

Contributions of allotments to food security and urban resilience

A case study in Hamburg, Germany

Anja Winkler

Degree project • 30 credits Swedish University of Agricultural Sciences, SLU Faculty of Natural Resources and Agricultural Sciences Sustainable Development – Master's Programme Uppsala 2025

Contributions of allotments to food security and urban resilience. A case study of Hamburg, Germany

Anja Winkler

Supervisor:	Michael Jones, Swedish University of Agricultural Sciences, Department of Urban and Rural Development
Examiner:	Malin Beckman, Swedish University of Agricultural Sciences, Department of Urban and Rural Development

30 credits				
Second cycle, A2E				
Independent project in Sustainable development, A2E – Masters Programme Sustainable Development				
EX0901				
Sustainable Development – Master's Programme				
Department of Aquatic Science and Assessment				
Uppsala				
2025				
All featured images are used with permission from the copyright owner.				
https://stud.epsilon.slu.se				

Keywords:

allotments, food security, urban resilience

Swedish University of Agricultural Sciences

Faculty of Natural Resources and Agricultural Sciences Department of Urban and Rural Development

Abstract

As having possibilities for local food production and storage is known to foster food security in urban settings, this thesis explored contributions of an allotment site in Hamburg, Germany, to food security and urban resilience. For this, the following two research questions were formulated: What are the legal structures governing the use of allotments in Hamburg, Germany on food security and urban resilience and how are they perceived? And how does an allotment garden in Hamburg, Germany contribute to the food security of its members and to urban resilience? To answer these, a systematic review of policy documents and semi-structured interviews with eight allotment gardeners were carried out. This thesis identified 17 governance documents for allotments in Hamburg across different levels. In these, German allotments are positioned in way that eliminates challenges community gardens often face in the US and, but the recognition given to allotments fails to acknowledge the full scope and multitude of ES produced by allotments. The interviews revealed that gardeners had an increased food availability, awareness of food sources, utilization of fresher and higher-quality produce, and practices like preserving surplus food. They further showed that allotments contribute to urban resilience through several mechanisms aligned with resilient ES management principles, where diversity and redundancy are maintained, reinforcing and dampening feedbacks are actively managed, and learning and experimentation are enabled. Also, gardeners were aware of the governing documents that directly mention allotments, appreciated specific regulations, and voiced only three changes to the regulations imposed on allotment gardening.

Keywords: allotments, food security, urban resilience

Table of contents

List	of tables	6
List	of figures	7
Abbi	reviations	8
1.	Introduction	10
1.1 1.2	Aim and research questions	11
2.	Background	13
2.1 2.2	The 21 st centuries food system and urban food supply Allotments	13 15
2.3	Case Study Site	16
2.4	Previous studies in the field	17
	2.4.1 Allotments and food security	17
	2.4.2 Allotments and urban resilience	. 19
		20
3.	Theory	23
3.1	Resilience of social-ecological systems in an urban context	23 24
3.3	Food Security	24
4.	Methods	29
4.1	Methodological Background	29
	4.1.1 Systematic reviews	29
	4.1.2 Semi-structured interviews	30
4.2	Systematic review of governance structures	30
4.3	Semi-structured Interviews with allotment gardeners	31
	4.3.1 Interview design	31
	4.3.2 Data collection and analysis	32
4.4	Positionality	33
4.5	Ethical considerations	33
5.	Results	34
5.1	Governance structures of allotments in Hamburg	34
5.2	Perceived contributions of allotments to food security and urban resilience	38

	5.2.1 General information of the respondents and their allotment	.38			
	5.2.2 Food security	. 39			
	5.2.3 Urban resilience	.42			
6.	Discussion	.49			
6.1	Systematic review of governance structures	.49			
6.2	Contributions of allotments to food security	. 50			
6.3	Contributions of allotments to urban resilience	. 52			
	6.3.1 Maintain diversity and redundancy	.53			
	6.3.2 Manage slow variables and feedbacks	.54			
	6.3.3 Foster an understanding of SES as CAS	. 55			
	6.3.4 Encourage learning and experimentation	. 56			
	6.3.5 Broaden participation	. 57			
	6.3.6 Higher levels of governance	. 59			
6.4	Limitations	.60			
7.	Conclusion	.61			
Refer	rences	.63			
Popu	lar science summary	.70			
Ackn	owledgements	.71			
Appe	Appendix 172				
Appe	ndix 2	.74			

List of tables

Table 1: The used principles for enhancing resilience of ecosystem services in social-
ecological systems, derived from Biggs et al. (2012) and Stockholm Resilience
Centre (2015)24
Table 2: The dimensions of food security, adapted from FAO (2008)
Table 3: Summary of found documents that govern allotments, their date and date of the
latest reform, scale, type of governance, and content
Table 4: Date, location, interview duration and time of plot lease of the interview
respondents
Table 5: Summary of findings regarding food access, availability, utilisation, and quality39
Table 6: Summary of findings regarding urban resilience, structured by the principles for
resilient ecosystem service management42

List of figures

Figure 1: Allotment site of the Gartenfreunde Volkspark e.V., Source: Google maps......17

