data show that knowledge is predominantly shared through oral communication.

We further elaborated on heterogeneity as an important factor influencing social learning. Preliminary results indicate a negative statistically significant relationship

between garden heterogeneity in culture and education and social learning potential. Furthermore, there seems to be a negative influence of heterogeneity in age and income on social learning potential, yet without statistical significance. Thus, we assume a weak negative effect on communities' heterogeneity to social learning potential in general. However, based on the graphic illustration (Figure 9. Scatterplot) linearity or a uniform effect cannot be assumed. This is not surprising since relationships in social settings are likely to be non-linear. Drawing on our empirical results, we assume a positive effect of garden heterogeneity to some degree, while too heterogeneous communities lead to diverse interests' groups making social learning processes more difficult, and may lead to conflicts. Yet, even conflicts call for conflict-resolution mechanisms that need to be developed among the participants and are thus in fact part of a social learning process (Glasser 2009). Moreover, there is a need to distinguish between various forms of heterogeneity and their links to other characteristics, such as group size (Poteete and Ostrom 2004). Larger communities tend to be more heterogeneous. Primarily results confirm a significant weak negative relation of social learning potential and core group size, by referring to the Pearson correlation coefficient (r= -0,216, p= 0.017). The heterogeneity debate in general offers further insights on the necessity to explore the finely tuned necessary degree of heterogeneity in communities – not too little and not too much diversity that let the garden activities prevail and facilitate particularly social learning, one of the guiding motivations of these urban initiatives. As such further investigation of these issues could lead to recommendations on group set ups.

There are some limitations to the dataset. A weakness of the empirical data collection is that only one member of the leader or core group of each garden was involved in the study. We thus only received the perception of one community member. In general, the assessment of what is actually learned, in contrast to the learning potential, turned out to be challenging. This is because learning in community gardens often takes place subconsciously and gardeners may not always recognize that something new is learned. Furthermore, the measurement of the social learning potential can be expanded to additional criteria. Tran et al. (2018) for instance mention social learning in farming households through self-reflection. There are further factors influencing social learning in communities of practice. As such Tran et al. (2018) and Rogge et al. (2018) point to the role of trust and that members of a group mainly prefer to interact with persons they trust most, while Pahl-Wostl (2006) describes trust and social capital rather as an outcome of social learning. It would additionally be interesting to figure out how ideas and attitudes that a small group acquires affect members of the

wider community group (Reed et al. 2010). However, more qualitative as well as quantitative data is necessary to investigate further on social learning. Thus, it seems like there is still much to explore in a fairly young movement of urban gardeners and we assume that this paper is a suitable foundation for the ongoing research.

5 Supplementary Results

This chapter presents supplementary results that are only partially addressed in the Chapters 2 to 4. For the sake of completeness, they are therefore demonstrated below. The chapter provides additional insights on community gardens' purposes and motivations (addressed in all three main chapters), bundles of rights (addressed in all three main chapters), and group heterogeneity (additionally to Chapter 3 and 4.) These results help to further answer the key research questions.

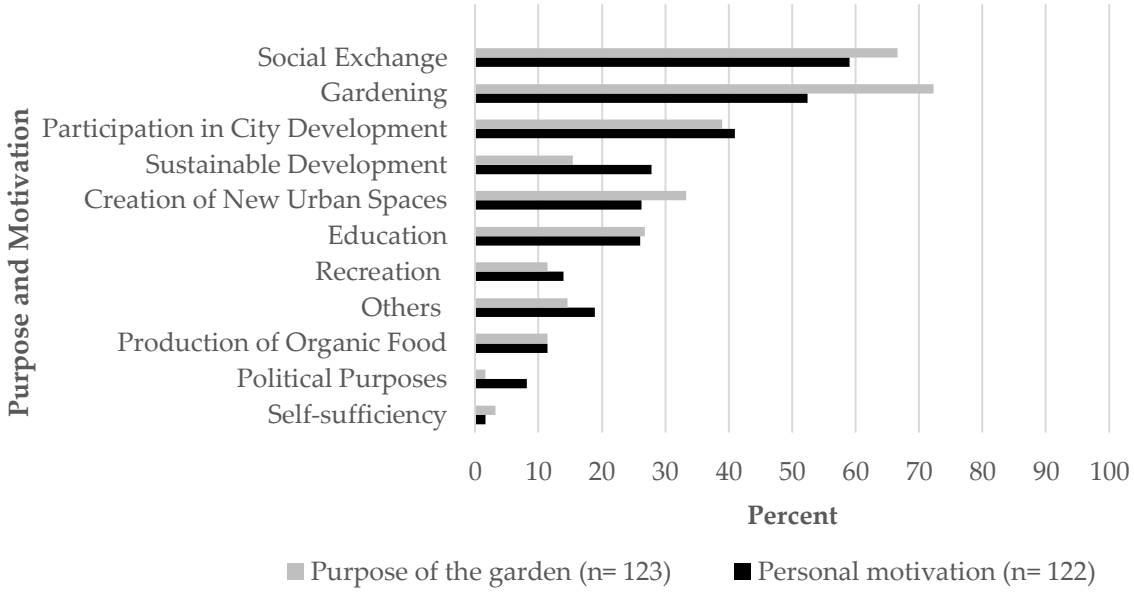

Figure 10: Purpose and motivation of community gardening
Note: Out of the presented list, respondents could choose 3 main purposes/ motivations. Additional responses for other purposes were: integration (12), campus development, social agriculture, experience of nature, meeting point for the neighborhood, art, all topics are important. Additional responses for other purposes were: integration (7), full-time employment (5), ecology (2), campus development, compensation daily work, creation of a humanistic culture, develop free space for young people, project promotion, resonance, organization, intergenerational exchange, all topics are important.

Figure 10 demonstrates reasons for people to found community gardens and gardeners' motivation to participate. As one can derive from the graph, the main purposes of gardens' establishment do not always correspond to gardeners' main motivation to participate. As such, the most mentioned purpose is gardening, while the most cited motivation is social exchange. However, social exchange is also the second most mentioned purpose of the establishment of community gardens. Thus, the results particularly confirm the importance of socializing in community gardens. The results further indicate the importance of community gardens as an opportunity to participate in city development and to foster sustainable development. In addition, in more than 25 percent of the examined gardens, education is indeed an important purpose and

personal motivation to join a community garden. Political purposes and self-sufficiency are the scarcest stated purposes and personal motivations. However, political purposes are more often a reason for joining a garden than an intention why gardens are founded. A closer look at the category "others" prevails that integration (i.e. social integration of migrants) is frequently mentioned as purpose and motivation, as well. Similar results regarding the purposes and motivations of gardening are highlighted in the study of Winkler et al. (2019).

Table 16: Bundles of rights in community gardens (n=123) (%)

Bundles of rights	Third party		Leader group		Core group		All gardeners		All citizens		I do not know	
Access right[a]	0	(0.0)	2	(1.6)	2	(1.6)	51	(41.5)	68	(55.3)	0	(0.0)
Withdrawal right[a]	1	(0.8)	0	(0.0)	4	(3.3)	92	(74.8)	25	(20.3)	1	(0.8)
Management right[b]	1	(0.8)	41	(33.3)	40	(32.5)	31	(25.2)	4	(3.3)	6	(4.9)
Exclusion right[b]	8	(6.5)	40	(32.5)	34	(27.6)	18	(14.6)	1	(0.8)	22	(17.9)
Alienation right[b]	6	(4.9)	43	(35.0)	38	(30.9)	14	(11.4)	1	(0.8)	21	(17.1)

Note: The access right is defined as the right to enter the resource system. The withdrawal right is defined as the right to obtain products of the resource, i.e. the right to harvest. The management right means the right to regulate internal use patterns, e.g. determine how and when harvesting can take place. In comparison, the right of exclusion implies the right to determine who will have access rights, while the right of alienation is defined as the right to transfer the exclusion and management right to other individuals. Bundles of rights are frequently held in the cumulative manner presented in the left column, meaning that e.g. the individual who hold the alienation right also holds the full set of rights. Individuals who hold the full set of rights are defined as owners. **a**= operational level rights; **b**= collective-choice rights.

Additionally, Table 16 presents results of the bundles of rights approach. The bundles of rights approach based on Schlager and Ostrom (1992) are adopted to community gardens to examine which structural group of the garden community hold what kind of right. Chapter 3 (p. 57) already discloses the results for *access right* and *management right* as variables to measure the criterion *participation*. For the sake of completeness, the total set of bundles of rights are presented below.

The findings demonstrate that in about 55 percent of the examined gardens "all citizens" have the right to enter the resource system. In 20 percent of the gardens "all citizens" even hold withdrawal rights. However, in only three percent of the gardens, this group is allowed to also manage the garden. Thus, in more than half of the examined community gardens, citizens are "authorized users" holding the operational-level rights of access and withdrawal, but not the collective-choice rights of management, exclusion, and alienation (Schlager and Ostrom 1992). Without the collective-choice rights, individuals do not have the authority to change the operational rules, e.g. to specify their own rules for harvesting. As seen in Table 16, collective-choice rights are mostly hold by

the garden community: in 25 percent by all gardeners (irregular gardeners, core group, and the leader group), in 32 percent only by the core group (regular gardeners and leader group), and in 33 percent only by the leader group of the garden community. However, findings of Chapter 3 also indicate, that there are little obstacles to participate in community gardens, meaning little hindrances to become a member of the garden community and thus gain collective-choice rights, as well. The results further indicate that the leader group holds more often the right of alienation and consequently the full set of rights[18]. However, in 31 percent of the gardens even the core group, and in 11 percent of the gardens, the total garden community holds the full set of rights, as well. The results confirm the assumptions made by Schlager and Ostrom (1992), that individuals may hold well-defined property rights but not inevitably the full set of rights. The results further confirm that not only the owner but all users who hold property rights to the resource make long-term investments and participate in the maintenance of the resources (the community garden).

Table 17: Spearman correlation coefficient of heterogeneity and selected criteria/ variables

Selected criteria/ variables	Heterogeneity in culture		Heterogeneity in education		Heterogeneity in age		Heterogeneity in income	
	r_s	n	r_s	n	r_s	n	r_s	n
Social interaction criterion[a]	-0.257**	121	-0.183*	121	-0.075	123	-0.113	110
Collective use variable[b]	-0.354**	121	-0.375**	121	-0.171	123	-0.183	110
Perceived success criterion[a]	-0.157	121	-0.222**	121	-0.037	123	-0.067	110
Complaints variable[c]	-0.186*	120	-0.232*	121	-0.064	122	-0.026	110
Rule compliance variable[c]	-0.183	110	-0.243*	110	-0.107	112	-0.065	100
Monitoring and sanctioning[d]	0.265**	118	0.323**	119	0.231*	120	0.096	108

Note: * = $p < 0.05$; ** = $p < 0.001$. **a**= Jointly with the criterion *participation* used to measure social sustainability (Chapter 3). **b**= Jointly with the variables *frequency of social activities* and *perceived importance of social exchange* used to measure the criterion *social interaction* (Chapter 3). **c**= Jointly used with the variables *fairness* and *participants' perspective on success* used to measure the criterion *perceived success* (Chapter 3). **d**= Used as independent variable that affect social sustainability (Chapter 3).

[18] It can be assumed that the alienation right to the garden area (resources system) is held by the municipality or private investors (third party), since those are almost always the owner of the urban space (see Chapter 4). Hence, the municipality or private owners can withdraw the right of the garden area from the garden community. While community gardeners are rarely the owner of the urban area, they may hold the alienation right to other resources such as the harvest, tools, etc.

Based on the results on heterogeneity gained in Chapter 3 and Chapter 4, additional analyses were conducted to gain more insights on the effect of heterogeneity to several criteria and variables of this study. Based on literature of collective action theory, criteria and variables were selected from which a relationship between the diverse forms of heterogeneity can be expected. The Spearman correlation coefficient is used to investigate initial results of relationships[19]. For a better overview, Table 17 reveals the criteria and variables where a statistical significant effect is confirmed, whereas all others are just mentioned in the text below. As seen in Table 17 a statistically significant effect is more often uncovered for heterogeneity in culture and education than for heterogeneity in age or income. These findings are further confirming the results of Chapter 3 and 4. There is a negative statistically significant, but weak relationship between heterogeneity in culture and *social interaction,* as well as heterogeneity in education and *social interaction*. As a reminder, the criterion *social interaction* is defined by the variables *collective use*, *frequency of social activities*, and *perceived importance of social exchange* (see Chapter 3, Table 8). When examining the single variables of the criterion *social interaction*, results particularly show a negative correlation between heterogeneity and the variable *collective use*. This indicates that communities more heterogeneous in culture and education are using resources less collectively. A statistically significant effect on heterogeneity to the variable *frequency of social activities* and to the variable *perceived importance of social exchange* cannot be assumed.

Regarding the criterion *perceived success,* a negative significant weak correlation is only disclosed for educational heterogeneity. The criterion *perceived success* is determined by the variables *rules compliance, fairness, participants` perspective on success,* and *complaints* (Chapter 3, Table 8). Scrutinizing the single variables has shown a weak statistically significant correlation between cultural heterogeneity and *complaints* and educational heterogeneity and *complaints*. These results imply that communities more heterogeneous in culture and education indeed face more complaints and conflicts. Regarding the variable *rule compliance*, statistically significant results are achieved for heterogeneity in education, implying a negative weak correlation. Thus, communities more heterogeneous in education may face lower rule compliance. However, there are no statistically significant relationships between heterogeneity (all forms) and the

[19] The correlation coefficient uncovers the relationship between variables, but no causality. However, the causal direction can be inferred from collective action theory, reveal heterogeneity as independent variable (see Chapter 3) (Bryman 2016). To assess the Spearman correlation coefficient, the classification of Cohen (1992) is referred. Additionally, variables were plotted on a scatter diagram to check for non-linear relationships.

variable *fairness*, and between heterogeneity (all forms) and the variable *participants' perspective on success.* The results of Table 17 further indicate a weak positive effect on heterogeneity and the variable *monitoring and sanctioning*, implying that in more heterogeneous communities more monitoring and sanctioning is taking place (based on Ostroms' Design Principles *monitoring and sanctioning* was used as an independent variable in Chapter 3, Table 10). Surprisingly, there is no statistically significant relationship between the variables *rule compliance* and *monitoring and sanctioning*, as it could be expected. Additional analysis indicates that heterogeneity does not have a statistically significant effect on the variables *perceived trust within the community*, and *rule set and design* (both also used as independent variables in Chapter 3).

6 General Conclusion

Community gardening, as urban agriculture in general, has become an international growing movement with concomitant growing scientific interest in this topic. Several scholars of the field particularly underscore gardens' social functions through collective action, social interaction, and education, as well as their contribution to sustainable development, especially the social dimension (Martin et al. 2016; Pourias et al. 2016; Spilková 2017). Moreover, social interaction is frequently mentioned as motivation why gardeners participate in community gardens. Thus, the overall research objective of this thesis has been to investigate community gardens collective and social processes. To do so, the commons and collective action theories were used as a framework to develop a wide range of criteria that enables to first, explore and categorize community gardens as commons, and second, to investigate and conceptualize gardens' social and collective processes. Third, the conceptualization of gardens' collective and social processes was further used to explore the conditions that influence these processes.

The results of the main Chapters 2 to 4 are synthesized in Section 6.1. Section 6.2 offers a critical discussion of the findings, discloses the research limitations, and provides future research questions. Finally, Section 6.3 offers recommendations for policy makers, urban planners, and practitioners.

6.1 Synthesis of Results

Reasons why gardens are founded and why urban dwellers join a garden are manifold, as well as their benefits, actors, or spaces are. Gardening itself is an important activity of community gardens, but their gardeners focus less on food production and more on social interaction and social exchange (see also Chapter 5). Likewise, gardening

is used as an expression of the right to the city, participation in urban development, and the desire of sustainable and livable cities. Nonetheless, history and current examples of urban agriculture and community gardening show their benefits and potential for food security and food sovereignty in cities all over the world. As a result, community gardens can improve food supply for urban dwellers particularly during crisis. These functions and other benefits of community gardening should not be neglected, neither their social, nor their ecological as well as economic benefits. However, this thesis focused on gardens' social benefits, particular through their collective action and social interaction, by studying community gardens as commons, in Germany.

Chapter 1 presented the theoretical background on urban agriculture and community gardens, defined the overall problem situation, research gaps, and the overall research question of this thesis. To address the research gaps and to answer the research questions the research design consisted of an in-depth literature review that led to a complex criteria development, mainly based on collective action theory and the study of the commons. Based on the criteria development, an online questionnaire was created and a quantitative study was conducted. First, as a pilot-study in the Rhine-Ruhr agglomeration with eleven cases (Chapter 2), second, as a German-wide study and the involvement of 123 community gardens in the data collection (Chapter 3 and 4).

The following paragraphs summarize how the single chapters answer the research questions and how the overall research contributes to the study of community gardens' social functions and their role as commons.

Chapter 2 offered a detailed examination of community gardens as commons. The objective of this chapter was to answer the overall research questions of this study: 1) What defines community gardens as commons and how can they be categorized? 2) How are community gardens organized as commons and spaces for social interaction? The results showed that community gardens are organized through a diversity of property right regimes, as well as various degrees of collective use of diverse material and immaterial resources. These diverse degrees of collective use, meaning measurable degrees of possible social interaction through collective cooperation, organization, and communication while sharing resources. Consequently, the chapter demonstrated that gardens can be defined as commons because of a diversity of property right regimes and various collective uses and activities. Additionally, the chapter provided a categorization of community gardens as commons based on their degree of collectivity. Moreover, the chapter disclosed that gardens differ in their function as commons, as well.

Chapter 3 elaborated on the findings of Chapter 2 and presented a more comprehensive analysis of community gardens' collective and social processes, as well as their influencing factors. Thus, Chapter 3 mainly answered the following key research questions: 3) How can community gardens' social processes be analyzed and made operational? 4) What influences the social processes in community gardens? Community gardens collective and social processes were made operational through the development of the criteria *social interaction*, *participation*, and *perceived success* that were further used as a concept to assess gardens' social sustainability. Moreover, a multiple linear regression analysis disclosed that gardens social and collective processes, operationalized here as social sustainability, are positively influenced by the variables *trust within the community* and the variable *management group*. A negative effect revealed the variable *group heterogeneity*. The variables *size of the community, size of the area, degree of rule design*, and *degree of monitoring and sanctioning* displayed no statistically significant effect on gardens' social sustainability. Overall, Chapter 3 provided detailed insights on gardens' social processes and offered a new methodological approach to evaluate social sustainability in community gardens, shown through an empirically analysis.

Chapter 4 scrutinized learning as a social action taking place in community gardens and contributed to the following main research questions: 3) How can community gardens' social processes be analyzed and made operational? 4) What influences the social processes in community gardens? 5) What is the role of learning and sharing knowledge in community gardens and how is learning taking place? Based on the social learning concept, the chapter elaborated empirically on who is learning and what is learned in community gardens. Findings showed diverse learning communities as well as a diversity in the learning content in the individual gardens. Moreover, the chapter investigated on how learning is taking place, operationalized as social learning potential through the developed criteria *social interaction*, *participation,* and *knowledge sharing*. In this respect, community gardens' social processes were further made operational by examining learning as collective and social interaction. Based on the results of the previous section, this chapter additionally elaborated on the impact of group heterogeneity as a significant influencing factor. Based on the Spearman Correlation Coefficient, the study disclosed that cultural and educational heterogeneity are influencing factors of gardens social learning processes, while heterogeneity in age and income does not reveal a statistically significant effect to gardens social learning potential. Overall, Chapter 4 provided an empirically proven systematization on the

encompassing social learning concept, an explicit measurement of social learning potential, and further disclosed preliminary results on the effect of group heterogeneity.

Based on the three main chapters, the overall research expressed, that a wide range of criteria is needed to capture and operationalize gardens' collective and social processes. It was demonstrated that commons are an appropriate approach that can take on such a comprehensive criteria development. Using commons as a framework allowed for the examination of community gardens as commons, to operationalize gardens' social processes and to investigate their influencing factors.

While in Chapter 2, community gardens are examined and categorized as commons, due to diverse property right systems and their collective use of various resources (research question 1), the chapter also stated that the characteristics of commons is much more complex, depending on e.g. self-monitoring, self-sanctioning, and rule design (see Section 2.2.1). This complexity is appreciated in Chapter 3, where the developed criteria (mainly based on the collective action theory of Ostroms design principles and SES framework) offered additional insights on community gardens' functions as commons. More specifically, Chapter 3 provided insights on rule design, showing that gardeners particularly develop rules for food production and harvesting that are self-monitored through the garden community. Contrary to expectations literature on commons, sanctioning is taking place only in a few community gardens (see Section 3.4). Additionally, Chapter 4 offered initial insights on the production of the knowledge commons through social interaction and knowledge sharing in community gardens. As such, community gardens are also defined as commons by the production of other types of commons (research question 1). Thus, beyond the findings of Chapter 2, community gardens can be defined as commons described as complex institutions in which land and other resources are used collectively by self-governance and rules that are self-restrictive and self-sanctioning (de Moor 2015). While describing community gardens as commons is not new, this study notably offered a detailed examination of them, which so far was missing in the academic realm.