Abbreviations

BaumschutzVO	Verordnung zum Schutz des Baumbestandes und der					
	Hecken in der Freien und Hansestadt Hamburg (Engl.:					
	Ordinance on the protection of trees and hedges in the					
	Free and Hanseatic City of Hamburg)					
BBodSchG	Bundesbodenschutzgesetz (Engl.: Federal soil protection					
	law)					
BKD	Bundesverband der Kleingartenvereine Deutschlands					
	(Engl.: Federal association of allotment garden					
	associations in Germany)					
BKleinG	Bundeskleingartengesetz (Engl: Federal allotment					
	garden law)					
BNatSchG	Bundesnaturschutzgesetz (Engl.: Federal Nature					
	Conservation Act)					
CAS	Complex adaptive systems					
DüngG	Düngemittelgesetz (Engl.: Fertiliser Act)					
ES	Ecosystem services					
GPP	Good professional practice					
HmbAbwG	Hamburgisches Abwassergesetz (Engl.: Hamburg					
	Wastewater Act)					
HmbBNatSchAG	HamburgischesGesetztzurAusführungdesBundesnaturschutzgesetzes(Engl.: Hamburg Act on the					
	Implementation of the Federal Nature Conservation Act)					
HWaG	Hamburgisches Wassergesetz (Engl.: Hamburg Water					
	Act)					
KSG	Bundesklimaschutzgesetz (Engl.: Federal Climate					
	Protection Act)					
LFGB	Lebens- und Futermittelgesetzbuch (Engl.: Food and					
	feed law)					
LGH	Landesbund der Gartenfreunde in Hamburg (Engl:					
	Regional Association of Gardening Friends in Hamburg)					
LHM	Merkblatt zur Heckenpflege (Engl.: Leaflet on hedge					
	maintenance)					

LUAG	Merkblatt zur Nutzung von Kleingärten in Hamburg
	(Engl.: Leaflet on the use of allotment gardens in
	Hamburg)
LUWW	Merkblatt über die Nutzung von Wasserversorgungs-
	und Abwasserbeseitigungsanlagen auf
	Kleingartenparzellen (Engl.: Information sheet on the
	use of water supply and waste water disposal facilities
	on allotment garden plots)
NAP	Aktionsplan zur Nachhaltigen Anwendung von
	Pflanzenschutzmitteln (Engl.: Action Plan for the
	sustainable use of plant protection products)
PflSchG	Gesetz zum Schutz der Kulturpflanzen (Engl.: Law on
	the protection of cultivated plants)
SES	Social-ecological systems
UA	Urban agriculture
WHG	Gesetz zur Ordnung des Wasserhaushalts (Engl.: Law on
	the organisation of the water balance)

1. Introduction

Large cities typically rely on the global food system of industrial agriculture, to feed more than half of the global population (World Bank, 2023). This dependency will only increase as in 2050 the urban population is expected to double compared to its current size (*ibid*.). Urban spaces are already hotspots of intense resource use (Doernberg et al., 2019) and their high demand for food is a major driver to the industrialisation and intensification of conventional agriculture (Barthel and Isendahl, 2013; Benton et al., 2021; Gladek et al., 2017; Ritchie et al., 2022). Cities use around 2 % of the global land area (BMUB, 2015) while 90 % of them are located on coastlines, leaving more than half of the global population to be increasingly exposed to climate change (Elmqvist et al., 2019; UN Atlas of the Ocean, 2016). This illustrates the urgent need for transformative action towards a development that is climate-resilient (United Nations, 2023a). In times of increasing disturbances, threats, and uncertainty, resilience and buffering capacities for food security and cities must be fostered (Berkes et al., 2002; Colding et al., 2020; Steffen et al., 2015). As humanity has stepped into the urban century, overcoming sustainability issues across urban areas is increasingly critical for a sustainability transformation of the whole planet (Elmqvist et al., 2019).

For people living in cities, food security was always regarded as a key resilience feature (Barthel and Isendahl, 2013) and food security is again gaining recognition as a problem facing urban populations (Burton et al., 2013). Issues of food security, food sovereignty, and the potential of urban food are increasingly gaining an urban dimension (Burton et al., 2013; Hebinck et al., 2021). Due to the massive consumption of resources in cities, questions of food production and consumption are now directly linked to sustainable development and food security in urban areas (Doernberg et al., 2019). Meeting these challenges, while urbanization continues to accelerate, will require transformative solutions to shape the earth's system dynamics and biosphere in a sustainable way (Elmqvist et al., 2019).

One way of urban agriculture (UA), which concerns the production of food in and around cities, are allotments (Hawes et al., 2024). According to the German Federal Allotment Garden Law (BKleinG, German: Bundeskleingartengesetzt), allotments are defined as "a garden which serves the user for non-commercial use [...] and for recreation while being situated in an area in which several individual gardens

are grouped together with communal facilities" (Bundestag, 2006, para. 1). In the German political dialog, they are presented primarily for their positive contribution to biodiversity and their social benefits, see for example BUMB (2015), even though evidence suggests that UA has the potential to play a role in improving food security in cities and strengthening urban resilience in a changing climate (Burton et al., 2013).