Additionally, using the commons as a framework was helpful to gain a more profound understanding and insights on gardens' social processes. This research empirically affirms community gardens' importance for social interaction, particularly in higher-income countries like Germany. The research demonstrated that the individual gardens provide urban spaces for various interactions, e.g. the collective use of various material and immaterial resources, social interaction through various social activities (Chapter 2), collective management and participation (Chapter 3), and through learning

and education (Chapter 4). What makes community gardens even more special in this regard, is their openness and welcoming culture, which is expressed via open access and participation rights. As a result, urban dwellers are invited to partake within these collective and social activities and frequently benefit from community gardens functions, even if they do not partake in their provision. These findings are in line with Kornberger and Borch (2015) who state that the urban commons, in contrast to the traditional commons, do not necessarily center around the free-riding problems. Rather the value of urban commons such as community gardens increase when they are used by many people (Kornberger and Borch 2015). However, this can better be explained through gardens' focus on the production of non-subtractive resources, i.e. social capital. Gardens that target rather the production of subtractive resources, i.e. food production, may more often face the free-rider problems described by Hardin (1968).

Using the commons as a framework did furthermore serve the operationalization of gardens' social processes (research question 3), which was measured as social sustainability (Chapter 3) and social learning potential (Chapter 4) in this study. Indeed, social learning can also be a part of the social sustainability concept, however, because of the complexity of sharing knowledge, already recognized in Chapter 2, a separate examination and analysis was conducted. The developed criteria *social interaction* and *participation* used for both operationalization processes turned out to be suitable factors to operationalize social processes. The operationalization of gardens' social processes furthermore helped to analyze how these processes are influenced (research question 4), and thus, how collective action in community gardens can be facilitated. As the findings of Chapter 3 and 4 disclosed, collective action can be fostered through increasing trust within the community and if a broader user group is in charge of the garden management. In contrast, communities that are too heterogeneous, particularly in culture and education, make collective and social processes more difficult. However, the impact of heterogeneity is even more complex and very homogeneous as well as very heterogeneous communities seem to face difficulties. Thus, it can be assumed that the effects may depend on how good heterogeneity and emerging conflicts are negotiated and managed (Hou 2017; Mansuri and Rao 2004). For instance, supplementary results on Chapter 5 disclosed that communities that are more heterogeneous use their resources less collectively. Using resources less collectively (e.g. through a collective division, see Section 2.3.2) could also be understood as a strategy to handle heterogeneity. That is to say that if interests are too diverse it could be helpful if gardeners clearly allocated resources, particularly those that are more rivalrous (see also

Section 2.5). While using resources less collectively also means less social interaction, social interaction and trust can be increased through additional social activities such as garden parties or barbeques. Understandings like this are very helpful for structuring garden management and institutions in the surrounding community to support gardeners seeking to foster collective action and social interaction.

Finally, the study provided original insights, empirically proved gardens' social importance, and thus contributes to the scientific research of gardens' collective and social functions. In addition, this study threw light on community gardens' processes of self-management and self-organization, which has been rarely studied within the academic realm. By referring to a comprehensive dataset, the study concurrently addressed the lack of empirical studies and quantitative data on community gardens, particularly in non-English speaking countries, where studies and data on community gardens are widely underrepresented. The research further contributed to the general study of the commons and helped particularly to get a better understanding about the new and urban commons as a more recently emerged scientific field. Moreover, the study proved that urban dwellers are indeed able to manage and organize their surrounding urban space as commons in a creative and very diverse fashion, with the absence of a tragedy of the commons.

The presented concepts and criteria are a sufficient foundation to further study collective and social processes and types of new and urban commons. For instance, the criteria serve to compare community gardens based on their collective processes across diverse countries or regions. As such primary results of a study of Göttel and Penker (2017) indicate differences in the collective organization between gardens in Europe and the USA. On top of this, the concepts of this research can also be adopted and adjusted to investigate how community gardens differ from traditional commons, as well as from other types of new and urban commons.

6.2 Research Limitations and Suggestions for Further Research

While Chapter 2 to 4 already addressed specific limitations, this section presents more general limitations and provides suggestions for further research.

This research focused on social processes that are generally difficult to grasp and depend on a wide range of criteria. While this research made use of a very comprehensive criteria set, various additional factors could be taken into consideration for future research and analysis. As an example, Frey and Rusch (2013) emphasize that

a complete list of success factors that influence collective action would comprise more than 100 criteria. However, according to statistical analysis such as regression analysis, additional criteria require a larger sample size. Furthermore, social processes can be examined not only through collective action theory but additional useful tools, such as social capital or social movement theory as already done by Nettle (2014). Hence, further research should extend the number of variables by also including additional theories, as well as strive for larger sample sizes (see also suggestions below).

One further limitation of this research is the focus on the status-quo of community gardens, not considering past or future expectations. In commons literature, the time horizon of users is mentioned as important feature for long-term collective action (Ostrom 1990; Ostrom 2009). If members of community gardens spend time together and better know each other, cooperation and trust can increase over time, while free-riding should decrease (Foster 2006; Ostrom 2010a). Thus, this study originally accounted for a long-term perspective by developing the variable *permanence*, which was earmarked as an additional variable of the criterion *perceived success* of community gardens (Chapter 3). The variable *permanence* was defined by the sub-variables, *duration of the garden project*, *fluctuation within the garden group*, and *duration of land use approval*. However, according to results of factor analysis, this variable was not considered for explaining the criterion *perceived success*. Nonetheless, it can be assumed that citizens with longer time horizons are more likely to consider long-term strategies for sustaining the commons (Mansuri and Rao 2004). Since more than 40 percent of the community gardens have only temporary land use rights (less than 5 years), it can be surmised that urban gardeners' time horizon is not reduced to the physical space but to the changes they enable in the long-term. This can be confirmed by gardeners' motivation to contribute to sustainable development through community gardening. The time horizon and period the communities are acting together may also have an impact on gardens' ability to deal with conflicts and heterogeneity. Future research could establish and investigate research questions that center around the long-term perspective or duration of community gardens' and communities' ability to deal with various challenges such as group heterogeneity.

Particularly the role of heterogeneity requires further examination. It is of great interest to examine the circumstances that lead to negative and positive effects of heterogeneity and how communities cope with it. Initial results indicate, that more heterogeneity is correlated with increasing complaints and conflicts, while in more heterogeneous communities more monitoring and sanctioning is taking place, as well

(Chapter 5). Thus, monitoring and sanctioning, but also detailed rules or conflict resolution mechanisms can be helpful to deal with heterogeneity. Additional research on group composition will give more insights on the new and urban commons, help communities to foster collective action, and allow recommendations on group set up. To gain more insights on group heterogeneity, we need to also take other aspects into consideration. Heterogeneity should be measured in more detail by e.g. the number of participants with different cultural background, or gardeners' differences in age, but also through additional forms of heterogeneity, not considered in this work, e.g. family status, religion, political orientation, etc. Additionally, a more complex analysis that considers the interplay of many factors is necessary.

Moreover, community gardens should undergo a more critical review. Exclusiveness is an issue that frequently affects communities and that is to be found in community gardens literature, as well (Follmann and Viehoff 2015; Okvat and Zautra 2011). Gardens that are fenced in and locked face exclusiveness, since access is determined by key holders and, thus, citizens may doubt the gardens' openness to their participation (Schmelzkopf 1995; Tan and Neo 2009). However, in some areas fences seem necessary to protect the garden from thefts and vandalism. Thus, there is the challenge to protect the commons but also to enable residents to become a commoner (Follmann and Viehoff 2015; Ostrom 1990). Beside fences, infrastructure, such as missing toilets, can be a barrier that leads to the exclusion of older citizens or people with disabilities (Kingsley et al. 2009). Regarding this, Christensen (2017) stated that the social capital produced in community gardens is not inevitably positive. By investigating the variables *access right*, *management right*, and *precondition to participate* (see Chapter 3 and 4), this research implies the issue of exclusion to some degree. However, exclusion gained no further attention and is not further discussed in this thesis. Beside exclusion community gardens also face neoliberalism, if local governance outsource the maintenance of public spaces through civic engagement and community gardening (Bonow and Normark 2018; Rosol 2010). Furthermore, community gardens may facilitate gentrification if gardening leads to a growing attractiveness of the neighborhood, that in turn may result increasing housing prices (Bonow and Normark 2018; Follmann and Viehoff 2015; Rosol 2010). Negative impacts like this should not go unmentioned and need to be considered in forthcoming research and the assessment of gardens' social functions. For instance, future research, could deal with the exclusion of specific milieus or groups. As an example, this research shows that jobseekers are an underrepresented group in community gardens (see Table 13).

Beside this, there are some weaknesses in the survey and data, which are related to the general advantages and disadvantages of quantitative research. While quantitative data allows measurement and statistical analysis by referring to a wider range of cases, it lacks detailed investigations of individual cases with the potential to disclose more insights on interactive processes (Neuman 2014). Because the underlying method of this research paper was an online study, the survey was limited to gardens with an internet presence and email account. It can be assumed that many gardens have an internet presence since it enables them to draw attention to the project as well as to find support and participants. Nevertheless, gardens without internet presence and email address are excluded from this research. Moreover, the questionnaire was dedicated to members of the leadership team or core group from whom it can be expected to have well-founded knowledge about garden processes. Since these structural groups are likely to be more involved in garden processes, they may not find the required time to answer the questionnaire. This is confirmed by responses gained from some gardeners, saying that they do not have time to answer the questionnaire, also because they get many requests for scientific examinations. An appropriate approach for future research would be the development of two but less comprehensive questionnaires. One for leaders or members of the core group to gain general facts about the gardens' management, and one dedicated to the general garden group. This approach could increase the sample size, as well. Additionally, this approach would allow to get several perceptions on criteria like *trust*, *fairness*, *importance of social exchange*, etc. (see limitations of Chapter 3 and 4).

In general, to increase the understanding of gardens collective and social processes, as well as to make these processes measurable, a multimethod approach relying on qualitative and quantitative research is suggested for future research. However, an expertise of both research approaches, as well as more time is required (Neuman 2014). Additionally, action research seems to be a sufficient approach to examine community gardens further (Halder 2017; Nettle 2014).

One weakness of the concepts and measurements used in this research is low reliability. While the theoretical ideas about the measurement of social sustainability and social learning could be confirmed through factor analysis, values on Cronbach alpha are considerable low (social sustainability: Cronbach's alpha= 0,488; social learning potential: Cronbach alpha= 0.514). While literature often state Cronbach alpha values of 0.7 as adequate, in praxis even lower values of 0.5 can be suggested as acceptable. (Schmitt 1996; Schnell and Esser 2013; Streiner 2003). In addition, Schmitt (1996), state that lower reliabilities must not inevitably lead to a rejection of the scale or measurement.

Following Schecker (2014), this is particularly relevant if the operationalization is challenging, as noted for this research. Additionally, low values of Cronbach alpha can be explained by the small number of items and the scale used in this study (five-point scale for most of the criteria and variables). For these reasons, this research accepted the low Cronbach's alpha values. Thus, the low reliability points even more to an expansion of the presented approaches through additional criteria and larger sample sizes (see above).

Finally, because of the lack of data and the challenge to gain enough data on community gardens on international and national level, more data needs to be gathered and published. This would advance the research on community gardens and relieve gardens from too many research requests. Particularly data on gardens that ceased to exist is not available and would provide more insights on the maintenance of community gardens and the commons. To provide open access data would correspond to the idea of the commons and sharing knowledge, as well[20].

6.3 Recommendations for Policy Makers, City Planners, and Practitioners

Urbanization processes across the world are causing various economic, ecological, and social deficiencies and will increasingly determine urban living conditions (see Section 1.2). One of these issues is that in growing cities, urban green spaces are more and more disappearing (Kabisch 2015) while other cities are experiencing population losses, with the challenge to reuse vacant spaces (Morckel 2015). In this respect community gardening plays a crucial role with its ability to change even small areas unsuitable for gardening and food production, into urban green spaces. Moreover, community gardens do not only serve as green spaces and self-organized/managed playgrounds, but even more as areas for social learning and various collective and social interactions, as this study disclosed. Based on gardens' multidimensional benefits, they have the potential to advance sustainability especially on the city level, and thus play a crucial role in achieving the SDGs, that the German government also committed itself to. Additionally, considering community gardens as a strategy to move toward sustainability also means to integrate citizens, and thus share responsibility for sustainable development among various actors.

[20] Data of this thesis is provided as supplementary material published within the journal Sustainability.

Various recommendations for policy makers and urban planners to foster community gardens are already given by scientists within the field city planning and urban agriculture. As an example, Lovell (2010) offers in her work diverse planning strategies for various functions of urban agriculture and community gardening. Depending on a garden's function for community socialization and education, she recommends offering various activities within already existing programs that go beyond gardening and encourage socialization and learning. Yet, various developments and interdependencies need to be considered. Wolch et al. (2014) argue that urban planners should address the problem of gentrification (see section above). In addition, Follmann and Viehoff (2015) remark that in growing cities, the promotion of space for urban gardens may increase the pressure on land for e.g. new social housing projects, kindergartens, or schools. However, Colding et al. (2013) state that the provision of small spaces such as roofs or university campuses can justify the provision of space for gardening and self-management (Colding et al. 2013).

To some degree, policy makers and urban planners do already appreciate community gardens' multidimensional benefits and support their emergence and maintenance. For example, community gardens in the United States are promoted and supported through the federal and state governments (Drake and Lawson 2015; McClintock 2010). In Germany, community gardens' benefits are e.g. acknowledged within a handbook published by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB). The handbook underscores the multidimensional functions of community gardens and gives advice for municipalities to support them (BMUB 2015). In particular, the document stresses the importance of a bottom-up approach, rather than top-down.

Despite community gardens' increasing recognition, many urban garden projects are still lacking appreciation and support, and thus struggle with e.g. land access, funding, or interim use contracts (Drake and Lawson 2015; Follmann and Viehoff 2015; Tornaghi 2012). In this respect, Tornaghi (2012) reported that "*the ability of local and regional institutions to respond to [the] new demands are limited and constrained by planning traditions*" (p. 350). In her work, she further criticizes that the commons are not considered as a strategy to manage urban places.

Hence, there is a need to increase the support of community garden activities, not only to offer urban green spaces to the public, but also to respond to various populations' social needs. This study proved urban dwellers' desires to social exchange, to take part in city development, and to experience knowledge and learning about nature (see also

Chapter 5). In particular, gardens' contribution to social sustainability and their potential as places for learning and education was proven within this research (Chapter 3 and 4). To use this enormous potential of community gardens, urban planners and policy makers should support the foundation and maintenance of more gardens by providing spaces, infrastructure, and funding (e.g. access to water, toilets, electricity). This support is justified and required, because community gardeners take on key task of the government such as provide social spaces for exchange and learning, as well as advocate for climate protection, conservation of nature, and much more (see Section 1.1). Most of all, long-term contracts and protecting gardens through law (like allotment gardens) are necessary to allow for planning security. While interim use rights can be a solution for community gardening, it should not be the preferred one. If so, practitioners need to be supported in finding a new area for long-term use, afterwards. In addition, policy makers should engage even more in defining precise goals, such as a specific percentage of self-managed urban green space in cities to foster and ensure the emergence and maintenance of social and greens spaces such as community gardens. Most important, urban planners and politicians should recognize the ability of citizens to self-mange urban spaces and appreciate the value sprouts out of it. They should consider the commons management as a strategy to address social, but also ecological and economic issues in urban life. This research proved urban dwellers' ability to self-manage and maintain the commons and provided detailed insights on the processes that lead to successful management of gardens as commons. Therefore, community gardens as commons ought to be integrated in the urban planning debate, and policy makers and city planners need to facilitate these collective and social processes.

When it comes to practitioners, they should advocate for the rights to the city and search for ongoing negotiation, cooperation, and conversation with authorities. However, community gardens maintenance does also depend on practitioners' successful management of the resources. This research shared insights on the common's management, helpful to foster gardens collective action and self-management. Yet, because of gardens' diversity, e.g. in location, group compositing, basic prerequisites, there is no blueprint for successful implementation and maintenance of community gardens and the commons. Many solutions seem to fit, since many factors influence gardens' collective and social processes, as well. But, this research gives some insights into how community gardens are run as commons and how collective action can be fostered. Particularly, Chapter 2 offers insights on various opportunities to the collective use of urban resources and the establishment of various property right regimes.

According to Colding and Barthel (2013) the diversity of property rights also provides a better matching of citizens' preferences for participation in the commons. Moreover, the research showed that trust, and management by a larger group of participants seems to be a key to overcome collective action problems. In contrast, practitioners should be aware of a negative impact of group heterogeneity and find solutions how to deal with it. One solution can be to clearly allocate resources, particularly those that are more rivalrous (see Section 2.5 and Section 6.1). Furthermore, monitoring and sanctioning can play a crucial role in more heterogeneous communities (see Chapter 5). An additional key challenge for community gardeners is to find participants who take responsibility and participate regularly (Drake and Lawson 2015; Follmann and Viehoff 2015). This is also confirmed by the qualitative data gained in this research, which was evaluated and analyzed within the master thesis of Schreier (2018). In this respect, Schreier (2018) points to the importance of a welcome culture, inclusiveness rather than exclusiveness, and a working communication structure of community gardens. Decisively, practitioners should always adjust their commons management to the changing environment as well as the changing community. Practitioners should be open minded, creative and brave while experimenting with various ideas of the commons and urban gardening.

Finally, I hope this work stimulates reflection about the role of community gardens and the commons, about the idea of the city as a common, as well as the ability of communities to self-govern their resources. Furthermore, I hope this work leads to an increasing appreciation and support of community gardens and general social and collective activities that meet various social and environmental goals and help to move toward sustainable development and sustainable cities.

References

ACGA (American Community Gardening Association). n.d. *Frequently asked questions*. Available at: https://communitygarden.org/resources/faq/. [Accessed January 7, 2019]

Ackermann, K., Conard, M., Culligan, P., Plunz, R., Sutto, M.-P., and Whittinghill, L. 2014. Sustainable food systems for future cities: The Potential of urban agriculture. *The Economic and Social Review* 45 (2):189-206.

Adger, W. N. 2003. Social capital, collective action, and adaption to climate change. *Economic Geography* 79 (4):387-404. DOI: 10.1111/j.1944-8287.2003.tb00220.x

Agrawal, A., and Gibson, C. C. 1999. Enchantment and disenchantment: The role of community in natural resource conservation. *World development* 27 (4):629-649. DOI: https://doi.org/10.1016/S0305-750X(98)00161-2

Ainscow, M., Booth, T., and Dyson, A. 2006. *Improving schools, developing inclusion*. New York: Routledge.

Amin, A., Cameron, A., and Hudson, R. 2003. The alterity of the social economy. In *Alternative Economic Spaces* edited by A. Leyshon, R. Lee and C. Williams. 27-54. London: SAGE Publications.

Angotti, T. 2015. Urban agriculture: long-term strategy or impossible dream? Lessons from Prospect Farm in Brooklyn, New York. *Public Health* 129 (4):336-41. DOI: 10.1016/j.puhe.2014.12.008

anstiftung. 2016. *Die urbanen Gemeinschaftsgärten im Überblick (Overview of urban community gardens)*. Available at: https://anstiftung.de/urbane-gaerten/gaerten-im-ueberblick. [Accessed April 3, 2016]

anstiftung. 2017. *Die urbanen Gemeinschaftsgärten im Überblick (Overview of urban community gardens)*. Available at: https://anstiftung.de/urbane-gaerten/gaerten-im-ueberblick. [Accessed August 12, 2017]

anstiftung. 2018. *Die urbanen Gemeinschaftsgärten im Überblick (Overview of urban community gardens)*. Available at: https://anstiftung.de/urbane-gaerten/gaerten-im-ueberblick. [Accessed January 12, 2018]

anstiftung. 2019. *Die urbanen Gemeinschaftsgärten im Überblick (Overview of urban community gardens)*. Available at: https://anstiftung.de/urbane-gaerten/gaerten-im-ueberblick. [Accessed June 20, 2019]

Appel, I., Grebe, C., and Spitthöver, M. 2011. *Aktuelle Garteninitiativen - Kleingärten und neue Gärten in deutschen Großstädten (Current garden initiatives - allotments and new gardens in major German cities)*. Kassel: Kassel University Press.

Armitage, D., Marschke, M., and Plummer, R. 2008. Adaptive co-management and the paradox of learning. *Global environmental change* 18 (1):86-98. DOI: https://doi.org/10.1016/j.gloenvcha.2007.07.002

Armstrong, D. 2000. A survey of community gardens in upstate New York: Implications for health promotion and community development. *Health Place* 6 (4):319-327. DOI: 10.1016/S1353-8292(00)00013-7

Baerlein, T., Kasymov, U., and Zikos, D. 2015. Self-governance and sustainable common pool resource management in Kyrgyzstan. *Sustainability* 7 (1):496-521. DOI: 10.3390/su7010496

Bandura, A. 1977. *Social learning theory*. New Jersey: Prentice Hall.

Barthel, S., Folke, C., and Colding, J. 2010. Social–ecological memory in urban gardens: Retaining the capacity for management of ecosystem services. *Global Environmental Change* 20 (2):255-265. DOI: 10.1016/j.gloenvcha.2010.01.001

BBR (Bundesamt für Bauwesen und Raumordnung). 2008. *Metropolregion Rhein-Ruhr - ein Kunstprodukt (Metropolitan region Rhine-Ruhr - an art project)*. Bonn: Selbstverlag des Bundesamtes für Bauwesen und Raumordnung.