While there is a growing body of international research on urban food security, including some focus on Germany, allotments remain underrepresented within this field, see for example Kotsila et al. (2020), Sanz Sanz et al. (2023), or Wittenberg et al. (2022). This study addresses this gap by examining one urban allotment in Hamberg, Germany, as a case study. It furthermore contributes to the need for empirical assessments of the contributions of allotments to food security, that is stated by CoDyre et al. (2015).. By assessing the contributions of allotments to food security, thus study addresses this knowledge gap and also responds to recent calls for exploring and evaluating policy instruments and their interactions with urban food practices, particularly in German cities (Doernberg et al., 2019; Hebinck et al., 2021). By focusing on one allotment, this study provides insights into place-specific challenges and sources of resilience, which are further gaps identified by literature, see Hebinck et al. (2021) and (Barthel and Isendahl 2013).

1.1 Aim and research questions

Considering the presented research gaps, the aim of this thesis project is set out to explore one urban allotment in Hamburg, Germany, as a case study to investigate urban resilience and food security issues. To achieve this, the following research questions are formulated:

1) What are the legal structures governing the use of allotments in Hamburg, Germany on food security and urban resilience and how are they perceived?

2) How does an allotment garden in Hamburg, Germany contribute to the food security of its members and to urban resilience?

1.2 Delimitations

This thesis only aims to gain data and knowledge about one allotment garden club from Hamburg. The results of the thesis are thus not generalisable and only speak for this specific context. Furthermore, food security is explored by utilising three of the four dimensions of food security outlined by FAO (2008). Food security is not assessed over time due to the time frame of the thesis project.

This study also examines the contributions of allotments to urban resilience, but does so by using the principles for resilient ecosystem service (ES) management by Biggs et al. (2012) and the Stockholm Resilience Centre (2015). and their contributions to food security, as it is an important resilience facet of cities. The empirical data regarding urban resilience is furthermore focused on interviews conducted with allotment gardeners, meaning the analysis is limited to the factors and themes that emerged from those interviews. For example, while infrastructure or water management are important aspects of urban resilience, they were not themes that arose during the interviews with allotment gardeners. Therefore, the thesis does not assess other resilience factors that were not directly discussed by the study participants. This targeted approach allows for an in-depth exploration of the generation of ES in the allotment garden context, but also means that the findings may not capture the full breadth of how allotments could contribute to overall urban resilience.

2. Background

This chapter will provide more information on production of food with industrial agriculture and the provision of food within cities. This is followed by a presentation of allotments and a description of the research location. Lastly, previous studies on allotment gardens will be reviewed.

2.1 The 21st centuries food system and urban food supply

The potential or UA to avoid social and environmental externalities of global food production is generally not considered in urban planning (Langemeyer et al., 2021). The recent COVID-19 pandemic was a first push to revive the debate over vulnerabilities of the current food and urban system, which in turn have also brought increased awareness to the issue of food security and urban resilience (Haysom and Battersby, 2023; Manikas et al., 2023). It also suggests that food and agriculture must resurface in urban policy making and planning, after being only marginally present in the recent past (Doernberg et al., 2019; Sieveking, 2021). Food and agricultural production should not be viewed as the counterpart to cities or non-urban as they have been for decades, but rather as an urban activity, that contributes to their resilience (Barthel and Isendahl, 2013; Doernberg et al., 2019).

Germany relies on food imports to feed its citizens and spent in 2020 alone 95 billion USD on imports of food products (Jumle, 2022). 80 % of all imports were from EU-countries and the biggest exporters to Germany in 2020 were the Netherlands, Italy and Poland (Jumle, 2022). Germany is generally regarded as food secure, as less than 1 % of the German population was unable to afford a healthy diet in 2020 and over 40 % of adults in Germany are obese and overweight, the prevalence for obesity in Germany was higher than 56 % in 2016 (GAFS, 2023). From 2020 to 2022 only 3.8 % of the German population, about 3.2 million people, were moderately or severely food insecure (GAFS, 2023). This also goes for the (near) future, as an EU environment agency report found that for countries with high average per capita income and located in temperate climate zones the overall impact of threats are small (Sundström et al., 2014).

Cities become complex and resilient, as many have existed for thousands of years and overcome disasters (Elmqvist et al., 2019). However, the context of the Anthropocene will bring new challenges and risks, as cities are now increasingly vulnerable to supply chain disruptions, extreme weather events, and temperature changes (Elmqvist et al., 2019). Large cities have relied on the global food system to consume foodstuff from far-flung areas of the planet (Barthel and Isendahl, 2013), so that food processing and agriculture within or close to cities have lost their importance for urban development (Doernberg et al., 2019). Distant food supplies can lead to reduced vulnerability to food shortages and increased resilience in times of moderate crises, but interruptions in supply lines now threaten urban food security (Barthel and Isendahl, 2013; Langemeyer et al., 2021).