BBR (Bundesamt für Bauwesen und Raumordnung), and IKM (Initiativkreis Europäische Metropolregionen in Deutschland). 2012. *Regionales Monitoring 2012 – Daten und Karten zu den Europäischen Metropolregionen in Deutschland (Regional monitoring 2012 - data and maps from the European Metropolitan Regions in Germany)*. Available at: http://www.deutsche-metropolregionen.org/fileadmin/ikm/01_monitoring/Regionales_Monitoring_IKM_BBR_2013.pdf. [Accessed June 14, 2019]

BDG (Bundesverband Deutscher Gartenfreunde e.V.). 2018. *Daten und Fakten (Data and facts)*. Available at: https://www.kleingarten-bund.de/de/bundesverband/zahlen-und-fakten/. [Accessed January 17, 2019]

Bege, S. 2010. *Das Konzept der Metropolregion in Theorie und Praxis - Ziele, Umsetzung und Kritik (The concept of the Metropolitan Region in theory and practice - goals implementation and criticism)*. Wiesbaden: Gabler Verlag.

Bendt, P., Barthel, S., and Colding, J. 2013. Civic greening and environmental learning in public-access community gardens in Berlin. *Landscape and Urban Planning* 109 (1):18-30. DOI: 10.1016/j.landurbplan.2012.10.003

Bigell, W. 2015. Allotment and Community Gardens: Commons in German Cities. In *Spaces in-between - Cultural and Polotical Perspectives on Environmental Discourse*, edited by M. Luccarelli and S. Bergmann. 102-130. Leiden: Brill/ Rodopi.

Block, D. R., Chávez, N., Allen, E., and Ramirez, D. 2012. Food sovereignty, urban food access, and food activism: Contemplating the connections through examples from Chicago. *Agriculture and Human Values* 29 (2):203-215.

BMUB (Bundeministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit). 2015. Gemeinschaftsgärten im Quartier - Handlungsleitfaden für Kommunen (Community gardens in the neighborhodd - A handbook for municipalities). Berlin.

BMVBS (Bundesministerium für Verkehr, Bau und Stadtentwicklung), and BBR (Bundesamt für Bauwesen und Raumordnung). 2008. Städtebauliche, ökologische und soziale Bedeutung des Kleingartenwesens (The importance of allotment gardens for urban development, environment and society). Bonn.

Bonow, M., and Normark, M. 2018. Community gardening in Stockholm: Participation, driving forces and the role of the municipality. *Renewable Agriculture and Food Systems* 33 (6):503-517. DOI: 10.1017/S1742170517000734

Bos, J. J., Brown, R. R., and Farrelly, M. A. 2013. A design framework for creating social learning situations. *Global Environmental Change* 23 (2013):398-412. DOI: doi.org/10.1016/j.gloenvcha.2012.12.003

Boukharaeva, L. M., and Marloie, M. 2006. Family urban agriculture as a component of human sustainable development. *CAB Reviews Perspectives in Agriculture Veterinary Science Nutrition and Natural Resources* 25 (5):1-10. DOI: 10.1079/PAVSNNR2006025

Bryman, A. 2016. *Social research methods*. 5 ed. Oxford: Oxford University Press.

Bull, R., Petts, J., and Evans, J. 2008. Social learning from public engagement: Dreaming the impossible? *Journal of Environmental Planning and Management* 51 (5):701-716. DOI: https://doi.org/10.1080/09640560802208140

Cabral, I., Keim, J., Engelmann, R., Kraemer, R., Siebert, J., and Bonn, A. 2017. Ecosystem services of allotment and community gardens: A Leipzig, Germany case study. *Urban Forestry & Urban Greening* 23:44-53. DOI: http://dx.doi.org/10.1016/j.ufug.2017.02.008

Campbell, L., and Wiesen, A. 2011. *Restorative commons: Creating health and well-being through urban landscapes*. 39 ed. Philadelphia: USDA Forest Service.

Capra, F. 2009. Foreward. In *Social learning towards a sustainable world - Principles, perspectives and praxis*, edited by A. E. J. Waks. 13-15. Wageningen: Wageningen Academic Publishers.

Caputo, S. 2012. The purpose of urban food production in developed countries. In *Sustainable Food Planning*, edited by A. Viljoen and J. S. C. Wiskerke. 259-270. Wageningen: Wageningen Academic Publishers.

Christensen, S. 2017. Seeding social capital? Urban community gardening and social capital. *Civil Engineering and Architecture* 5 (3):104-123. DOI: 10.13189/cea.2017.050305

Cleff, T. 2015. *Deskriptive Statistik und Explorative Datenanalyse - Eine computergestützte Einführung mit Excel, SPSS und STATA (Descriptive statistics and exploratory data analysis - A computer-assisted introduction with Excel, SPSS and STATA)*. 3 ed. Wiesbaden: Gabler Verlag.

Cohen, J. 1992. A power primer. *Psychological Bulletin* 122 (1):155-159. DOI: https://doi.org/10.1111%2F1467-8721.ep10768783

Colding, J., and Barthel, S. 2013. The potential of urban green commons in the resilience building of cities. *Ecological Economics* 86 (2013):156-166. DOI: 10.1016/j.ecolecon.2012.10.016

Colding, J., Barthel, S., Bendt, P., Snep, R., van der Knaap, W., and Ernstson, H. 2013. Urban green commons: Insights on urban common property systems. *Global Environmental Change* 23 (5):1039-1051. DOI: 10.1016/j.gloenvcha.2013.05.006

Cox, M., Villamayor-Tomas, S., Epstein, G., Evans, L., Ban, N. C., Fleischman, F., Nenadovic, M., and Garcia-Lopez, G. 2016. Synthesizing theories of natural resource management and governance. *Global Environmental Change* 39 (2016):45-56. DOI: doi.org/10.1016/j.gloenvcha.2016.04.011

Davidson-Hunt, I., and Berkes, F. 2003. Learning as you journey: Anishinaabe perception of social-ecological environments and adaptive learning. *Conservation Ecology* 8 (1):5.

Davy, B. 2014. Polyrational property: Rules for the many uses of land. *International Journal of the Commons* 8 (2):472-492. DOI: http://doi.org/10.18352/ijc.455

De Angelis, M. 2003. Reflections on alternatives, commons and communities or building a new world from the bottom up. *The commoner* 6:1-14.

de Haan, E., Meier, S., and Haartsen, T. 2017. Defining 'success' of local citizens' initiatives in maintaining public services in rural areas: A professional's perspective. *European Society for Rural Sociology* 58 (2):312-330. DOI: 10.1111/soru.12173

de Moor, T. 2015. *The dilemma of the commoners: Understanding the use of common-pool resources in long-term perspective*. New York: Cambridge University Press.

Dempsey, N., Bramley, G., and Brown, S. P. a. C. 2009. The social dimension of sustainable development: Defining urban social sustainability. *Sustainable Development* 19:289-300. DOI: 10.1002/sd.417

Die Urbanisten. 2016. *Projekte (Projects)*. Available at: https://www.urbaneoasen.de/projekte/. [Accessed April 3, 2017]

Drake, L., and Lawson, L. J. 2015. Results of a US and Canada community garden survey: shared challenges in garden management amid diverse geographical and organizational contexts. *Agriculture and Human Values* 32 (2):241-254. DOI: 10.1007/s10460-014-9558-7

Draper, C., and Freedman, D. 2010. Review and analysis of the benefits, purposes, and motivations associated with community gardening in the United States. *Journal of Community Practice* 18 (4):458-492. DOI: 10.1080/10705422.2010.519682

Eizenberg, E. 2012. Actually existing commons: Three moments of space of community gardens in New York City. *Antipode* 44 (3):764-782. DOI: 10.1111/j.1467-8330.2011.00892.x

Eizenberg, E., and Jabareen, Y. 2017. Social sustainability: A new conceptual framework. *Sustainability* 9 (1):1-16. DOI: 10.3390/su9010068

Enqvist, J., Tengö, M., and Bodin, Ö. 2014. Citizen networks in the garden city: Protecting urban ecosystems in rapid urbanization. *Landscape and Urban Planning* 130:24-35. DOI: 10.1016/j.landurbplan.2014.06.007

FAO (Food and Agriculture Organization). 2010. *Fighting poverty and hunger - Economic and social perspectives*. Available at: http://www.fao.org/docrep/012/al377e/al377e00.pdf. [Accessed June 14, 2019]

Feeny, D., Fikret Berkes, McCay, B. J., and Acheson, J. M. 1990. The tragedy of the commons: Twenty-two years later. *Human Ecology* 18 (1):1-18.

Ferris, J., Norman, C., and Sempik, J. 2001. People, land and sustainability: Community gardens and the social dimension of sustainable development. *Social Policy & Administration* 35 (5):559-568. DOI: 10.1111/1467-9515.T01-1-00253

Follmann, A., and Viehoff, V. 2015. A green garden on red clay: creating a new urban common as a form of political gardening in Cologne, Germany. *Local Environment* 20 (10):1148-1174.

Foster, S. R. 2006. The city as an ecological space: Social capital and urban land use. *Fordham Law School Occasional Papers* 82 (2):527-582.

Foster, S. R. 2011. Collective action and the urban commons. *Notre Dame Law Review* 87 (1):57-133.

Frey, U. J., and Rusch, H. 2013. Using artificial neural networks for the analysis of social-ecological systems. *Ecology and Society* 18 (2).

Frey, U. J., and Rusch, H. 2014. Modeling ecological success of common pool resource yystems using large datasets. *World Development* 59 (2014):93-103. DOI: 10.1016/j.worlddev.2014.01.034

Frey, U. J., Villamayor-Tomas, S., and Theesfeld, I. 2016. A continuum of governance regimes: A new perspective on co-management in irrigation systems. *Environmental Science & Policy* 66:73-81. DOI: 10.1016/j.envsci.2016.08.008

Game, I., and Primus, R. 2014. *Brief for GSDR, 2015*. Available at: https://sustainabledevelopment.un.org/index.php?page=view&type=111&nr=5764&menu=35. [Accessed 20 March, 2019]

Garmendia, E., and Stagl, S. 2010. Public participation for sustainability and social learning: Concepts and lessons from three case studies in Europe. *Ecological Economics* 69 (2010). DOI: https://doi.org/10.1016/j.ecolecon.2010.03.027

Gibson Graham, J. K. 2006. *A postcapitalist politics*. Minneapolis: University of Minnesota press.

Glaeser, E. L., Laibson, D., and Sacredote, B. 2002. An economic approach to social capital. *Economic Journal* 112 (483):437-58. DOI: 10.1111/1468-0297.00078

Glasser, H. 2009. Minding the gap: The role of social learning in linking our stated desire for a more sustainable world to our everyday actions and policies. In *Social learning towards a sustainable world - Principles, perspectives and praxis*, edited by A. E. J. Wals. 35-61. Wageningen: Wageningen Academic Publishers.