UA encompasses the production of food in urban areas, waste management, and systems of food processing, distribution, and sale (Burton et al., 2013). The different urban food systems, and different city types, are the main reason that cities have persisted for so long (Barthel and Isendahl, 2013). For example, during the 1900s and the two World wars, the number of urban gardens increased significantly in western Europe, as they were responsible for feeding millions of people by providing food independently (Barthel and Isendahl, 2013; Colding and Barthel, 2013; Kolbe, 2022). Early advocacy work regarding community gardens has often been formulated as way for low-income residents and minorities to access local, healthy, fresh, and affordable food (Kotsila et al., 2020). And while it provides a foundation for livelihoods and food security for the urban poor, it has also become a cultural-political form of expression and land use that promotes environmental education, social cohesion, and recreation (Langemeyer et al., 2021). Urban food is able to increase access to food and connect resource flows, which can in turn increase self-sufficiency and circularity of urban systems (Hebinck et al., 2021).

Now, urban gardens stand as symbols of a local way of improving urban life in terms of greening, sustainable conscious communities, and food provision (Kotsila et al., 2020), and counteract the vanishing of skills and spaces relating to water and food management (Barthel and Isendahl, 2013). The resurgence of urban gardens during the last decades has led to a transformation from redeveloping vacant plots during periods of war, crises, and suburbanisation to widespread and well-established practices of reforming urban landscapes and sustainability practices (Kotsila et al., 2020). They also increased in popularity during the COVID-19 pandemic and in many European cities, allotments are now mainly used for recreation and the experience of gardening (Dietrich, 2014). However, allotments could quickly be transformed for UA practices in times of crisis, for example by dedicating more parts of plots to food production, thereby preserving adaptive capacities (Langemeyer et al., 2021). This is relevant to all German allotments, as

not the complete allotment space is currently used for UA and the space that is used for food cultivation may not be utilised effectively.

Urban food is often viewed in the literature as a transformative lever for sustainability and it's potential for sustainable development is recognised due to its multifunctionality and reach into other domains (Doernberg et al., 2019; Hebinck et al., 2021). However, there are also risks connected to for example investments in specific food systems, as such short-term efforts for sustainability may be bad for the overall resilience of the system, or might even lead to a reinforcement of reinforcing feedback loops, compromising long-term resilience (Elmqvist et al., 2019). In the current state of the world we need to transform, and particularly urban structures need to be transformed in a way that maintains their functions under new conditions (Elmqvist et al., 2019). The potential ways to build cities that are more ecologically compatible are determined by many local factors such as the socio-economic history, ecological conditions, cultural contexts and institutional path dependency (Colding et al., 2020).

2.2 Allotments

There are more than 1 million allotments in Germany, about 3 million allotments are estimated for total Europe, taking up more than 460 km² of land (BMUB, 2015; Colding and Barthel, 2013; Dietrich, 2014). Most of them are organised in clubs and follow local and national association regulations and laws that determine the plot management (BMUB, 2015; Colding et al., 2022a). According to the BKleinG, allotment gardening is a form of a collective, green-space management (Bundestag, 2006). An allotment garden club contains multiple plots of equal size on land often owned by municipalities, which are typically located on public land or vacant plots and thus make them vulnerable to displacement initiated by economic developments of the land (Colding and Barthel, 2013; Delshad, 2022). Allotment clubs typically offer fixed numbers and sizes of plots, in combination with a membership fee, where plots are typically leased for a long time (Colding et al., 2022a). Overall, allotments are well managed sites planted with trees, bushes, and flowers that provide the plot holders with fruit, vegetables and flowers and assuming that 1/3 of each allotment is used to for food production, allotments offer around 15.000 ha for the cultivation of food in Germany (Colding and Barthel, 2013; Kowarik et al., 2016). The average waiting period for an allotment in Hamburg is around 5 years and the nationwide rent has been constant at $0.18 \in$ per m^2 per year, resulting in an annual rent of around 66 \in for a plot with 370 m^2 (Rekowski, 2024). However, German allotments now struggle with a differentiated demand, where demand increases in growing and large cities but declines in shrinking and structurally weak regions (Bundesinstitut für Bau-, Stadt- und Raumforschung, 2019). This increases the already existing structural vacancy of allotment gardens in these weak regions, leading to ca. 65.000 vacant allotments plots in Germany (*ibid*.).

Allotments are a part of urban green commons, where "individuals and interest groups participating in management hold a rich set of bundles of rights" (Colding and Barthel, 2013, p. 159). Critical bundles of rights that participants in urban green commons possess are access and withdrawal rights, management rights, and sometimes also exclusion rights (Colding and Barthel, 2013). Urban green commons are furthermore key institutions for regulating societal and natural resources in cities and their key governance features are democratic influence, common participation, and social mobilisation (Colding et al., 2022a). Reasons for participating are typically not a dependency on the gardens for one's livelihood, but rather reasons such as being in contact with nature, partaking in social activities, having an interest in gardening (Colding et al., 2022b), even though German population groups also depend on food that is either provided for free or little money (Augustin and Rosol, 2023). The gardens are also sources of ES across city neighbourhoods (Egerer et al., 2020). As allotments can be harnessed for nature conservation efforts (Colding et al., 2020), it is no surprise that prominent values in urban community gardens are learning, sharing, and creating with nature (Kotsila et al., 2020).