Göttel, I., and Penker, M. 2017. Institutions for collective gardening: A comparative document analysis of 51 urban community gardens in Anglo-Saxon and German-speaking countries. In *XVI Biennial Conference International Association for the Study of the Commons (IASC)*. Utrecht: IASC.

GreenThumb. n.d. *Green thumb garden map*. Available at: https://greenthumb.nycgovparks.org/gardensearch.php. [Accessed May 25, 2019]

Guitart, D., Pickering, C., and Byrne, J. 2012. Past results and future directions in urban community gardens research. *Urban Forestry & Urban Greening* 11 (4):364-373. DOI: 10.1016/j.ufug.2012.06.007

Halder, S. 2017. *Gemeinsam die Hände dreckig machen. Aktionsforschung im aktivistischen Kontext urbaner Gärten und kollektiver Kartierungen (Get our hands dirty collectively. Action research in the context of urban gardens and collective mapping)*. Bielefeld: transcript Verlag.

Hancock, T. 2001. People, partnerships and human progress: Building community capital. *Health Promotion International* 16 (3):275-280.

Hardin, G. 1968. The tragedy of the commons. *Science* 162 (3859):1243-8.

Heckathorn, D. D. 1993. Collective action and group heterogeneity: Voluntary provision versus selective incentives. *American Sociological Review* 58 (3):329-350. DOI: 10.2307/2095904

Hernandez, M., and Manu, R. 2018. *Growing greener C´cities: Urban agriculture and the impact on SDG 11*. Available at: http://sdg.iisd.org/commentary/generation-2030/growing-greener-cities-urban-agriculture-and-the-impact-on-sdg-11/. [Accessed March 20, 2019]

Hess, C. 2008. Mapping the new commons. Paper read at twelfth biennial conference of the International Association for the Study of the Commons, 14-18 July, at Cheltenham, UK.

Hess, C., and Ostrom, E. 2003. Ideas, artifacts, and facilities. *Law and Contemporary Problems* 66 (111):111-145.

Hess, C., and Ostrom, E. 2005. A framework for analyzing the knowledge commons. In *Understanding Knowledge as a Commons - From Theory to Practice*, edited by C. Hess and E. Ostrom. 41-81. London: The MIT Press.

Hess, C., and Ostrom, E. 2006. A framework for analysing the microbiological commons. *International Social Science Journal* 58 (188):335-349. DOI: 10.1111/j.1468-2451.2006.00622.x

Hess, C., and Ostrom, E. 2007. Introduction: An overview of the knowledge commons. In *Understanding knowledge as a commons - From theory to practice*, edited by C. Hess and E. Ostrom. Cambridge/ Massachusetts: The MIT press.

Hou, J. 2017. Urban community gardens as multimodal social spaces. In *Greening Cities*, edited by P. Y. Tan and C. Y. Jim. 113-130. Singapore: Springer.

Huong, T. T. T., and Berkes, F. 2011. Diversity of resource use and property rights in Tam Giang Lagoon, Vietnam. *International Journal of the Commons* 5 (1):130-149.

Ison, R., and Watson, D. 2007. Illuminating the possibilities for social learning in the management of Scotland's water. *Ecology and Society* 12 (1):1-21.

Jabareen, Y. R. 2006. Sustainable urban forms - Their typologies, models, and concepts. *Journal of Planning Education and Research* 25 (1):38-52. DOI: 10.1177/0739456X05285119

Jenny, A., Fuentes, F. H., and Mosler, H.-J. 2007. Psychological factors determining individual compliance with rules for common pool resource management: The case of a Cuban community sharing a solar energy system. *Humam Ecology* 35 (2):239-250. DOI: 10.1007/s10745-006-9053-x

Johannes, E. 1955. Entwicklung, Funktionswandel und Bedeutung städtischer Kleingärten dargestellt am Beispiel der Städte Kiel, Hamburg und Bremen (Development, change of purpose, and importance of allotment gardens: Examples of Kiel, Hamburg, and Bremen). Kiel: Selbstverlag des Geographischen Instituts der Universität Kiel.

Kabisch, N. 2015. Ecosystem service implementation and governance challenges in urban green space planning—The case of Berlin, Germany. *Land Use Policy* 42:557-567.

Kingsley, J. Y., Townsend, M., and Henderson-Wilson, C. 2009. Cultivating health and wellbeing: Members' perceptions of the health benefits of a Port Melbourne community garden. *Leisure Studies* 28 (2):207-219. DOI: http://dx.doi.org/10.1080/02614360902769894

Kornberger, M., and Borch, C. 2015. Introduction. In *Urban commons: Rethinking the city*, edited by M. Kornberger and C. Borch. 1-21. New York: Routledge.

Krasny, M. E., and Tidball, K. G. 2009a. Applying a resilience systems framework to urban environmental education. *Environmental Education Research* 15 (4):465-482. DOI: https://doi.org/10.1080/13504620903003290

Krasny, M. E., and Tidball, K. G. 2009b. Community gardens as contexts for science, stewardship, and civic action learning. *Cities and the Environment* 2 (1):1-17.

Krikser, T., Piorr, A., Berges, R., and Opitz, I. 2016. Urban agriculture oriented towards self-supply, social and commercial purpose: A typology. *Land* 5 (28):2-19. DOI: 10.3390/land5030028

Landert, J., Schader, C., Moschitz, H., and Stolze, M. 2017. A holistic sustainability assessment method for urban food system governance. *Sustainability* 9:1-21. DOI: 10.3390/su9040490

Lawson, L. 2005. *City bountiful - A century of community gardening in America*. Berkeley/ Los Angeles: University of California Press.

Lee, S., and Webster, C. 2006. Enclosure of the urban commons. *GeoJournal* 66 (1-2):27-42. DOI: 10.1007/s10708-006-9014-3

Levkoe, C. Z. 2006. Learning democracy through food justice movements. *Agriculture and Human Values* 23 (1):89-98. DOI: 10.1007/s10460-005-5871-5

Lindemann-Matthies, P., and Brieger, H. 2016. Does urban gardening increase aesthetic quality of urban areas? A case study from Germany. *Urban Forestry & Urban Greening* 17:33-41.

Linn, K. 1999. Reclaiming the sacred commons. *New Village* 1 (1):42-49.

Löckener, A. E. C. 2018. Die Relevanz von informeller Bildung in urbanen Gemeinschaftsgärten in Deutschland: Eine Bestandsanalyse verschiedener Bildungsangebote in ausgewählten

Gemeinschaftsgärten (The importance of informal education in urban community gardens in Germany: An analysis of educational programs in selected community gardens). Unpublished bachelor thesis, Department of Food Nutrition Facilities, Münster University of Applied Sciences, Münster.

Lohrberg, F. 2016. Urban agriculture Europe: Agriculture interacting with the urban sphere. In *Urban agriculture Europe*, edited by F. Lohrberg, L. Lička, L. Scazzosi and A. Timpe. 8-13. Berlin: Jovis Verlag.

Lovell, S. T. 2010. Multifunctional urban agriculture for sustainable land use planning in the United States. *Sustainability* 2 (8):2499-2522. DOI: 10.3390/su2082499

Mamas, C., and Avramidis, E. 2013. Promoting social interaction in the inclusive classroom: Lessons from inclusive schools in England and Cyprus. *Learning, Culture and Social Interaction* 2 (4):217-226. DOI: https://doi.org/10.1016/j.lcsi.2013.07.001

Mansuri, G., and Rao, V. 2004. Evaluating community-based and community-driven development: A critical review of the Evidence. *The World Bank Research Obsever* 19 (1):1-39. DOI: 10.1093/wbro/lkh012

Martin, G., Clift, R., and Christie, I. 2016. Urban cultivation and its contributions to sustainability: Nibbles of food but oodles of social capital. *Sustainability* 8 (5):409. DOI: 10.3390/su8050409

McClintock, N. 2010. Why farm the city? Theorizing urban agriculture through a lens of metabolic rift. *Cambridge Journal of Regions, Economy and Society* 3 (2):191-207. DOI: 10.1093/cjres/rsq005

McClintock, N., Mahmoudi, D., Simpson, M., and Santos, J. P. 2016. Socio-spatial differentiation in the sustainable city: A mixed-methods assessment of residential gardens in metropolitan Portland, Oregon, USA. *Landscape and Urban Planning* 148 (2016):1-16. DOI: 10.1016/j.landurbplan.2015.12.008

McIvor, D. W., and Hale, J. 2015. Urban agriculture and the prospects for deep demoracy. *Agriculture and Human Values* 32 (4):727-741. DOI: 10.1007/s10460-015-9588-9

McKenzie, S. 2004. Social sustainability: Towords some definitions. *Hawke Research Institute* 27:1-29.

Morckel, V. 2015. Community gardens or vacant lots? Rethinking the attractiveness and seasonality of green land uses in distressed neighborhoods. *Urban Forestry & Urban Greening* 14 (3):714-721. DOI: https://doi.org/10.1016/j.ufug.2015.07.001

Morrow, O. 2019. Sharing food and risk in Berlin's urban food commons. *Geoforum* 99:202-212. DOI: https://doi.org/10.1016/j.geoforum.2018.09.003

Mougeot, L. J. A. 2006. *Growing better cities urban agriculture for sustainable development*, *In focus*. Ottawa: International Development Research Centre (Canada).

Moulin-Doos, C. 2014. Intercultural gardens: The use of space by migrants and the practice of respect. *Journal of Urban Affairs* 36 (2):197-206. DOI: 10.1111/juaf.12027

Müller, C. 2007. Intercultural gardens. Urban places for subsistence, production and diversity. *German Journal of Urban Studies* 46 (1):1-6.

Müller, C. 2011. Urban Gardening. Grüne Signaturen neuer urbaner Zivilisationen (Urban gardening. Green signatures of new urban civilizations). In *Urban gardening - Über die Rückkehr der Gärten in die Stadt*, edited by C. Müller. Munich: oekom Verlag.

Müller, C. 2012. Practicing commons in community gardens: Urban Gardening as a corrective for Homo Economicus. In *The Wealth of the commons: A world beyond market and state*, edited by D. Bollier and S. Helfrich. Amherst: Levellers Press.

MUNLV (Ministerium für Umwelt und Naturschutz, Landwirtschaft und Verbraucherschutz des Landes Nordrhein-Westfalen). 2009. Zukunft des Kleingartenwesens in NRW - Forschungsbericht zur Kleingartensituation in Nordrhein-Westfalen (Future of allotment gardening in NRW - Research report on the allotment garden situation in North Rhine-Westphalia). Düsseldorf.