2.3 Case Study Site

The Free and Hanseatic Hamburg is the second largest German city with over 1.8 million inhabitants and is located in northern Germany. Hamburg is one of Germanys three city-states, meaning it is a recognised federal state that consists of only one city. It also hosts one of Europe's biggest harbours, the Hamburger Hafen (Schafiyha and Knupp, 2023), which in 2016 was responsible for handling over 25 million tons of agricultural products and foodstuffs, representing around 18 % of its throughput (Port of Hamburg, 2017).

The city district Wandsbek is the second largest of Hamburg's seven main boroughs. It is located in the northeast of Hamburg (Harms and Schubert, 1989) and is its most populous district with more than 420.000 residents (Hamburg.de, 2023). In 1937 the city of Wandsbek joined the city of Hamburg through the Greater Hamburg Act, which brought several neighbouring municipalities under Hamburg's jurisdiction and greatly expanded the city's site and influence (Röpke, 1994). Today, the district is still characterised by its many woodlands, parks, and meadows and village-like neighbourhood (Hamburg.de, 2023) and hosts around 6.900 plots (BV HH, n.d.) of Hamburg's currently more than 33.000 allotments (Hamburg.de, n.d.). The allotment club in which the interviewees have an allotment plot is the Gartenfreunde Volkspark e.V., mapped in Figure 1, containing a little less than 200 plots. It is located next a water retention basin and small stream, the Osterbek, that connects to Hamburg's harbour.



Figure 1: Allotment site of the Gartenfreunde Volkspark e.V., Source: Google maps

2.4 Previous studies in the field

There is a broad field of scientific literature that assesses allotments and community gardens and the following subchapters explore previous studies in the field, as well as current policy and legislation referring to food security and urban resilience.

2.4.1 Allotments and food security

Allotments are an aspect of the European urban landscape and have historically ensured food security in times of crisis (Barthel and Isendahl, 2013; Colding et al., 2022a). They have also been a feature of German cities for more than 120 years and have played an important role in securing and improving access to food during both world wars and in the former East Germany (Dietrich, 2014; Kolbe, 2022). They are thus key for the long-term resilience of cities, as they provide significant capacity for close-by food production and diversify food resources (Barthel and Isendahl, 2013). Consequently, possibilities for local food and water production close to consumers support food production at multiple levels of social organisation and foster food security in urban settings (Barthel and Isendahl, 2013). Another

fundamental aspect of urban food security are grassroot knowledge and citizen participation in agriculture, which should spread across generations and between people within the food network (Barthel and Isendahl, 2013).

Allotments can be viewed as a type of urban food practice, which were found to enhance circularity by connecting flows of resources related to food, increase ecological resilience by producing and processing food more sustainably, increase the regional self-sufficiency of food, connect people to nature, and increase food chain equity (Hebinck et al., 2021). Gardens managed by communities also showed high processes and outcomes for reclaiming or recreating urban space and an increased (re-)connection to nature (ibid). Through their potential to supply populations with food, urban community gardens also contribute to the supply services of urban ecosystems (Kliem and Kulmann, 2022) and provide gardeners with an increased access to fresh foods (Guitart et al., 2012). Allotments also increase awareness of the origin and quality of fresh produce, and encourage working with others in producing, processing, and sharing local food, by using otherwise often thrown away products (Burton et al., 2013). They also reestablish the connection between urban residents and their life-support systems and act to reverse the vanishing of spaces for UA (Barthel and Isendahl, 2013). A revisioning of cities as places to grow food would also help to balance the trade-off between "short term efficiency and long-term resilience" (Barthel and Isendahl, 2013, p. 230) that urban spaces are caught in regarding food supply and security. However, a "glorification of urban (micro-) agriculture" (Augustin and Rosol, 2023, p. 7p) must be avoided and urban gardens and gardeners should not be considered as substitutes for social security that otherwise secure food access (Augustin and Rosol, 2023).

When comparing conventional agriculture with forms of urban food production in terms of greenhouse gas emissions, the former outperformed allotments when comparing the emissions per serving, also in Germany (Hawes et al., 2024). However were gardeners, who were around ³/₄ self-sufficient in summer and autumn and around ¹/₄ in the winter and spring months, able to reduce their annual CO₂ emissions by about 10 %, by e.g. consuming seasonally and reducing transport routes (Kliem and Kulmann, 2022). Generally, the agricultural use of urban spaces supports the local generation of food and thus reduces the costs of fossil fuel based transports (Burton et al., 2013; Colding and Barthel, 2013). Proposed measures to support UA are to increase transportation fees so that food produced in close proximity is favoured (Barthel and Isendahl, 2013) and, to make allotments able to compete with conventional agriculture, investments in infrastructure lifespan, a reuse of urban wastes as inputs, and maximised social benefits, like diets, networks, and education, are recommended (Hawes et al., 2024).

Assessments of self-sufficiency degrees for Hamburg city regions have presented a considerable potential for self-sufficiency, dependent on diet composition (meat vs. plant based) and available agricultural land (Joseph et al., 2019). In the data gathering, also a global increase in farms, land, research funding, and market for organic products was found (ibid.). This ties in with the identified wish of German consumers to buy seasonal and local products and the steady increase of direct selling locations of local farmers over the last years (*ibid*.). Private or communal gardens where not included in the analysis, but recognised for their ability to grow food. An assessment of the potential of allotments in two German cities presented however that Stuttgart's 3.005 allotments are able to cover the yearly demand of vegetables, potatoes, and herbs of 28.000 people (Kliem and Kulmann, 2022). Thus, showing that one allotment in Stuttgart would be able to feed more than nine people regarding the outlined demand (ibid.). This potential of urban gardens to feed city residents was also backed up by results from Canada, where harvest results of home gardeners were extrapolated to city level and were found to be able to produce enough food to sustain 2.900 people (CoDyre et al., 2015).