Netting, R. M. 1976. What Alpine peasants have in common: Observation on communal tenure in swiss village. *Human Ecology* 4 (2):135-146. DOI: https://doi.org/10.1007/BF01531217

Netting, R. M. 1981. *Balancing on an Alp: Ecological change and continuity in a Swiss Mountain community*. New York: Cambridge University Press.

Nettle, C. 2014. *Community gardening as a social action*. Farnham: Ashgate.

Neuman, W. L. 2014. *Social research methods: Quantitative and qualitative approaches*. 7 ed. Harlow: Pearson.

Okvat, H. A., and Zautra, A. J. 2011. Community gardening: A parsimonious path to individual, communtiy, and environmental resilience. *American Journal of Community Psychology* 47 (3-4):374-387. DOI: https://doi.org/10.1007/s10464-010-9404-z

Olson, M. 1965. *The logic of collective action: Public goods and the theory of groups*. Cambridge/ Mass: Harvard University Press.

Opitz, I., Berges, R., Piorr, A., and Krikser, T. 2016. Contributing to food security in urban areas: differences between urban agriculture and peri-urban agriculture in the Global North. *Agriculture and Human Values* 33 (2):341-358. DOI: 10.1007/s10460-015-9610-2

Opitz, I., Specht, K., Berges, R., Siebert, R., and Piorr, A. 2016. Toward sustainability: Novelties, areas of learning and innovation in urban agriculture. *Sustainability* 8 (4):1-18. DOI: 10.3390/su8040356

Ostrom, E. 1990. *Governing the commons : The evolution of institutions for collective action*, *Political Economy of Institutions and Decisions*. Cambridge: Cambridge University Press.

Ostrom, E. 1992. *Crafting institutions for self-governing irrigation systems*. San Francisco: Institute for Contemporary Studies.

Ostrom, E. 2002. Common-pool resources and institutions: Toward revised theory. In *Handbook of Agricultural Economics*, edited by B. L. Gardner and G. C. Rausser. 1315-1339. Amsterdam: Elsevier Science B.V.

Ostrom, E. 2003. How types of goods and property rights jointly affect collective action. *Journal of Theoretical Politics* 15 (3):239-270. DOI: 10.1177/095169280301500300

Ostrom, E. 2008. The challenge of common-pool resources. *Environment: Science and Policy for Sustainable Development* 50 (4):8-21.

Ostrom, E. 2009. A general framework for analyzing sustainability of social-ecological systems. *Science* 325 (5939):419-422. DOI: 10.1126/science.1172133

Ostrom, E. 2010a. Analyzing collective action. *Agricultural Economics* 41 (1):155-166. DOI: 10.1111/j.1574-0862.2010.00497.x

Ostrom, E. 2010b. The challenge of crafting rules to change open access resources into managed resources. In *Is economic growth sustainable?*, edited by G. Heal. 168-205. London: Palgrave Macmillan UK.

Ostrom, E. 2011. Background on the institutional analysis and development framework. *The Policy Study Journal* 39 (1):7-27.

Ostrom, E., Burger, J., Field, C., Norgaard, R. B., and Policansky, D. 1999. Revisiting the commons: Local lessons, global challenges. *Science* 284 (5412):278-282. DOI: 10.1126/science.284.5412.278

Pahl-Wostl, C. 2006. The importance of social learning in restoring the multifunctionality of rivers and floodplains. *Ecology and Society* 11 (1):1-14.

Pahl-Wostl, C., Craps, M., Dewulf, A., Mostert, E., Tabara, D., and Taillieu, T. 2007. Social learning and water resources management. *Ecology and Society* 12 (2):1-19.

Pahl-Wostl, C., Tàbara, D., Bouwen, R., Craps, M., Dewulf, A., Mostert, E., Ridder, D., and Taillieu, T. 2008. The importance of social learning and culture for sustainable water management. *Ecological Economics* 64 (2008):484-495. DOI: https://doi.org/10.1016/j.ecolecon.2007.08.007

Palau-Salvador, G., de Luis, A., Pérez, J. J., and Sanchis-Ibor, C. 2019. Greening the post crisis. Collectivity in private and public community gardens in València (Spain). *Cities* 92:292-302. DOI: https://doi.org/10.1016/j.cities.2019.04.005

Pearson, L. J., Pearson, L., and Pearson, C. J. 2010. Sustainable urban agriculture: Stocktake and opportunities. *International Journal of Agriculture and Sustainability* 8 (1&2):7-19. DOI: 10.3763/ijas.2009.0468

Pieraccini, M. 2015. Democratic legitimacy and new commons: examples from English protected areas. *International Journal of the Commons* 9 (2):552-572. DOI: http://doi.org/10.18352/ijc.509

Poteete, A. R., and Ostrom, E. 2004. Heterogeneity, group size and collective action: the role of institutions in forest management. *Development and Change* 35 (3):435-461. DOI: https://doi.org/10.1111/j.1467-7660.2004.00360.x

Pourias, J., Aubry, C., and Duchemin, E. 2016. Is food a motivation for urban gardeners? Multifunctionality and the relative importance of the food function in urban collective gardens of Paris and Montreal. *Agriculture and Human Values* 33 (2):257-273. DOI: 10.1007/s10460-015-9606-y

Provan, K. G., and Kenis, P. 2008. Modes of network governance: Structure, management, and effectiveness. *Journal of Public Administration Research and Theory* 18 (2):229-252. DOI: https://doi.org/10.1093/jopart/mum015

Ramsten, A.-C., and Säljö, R. 2012. Communities, boundary practices and incentives for knowledge sharing? A study of the deployment of a digital control system in a process industry as a learning activity. *Learning, Culture and Social Interaction* 1 (1):33-44. DOI: https://doi.org/10.1016/j.lcsi.2012.04.001

Randolph, J. 2011. *Environmental land use planning and management*. 2 ed. Washington: Island Press.

Rasouli, A. H., and Kumarasuriyar, D. A. 2016. The social dimention of sustainability: Towards some definitions and analysis. *Journal of Social Science for Policy Implications* 4 (2):23-32. DOI: 10.15640/10.15640/jsspi.v4n2a3

Rasper, M. 2012. *Vom Gärtnern in der Stadt (Urban gardening in cities)*. Munich: Oekom Verlag.

Razmerita, L., and Brun, A. 2011. Collaborative learning in heterogeneous classes. Paper read at he 3rd international conference on computer supported education, May 6-8, at Noordwijkerhout.

Reed, M. S., Evely, A. C., Cundill, G., Fazey, I., Glass, J., Laing, A., Newig, J., Parrish, B., Prell, C., Raymond, C., and Stringer, L. C. 2010. What is social learning. *Ecology and Society* 15 (4):1-10.

Rogge, N., Theesfeld, I., and Strassner, C. 2018. Social sustainability through social interaction—A national survey on community gardens in Germany. *Sustainability* 10 (4):1085. DOI: 10.3390/su10041085

Rogus, S., and Dimitri, C. 2014. Agriculture in urban and peri-urban areas in the United States: Highlights from the census of agriculture. *Renewable Agriculture and Food Systems* 30 (01):64-78. DOI: 10.1017/s1742170514000040

Rosol, M. 2010. Public participation in post-fordist urban green space governance: The case of community gardens in Berlin. *International Journal of Urban and Regional Research* 34 (3):548-563. DOI: 10.1111/j.1468-2427.2010.00968.x

Saldivar-Tanaka, L., and Krasny, M. E. 2004. Culturing community development, neighborhood open space, and civic agriculture: The case of Latino community gardens in New York City. *Agriculture and Human Values* 21 (4):399-412. DOI: 10.1007/s10460-003-1248-9

Schecker, H. 2014. Überprüfung der Konsistenz von Itemgruppen mit Cronbachs a (Testing the consistency of item groups with Cronbachs a). In *Methoden in der naturwissenschaftsdidaktischen Forschung*, edited by D. Krüger, I. Parchmann and H. Schecker. Berlin/ Heidelberg: Springer Spektrum.

Schlager, E., and Ostrom, E. 1992. Property-rights regimes and natural recources: A conceptual analysis. *Land Economics* 68 (3):249-262. DOI: 10.2307/3146375

Schmelzkopf, K. 1995. Urban community gardens as contested space. *Geographical Review* 85 (3):364-381. DOI: 10.2307/215279

Schmitt, N. 1996. Uses and abuses of coefficient alpha. *Psychological assessment* 8 (4):350.

Schnell, R., and Esser, E. 2013. *Methoden der empirischen Sozialforschung (Methods of social research)*. 10 ed. Munich: Oldenbourg Verlag.

Schreier, C. 2018. Erfolgsfaktoren Urbaner Gemeinschaftsgärten – Empirische Analyse im Raum Leipzig (Success factors of urban community gardens - Empirical analysis of community gardens in Leipzig). Unpublished master thesis, Department of Agricultural, Environmental and Food Policy, Martin-Luther-University Halle-Wittenberg, Halle (Saale).

SESMAD. 2014. *Social-ecological systems meta-analysis database: Background and research methods*. Available at: http://sesmad.dartmouth.edu/. [Accessed November 28, 2017]

Simon-Rojo, M., Recasens, X., Callau, S., Duzi, B., Eiter, S., Hernández-Jiménez, V., Kettle, P., Laviscio, R., Lohrberg, F., Pickard, D., Scazzosi, L., and Vejre, H. 2016. From urban food gardening to urban farming. In *Urban agriculture Europe*, edited by F. Lohrberg, L. Lička, L. Scazzosi and A. Timpe. 22-28. Berlin: Jovis Verlag.

Smit, J., Nasr, J., and Ratta, A. 2001a. *Urban agriculture: Food, jobs, and sustainable cities*. Available at: http://jacsmit.com/book.html. [Accessed June 14, 2019]

Smit, J., Nasr, J., and Ratta, A. 2001b. *Urban agriculture: Food, jobs, and sustainable cities. Chapter 1: Cities that feed themselves*. Available at: http://jacsmit.com/book.html. [Accessed June 14, 2019]

Smit, J., Nasr, J., and Ratta, A. 2001c. *Urban agriculture: Food, jobs, and sustainable cities. Chapter 2: Urban agriculture yesterday and today*. Available at: http://jacsmit.com/book.html. [Accessed June 14, 2019]

Smit, J., Nasr, J., and Ratta, A. 2001d. *Urban agriculture: Food, jobs, and sustainable cities. Chapter 3: Who Are the Urban Farmers?* Available at: http://jacsmit.com/book.html. [Accessed June 14, 2019]

Spilková, J. 2017. Producing space, cultivating community: The story of Prague´s new community gardens. *Agriculture and Human Values* 34 (4):1-11. DOI: 10.1007/s10460-017-9782-z

Statistisches Bundesamt. 2019. *Schätzung für 2018: Bevölkerungszahl auf 83,0 Millionen gestiegen (Estimation for 2018: Population increased to 83.0 million)*. Available at: https://www.destatis.de/DE/PresseService/Presse/Pressemitteilungen/2019/01/PD19_029_12411.html. [Accessed March 16, 2019]

Streiner, D. L. 2003. Starting at the beginning: An introduction to coefficient alpha and internal consistency. *Journal of Personality Assessment* 80 (1):99-103. DOI: https://doi.org/10.1207/S15327752JPA8001_18

Tan, L. H., and Neo, H. 2009. Community in Bloom: Local participation of community gardens in urban Singapore. *Local Environment* 14 (6):529-539.