2.4.2 Allotments and urban resilience

Besides increasing food security, allotments have benefits that are highly important for increasing urban resilience, such as adaptation to extreme weather events and bettering human well-being (Barthel and Isendahl, 2013; Colding et al., 2020; Langemeyer et al., 2021). They also increase social resilience, contribute to neighbourhood cohesion, and help with identification with and integration into cities (BMUB, 2015; Dietrich, 2014; Hebinck et al., 2021). Furthermore, they contribute to urban greenery (BMUB, 2015), quality of life (Dietrich, 2014) and are a source of leisure for urban citizens (Dietrich, 2014; Hebinck et al., 2021; Langemeyer et al., 2021). Allotment gardens contribute to food production, food resilience, biodiversity, diversification of urban food sources, water purification, and promote pollination (Colding et al., 2022a, 2022b; Dietrich, 2014; Langemeyer et al., 2021).

Through these contributions and benefits, they support resilience and adaptation towards climate change, also in the wider society (Burton et al., 2013; Colding et al., 2022a, 2020; Dietrich, 2014). Allotments are also critical for transmitting and retaining collective memories of food growth and ecosystem management (Colding and Barthel, 2013; Dietrich, 2014) and are a place of holistic learning for gardening, self-organisation, social entrepreneurship, and urban space politics (Colding et al., 2022a). Through diversifying the city landscape, more people are being involved in designing and managing hybrid infrastructures, which increases the pool of knowledge, resources, and competencies available (Andersson et al., 2022). Allotment gardens also contribute to environmental learning and provide learning

areas for climate-change adaptation and mitigation (Colding et al., 2022a). Experiences in nature decrease stress of urban life and support wellbeing in times of crisis (Colding et al., 2022b), such as the COVID-19 pandemic and thus show their importance in the "release and reorganisation phases of the adaptive renewal cycle"(Colding and Barthel, 2013, p. 162).

UA supply ES to cities and enhance global sustainability by building up urban resilience, but UA land use is under normal circumstances not prioritised in urban areas (Langemeyer et al., 2021). It however drastically increases in times of crisis and is, in the global north, often motivated by a desire to "counteract global dependencies, to gain control of food production capacities and foster local networks towards societal change and resilience" (Langemeyer et al., 2021, p. 2). The lack of importance of UA for urban resilience can be attributed to the limited recognition of environmental and social vulnerabilities and risk-related inequalities of urban inhabitants, the neglect of the increased negative environmental externalities caused by global food production, and the lack of consideration of the multifunctionality of UA and the multiple benefits it offers beyond the provision of food (Langemeyer et al., 2021). The view of urban gardening as marginal preoccupation of land will hinder any significantly contribute to urban resilience (Burton et al., 2013).

2.4.3 Governance of allotments

As ecosystems rely on continuous management, there must be locally adapted institutions that allow for and determine what types of ecological management inputs are warranted at particular sites or locations in cities (Colding et al., 2022b). A crucial part of the design process of urban gardening sites are institutional components, property rights rules, local norms, and social networks (Colding et al., 2022b). However, urban gardens are often located in a challenging position within the urban landscape, where they are recognised in terms of increasing food sovereignty, security, social empowerment, and greening cities, but struggle under the goals preferred by urban policies and are not organised enough to influence the policy on which they might depend (Kotsila et al., 2020). Across Europe, more than 250 urban gardens were initiated or supported by local governments at the municipal level, from which the majority was followed up with a co-governance model that split responsibilities and provided the gardens with land, funding, or technical support (Kotsila et al., 2020). Findings from the US suggest that municipal governments often impede the success of community gardens by having expensive plot fees and water access, exclusive plot fee structures, no secure and long-term land access, and a lack of administrative support and consistency (Delshad, 2022). In New Zealand and Germany, political and administrative barriers and enablers of community garden regarded local administration and

government, land tenure and land use, and policies, politics, and practices (Wesener et al., 2020).

Allotments have a quite rigid institutional and organisational structure, probably due their long-term ties with governments and the experience of organising themselves through more than one cycle of economic depression and hunger (Colding and Barthel, 2013). In allotment gardens, the allotment clubs and associations determine and enforce their own rules, which must comply with country law which are often effectively enforced by social pressure (*ibid*.). The organisation of the clubs is in Germany based on voluntary work, which requires board members to invest personal commitment and huge amounts of free time (Bundesinstitut für Bau-, Stadt- und Raumforschung, 2019).

Institutions in German urban greenery are the European Commission, the German federal government, its federal states, cities, and municipalities (BMUB, 2015). Food policy and policy activities are however fragmented and often the result of initiatives by individuals in administration (Doernberg et al., 2019). Especially in large German cities, integrated urban food policies and implementation through urban planning strategies still rare (*ibid.*) and there is currently no legislation that explicitly addresses urban food security or resilience. They are only indirectly addressed though the sustainable development goals (SDGs), the climate adaption act (KAG), and the Food, Commodities and Feed Act (LFGB).

The Sustainable Development Goals (SDGs) include food security in Goal 2: "End hunger, achieve food security and improved nutrition and promote sustainable agriculture", urban resilience in Goal 9: "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation", and urban food security in Goal 11: "Sustainable cities and communities" (United Nations, 2023b). In the most recent progress report, it is stated that business-as-usual approaches, especially given the rapid urbanisation intensifying those challenges, do not safeguard the environment nor protect the rights to food for a growing global population and that "[e]fforts to address hunger and food security are falling behind" (United Nations, 2023a, p. 53).

The proposal for a KAG (German: Klimaanpassungsgesetzt) has initiated a process to set targets and indicators for green city areas and gardens in accordance with the SDG's (Bundesregierung, 2023). The goal here is to prevent negative impacts of climate change or reduce them as far as possible by increasing resilience of society and ecological systems to climate change to maintain living conditions (*ibid*.). It is planned to include a cluster for urban development, spatial planning, and civil protection as climate change will threaten the food security of German citizens.

However, the first climate adaption strategy will only have to be presented by the government in September 2025 (Wettengel, 2023).

Urban food security is legally supported by the framework of LFGB (German: Lebensmittel- und Futtermittelgesetzbuch) of the German federal government. It is designed to uphold quality and safety standards in the food and consumer goods industry and contains guidelines for production, quality, and other characteristics of foodstuffs (BMEL, 2022a). The LFGB gives an authorisation for exceptions for the manufacture, treatment, and placing on the market of foodstuffs, tattooing products, cosmetic products, or consumer goods in times of crisis, if the vital supply of the population would be seriously jeopardised (*ibid*.). With this, food from non-typical sources or different production may be allowed to supply the population with food in times of crisis.

3. Theory

The following chapter will first present the resilience of social-ecological systems (SES) in an urban context, followed by principles for enhancing resilience in SES. A description of food security will end this chapter.

3.1 Resilience of social-ecological systems in an urban context

Resilience is an emergent property of SES and it determines the vulnerability of a system towards unforeseen events that can break the pattern of the adaptive cycle and the panarchy (Holling, 2001). It is most commonly defined as the capacity of a system to withstand shocks, by absorbing disturbance and reorganising while undergoing change to maintain identity, structure, function, and feedbacks (Folke et al., 2010; Loorbach et al., 2017). The resilience of a system is shaped by its adaptability, adaptive capacity, and transformability (Folke et al., 2010). These are also the main aspects of SES that resilience thinking focuses upon (*ibid*.).

In general, two types of resilience can be distinguished, specific and general (Folke et al., 2010) and resilience can be both, desirable or undesirable. For example, corruption is an undesired but very resilient system (Loorbach et al., 2017). Specific resilience addresses problems that relate to specific system aspects that might arise out of specific shocks (*ibid.*), like for example resilience against flooding, that is caused by extreme weather events. However, putting too much emphasis on increasing only the resilience of parts might diminish the overall resilience of a system or lower it in other parts, where an overemphasis on flood resilience may overlook interdependencies with other critical infrastructure like energy. General resilience addresses resilience towards all types of shocks, including new, unknown ones and thus acknowledges all types of uncertainty. Understanding the cycles and levels of a system, allows the identification of leverage points to foster sustainability and resilience in it (Holling, 2001).

In particular, urban resilience needs to be considered within the dynamics of complex adaptive systems (CAS), as cities face a high risk of cascading system failures, like power or water infrastructure failures, due to their high connectivity and concentration of infrastructure (Elmqvist et al., 2019). Furthermore, cities are open systems with multiple scales and resilience governance requires active resilience management that either strengthens desired or reduces undesired system resilience (*ibid*.). Therefore, in order to define the desirability of urban resilience, the question "resilience of what, to what, and for whom" (Elmqvist et al., 2019, p. 268) needs to be asked.

3.2 Principles for enhancing resilience in socialecological systems

Assessing the resilience of SES is difficult, but necessary for their successful management. The seven principles for resilient ES management in SES offer a possibility for assessment (Stockholm Resilience Centre, 2015), where five of them will be utilised in this thesis. These are presented in Table 1. The principles of connectivity and polycentric governance do not apply to this study, as they consider connections between systems in a landscape and this study is limited to one small system (the case study site), and are therefore excluded.