Tidball, K. G., and Krasny, M. E. 2009. From risk to resilience: What role for community greening and civic ecology in cities. In *Social learning towards a sustainable world*, edited by A. E. J. Wals. 149-164. Wageningen: Wageningen Academic Publishers.

Tornaghi, C. 2012. Public spce, urban agriculture and the grassroots creation of new commons: Lessons and challenges for policy makers. In *Sustainable Food Planning*, edited by A. Viljoen and J. S. C. Wiskerke. 349-364. Wageningen: Wageningen Academic Publishers.

Tran, T. A., James, H., and Pittock, J. 2018. Social learning through rural communities of practice: Empirical evidence from farming households in the Vietnamese Mekong Delta. *Learning, culture and social interaction* 16:31-44. DOI: https://doi.org/10.1016/j.lcsi.2017.11.002

UN (United Nations). 2015. Transforming our world: The 2030 Agenda for Sustainable Development. New York.

UN (United Nations). 2018. The Sustainable Development Goals Report 2018. edited by L. Jensen. New York.

UN (United Nations), DESA (Department of Economic and Social Affairs), and Population Division. 2018. *World Urbanization Prospects: The 2018 revision*. Available at: https://esa.un.org/unpd/wup/Download/. [Accessed January 10, 2019]

UNCED (United Nation Conference on Environment and Development). 1992. Agenda 21. New York.

UNCSD (United Nations Comission on Sustainable Development). 2001. Indicators of sustainable development: Framework and methodologies. New York

UNDP (United Nation Development Programme). 2019. *Goal 11: Sustainable cities and communities*. Available at: https://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-11-sustainable-cities-and-communities.html. [Accessed March 14, 2019]

UNESCO (United Nations Educational, Scientific and Cultural Organization). 2008. Links between biological and cultural diversity — Concepts, methods and experiences. Report of the International Workshop. Paris.

United States Census Bureau. n.d. *Quick facts*. Available at: http://www.census.gov/quickfacts/table/PST045215/3651000. [Accessed May 25, 2016]

Vallance, S., Perkins, H. C., and Dixon, J. E. 2011. What is social sustainability: A clarification of concepts. *Geoforum* 42 (2011):342-348. DOI: 10.1016/j.geoforum.2011.01.002

van der Schans, J. W., and Wiskerke, J. S. C. 2012. Urban agriculture in developed economies. In *Sustainable food planning - Evolving theory and practice*, edited by A. Viljoen and J. S. C. Wiskerke. 245-258. Wageningen: Wageningen Academic Publishers.

Varughese, G., and Ostrom, E. 2001. The contested role of heterogeneity in collective action: Some evidence from community forestry in Nepal. *World Development* 29 (5):747-765. DOI: https://doi.org/10.1016/S0305-750X(01)00012-2

Vedeld, T. 2000. Village politics: Heterogeneity, leadership and collective action. *The Journal of Development Studies* 36 (5):105-134. DOI: https://doi.org/10.1080/00220380008422648

Vejre, H., Eiter, S., Hernández-Jiménez, V., Lohrberg, F., Loupa-Ramos, I., Recasens, X., Pickard, D., Scazzosi, L., and Simon-Rojo, M. 2016. Can agriculture be urban? In *Urban agriculture Europe*, edited by F. Lohrberg, L. Lička, L. Scazzosi and A. Timpe. 18-21. Berlin: Jovis Verlag.

Vejre, H., and Simon-Rojo, M. 2016. Introduction. In *Urban agriculture Europe*, edited by F. Lohrberg, L. Lička, L. Scazzosi and A. Timpe. 16-17. Berlin: Jovis Verlag.

Wals, A. E. J., and Leij, T. v. e. 2009. Introduction. In *Social learning towards a sustainable world - Principles, perspectives and praxis*, edited by A. E. J. Wals. 17-32. Wageningen: Wageningen Academic Publishers

WCED (World Commission on Environment and Development). 1987. *Our common future*. New York: Oxford University Press.

Wenger, E. 1998. *Communities of practice. Learning, meaning and identity*. Cambridge: Cambridge University Press.

Wenger, E. 2010. Communities of practice and social learning systems: the career of a concept. In *Social learning systems and communities of practice*. 179-198. London, UK: Springer.

Winkler, B., Maier, A., and Lewandowski, I. 2019. Urban gardening in Germany: Cultivating a sustainable lifestyle for the societal transition to a bioeconomy. *Sustainability* 11 (3):1-22. DOI: https://doi.org/10.3390/su11030801

Wolch, J. R., Byrne, J., and Newell, J. P. 2014. Urban green space, public health, and environmental justice: The challenge of making cities 'just green enough'. *Landscape and Urban Planning* 125:234-244. DOI: 10.1016/j.landurbplan.2014.01.017

Wright, E. O. 1993. Explanation and emancipation in marxism and feminism. *Sociological Theory* 11 (1):39-54. DOI: 10.2307/201979

Wright, E. O. 2006. Compass points. Towards a socialist alternative. *New Left Review* 41:93-124.

Yoo, C., and Lee, S. 2016. Neighborhood built environments affecting social capital and social sustainability in Seoul, Korea. *Sustainability* 8 (12):1-22. DOI: 10.3390/su8121346

Appendix

Data CD:

A. Questionnaire
B. Codebook
C. DATA (Excel Map)
   - Table S1: Data and analysis of the variable collective use
   - Table S2: Data and analysis of the variable rule set and design
   - Table S3: Data and analysis of the variable monitoring and sanctioning
   - Table S4: Data and analysis of the variables and criteria that determine social sustainability
   - Table S5: Data and analysis of the variable participants' perspective on success
   - Table S6: Data and analysis of the variable complaints
   - Table S7: Data of variables affecting social sustainability
   - Table S8: Data and analysis of the variable heterogeneity of the community

Nicole Rogge, M.Sc.

Date of birth: 30.01.1988 in Merseburg, Germany

ACADEMIC BACKGROUND

May 2015 to February 2020	**PhD Student at Martin-Luther-University Halle-Wittenberg (MLU), Institute of Agriculture and Nutritional Science, Department of Agricultural, Environmental, and Food Policy and Münster University of Applied Sciences (FH Münster), Department of Food · Nutrition · Facilities** PhD Thesis: Collective Action Theory and Urban Gardens Supervisors: Prof. Dr. Insa Theesfeld (MLU), Prof. Dr. Carola Strassner (FH Münster) Doctoral Studies Program at Münster University of Applied Sciences
October 2011 to August 2014	**Master of Science in Sustainable Services and Nutrition Management, Münster University of Applied Sciences, Department of Food · Nutrition · Facilities** Thesis Title: Urban Gardening at the Leonardo-Campus Münster - Systematic Literature Analysis, Organisation, Realisation, and Documentation of an Urban Community Garden
October 2008 to May 2011	**Bachelor of Science in Home Economics and Nutrition Science, Anhalt University of Applied Sciences, Bernburg** Thesis Title: Analysis of Food Security Situation in India by Using International Assessment Methods

WORK AND RESEARCH EXPERCIENCE

January 2017 to January 2019	**Research Assistant at Münster University of Applied Sciences, Department of Food · Nutrition · Facilities** Teaching Bachelor and Master Level Courses, Supervision of Bachelor and Master Theses
March 2014 to February 2015	**Tutor at Münster University of Applied Sciences, Department of Food · Nutrition · Facilities**

PUBLICATIONS

Rogge, N. (2015). Urban Gardening Am Leonardo-Campus in Münster: Organisation, Durchführung Und Dokumentation eines Urbanen Gemeinschaftsgartens (Urban Gardening at the Leonardo-Campus Münster: Organization, Implementation, and Documentation of an Urban Community Garden). Saarbrücken: Akademiker Verlag.

Theesfeld, I., & Rogge, N. (2017). The Role of Regional Identity in Urban Agriculture. Schriften der Gesellschaft für Wirtschafts- und Sozialwissenschaften des Landbaus e.V., Band 52, Landwirtschaftsverlag: 415-416.

Rogge, N., & Theesfeld, I. (2018). Categorizing urban commons: Community gardens in the Rhine-Ruhr agglomeration, Germany. International Journal of the Commons, 12(2), 251-274.

Rogge, N., Theesfeld, I., & Strassner, C. (2018). Social Sustainability through Social Interaction—A National Survey on Community Gardens in Germany. *Sustainability, 10*(4), 1085.

Rogge, N., Theesfeld, I., & Strassner, C. 2020. The potential of social learning in community gardens and the impact of community heterogeneity. Learning, Culture and Social Interaction 24 (2020). https://doi.org/10.1016/j.lcsi.2019.100351Feinberg, A., Hooijschuur, E., Rogge, N., Herder, P., Künneke, P., & Ghorbani, A. Sustaining Collective Action in Community Gardens. Prepared for submission in the Journal of Artificial Societies and Social Simulation.

CONFERENCE PRESENTATIONS

Rogge, N. Categorizing Urban Commons – Collective Action in Urban Gardens. 1st IASC Thematic Conference on Urban Commons: The City as A Commons - Reconceiving Urban Space, Common Goods And City Governance. Bologna, 6-7 November 2015.

Rogge, N. Urban Gardens as Commons - A Typology for Self-Governed Food Production Networks. XVI Biennial Conference IASC: Practicing the Commons: Self-Governance, Cooperation, and Institutional Change. Utrecht, 10-14 July 2017.

Rogge, N. Right to the City: Community Gardens as Commons. Grüne Liga e.V. Urban Farming Conference. Berlin, 11-13 September 2017.

Rogge, N. Collective Action Theory and Urban Gardens: A German-wide Study on Community Gardens Collective and Social Actions. Joint PhD Seminar of Leibnitz Institute of Agricultural Development in Transition Economies and Institute of Agricultural and Food Science – Agricultural Economics' Chairs. Halle, 29th January 2019.

Eidesstattliche Erklärung / Declaration under Oath

Ich erkläre an Eides statt, dass ich die Arbeit selbstständig und ohne fremde Hilfe verfasst, keine anderen als die von mir angegebenen Quellen und Hilfsmittel benutzt und die den benutzten Werken wörtlich oder inhaltlich entnommenen Stellen als solche kenntlich gemacht habe.
I declare under penalty of perjury that this thesis is my own work entirely and has been written without any help from other people. I used only the sources mentioned and included all the citations correctly both in word or content.

Berlin, 03.03.2020
Nicole Rogge