Principle	Description	Contribution to resilience
Maintain	Diversity (including variety, balance,	Both offer response options to disruption or
diversity and	and disparity of elements) and	change and enable adaption also to slow,
redundancy	redundancy allow elements of a system	ongoing change.
	to compensate if others fail.	
Manage slow	Slow variables determine underlying	Changes in feedbacks and slow variables
variables and	system structure and feedbacks refer to	can result in regime shifts (persistent, large,
feedbacks	changes that occur to a	and often abrupt changes in system
	process/variable/signal change that	dynamics and structure) or nonlinear change
	dampens (balancing feedback) or	if thresholds are exceeded.
	reinforces (reinforcing feedback)	
	subsequent changes.	
Foster an SES	Key properties (unpredictability of	Leads to emphasising holistic approaches,
as CAS	system components, uncertainty of SES,	integrated ES management, and highlights
understanding	possibly emerging microscale SES	system feedbacks and slow variables (see
	behaviour, and continuous adaptation	above).
	and evolution) and their implications	

Table 1: The used principles for enhancing resilience of ecosystem services in social-ecological systems, derived from Biggs et al. (2012) and Stockholm Resilience Centre (2015)

	must be understood for successful	
	management.	
Encourage	To enable adaptation in SES and to	Learning is fundamental to dealing with
learning and	maintain ES a constant revision of	uncertainty and building resilience, as
experimentation	existing knowledge is needed and	knowledge is always considered to be
	experimentation is a tool for facilitated	incomplete, while experimentation can
	learning and is thus fundamental for	bring learning about SES responses to
	adaptive (co-)management.	management or shocks.
Broaden	Participation (the active engagement of	A diverse stakeholder participation enables
participation	relevant stakeholders) directly affects	enforcement and learning, improves
	responses to disturbances.	legitimacy, and improves management of
		system capacity to disturbances.

Regarding diversity and redundancy, a biological diversity in allotment gardens is important regarding urban resilience as it protects against diseases, environmental stresses, and pests as different species vary in their responses and tolerances (Colding and Barthel, 2013). The cultural diversity in allotment gardens also fosters resilience by introducing diverse perspectives and generates knowledge for adaption (*ibid*.). The redundancy that allotments provide in terms of food production, enhancing the resilience of urban food systems, and decentralised management, reducing the risk of systemic failures of urban governance, are further important aspects that increase urban resilience. However, overly diverse and redundant systems suffer from stagnation whereas little redundancy and diversity increase system brittleness, posing threats to resilience (Biggs et al., 2012).

Interactions and feedbacks between fast and slow variables characterize the dynamics of SES, with slow variables like soil composition and water quality linked to regulating ES like climate and flood regulation (Biggs et al., 2012). The balancing and reinforcing feedbacks of allotment help to maintain urban systems in their desired regime, as they, for example, regulate the urban microclimate by providing cooling in the face of climate change. Also, do the diverse species and habitats in allotments reinforce the resilience of urban ecosystems, as they support a range of ES and enhance adaptive capacities to changes. A lack of monitoring slow variables and feedback often contributes to loss of resilience and environmental degradation, compromising urban resilience (Biggs et al., 2012).

Understanding the properties of CAS and their implications for SES will only positively affect management approaches and cannot diminish resilience (Biggs et al., 2012). When an understanding of SES implications is given in allotments, holistic approaches, that for example enhance soil health, water retention capacity, and ES, are emphasised. It also highlights slow variables and their importance not only for gardening, but also on the city level, increasing their promotion and

protection. Insufficient understandings of complexity however may not appropriately reflect fundamental CAS properties and may lead to stagnation, while challenging worldviews and institutional arrangements at the same time (Biggs et al., 2012).

Allotments provide opportunities for urban residents to learn about and personally engage with ecosystems, building environmental stewardship and providing socialecological memory which is crucial for long-term urban resilience (Barthel et al., 2010). Experimentation in allotments allows not only cities to test alternative systems of food production, but also provides opportunities for gardeners to compare gardening techniques or cultivation methods, that are important to city resilience. It may however be compromised if learning is facilitated in a short-term, non-collaborative way and if experimentation is done without the necessary resources, networks, trust, and leadership (Biggs et al., 2012).

Participation is a vital link for continuous learning and strengthens links between decision making and information gathering (*ibid*.). Participation in allotments provides urban residents with sources of locally grown foods, reducing externalities of long food supplies that are at risk for disruption, and thus increasing urban resilience and food security. It is furthermore interlinked with all other principles, as diverse participation is needed for diverse knowledge generation, learning, and diverse perspectives. It is also necessary for responding to SES changes by revising management and adaption practices. However, if participation fails to link to natural systems or to build social capital, it will diminish urban resilience (Biggs et al., 2012).

These five principles for enhancing resilience in SES will provide the base for assessing resilience, and will guide the interview questions regarding urban resilience, as their interactions regulate the SES functions in cities that provide essential ES to its citizens (Egerer et al., 2020).

3.3 Food Security

Food security is defined as a state when "all people, at all times, have physical and economic access to sufficient and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (World Food Summit, 1996). The right to food is furthermore a human right, recognised in Article 25.1 (*Universal Declaration of Human Rights*, 1948), and anchored in SDG 2 "No hunger" (United Nations, 2023a), with targets 2.1 and 2.2 addressing food security as an issue of food scarcity (Haysom and Battersby, 2023). Food security consists of four dimensions: availability, access, utilisation, and stability - all of which need to be

fulfilled simultaneously for it to be realised (FAO, 2008). Further description of each dimension is presented in Table 2.

Dimension	Scope	Explanation
Availability	Physical	Regards the supply side of food security and is determined by
		net trade, food production, and stock levels.
Access	Economic and	Regards the demand side of food security and means that food
	physical	must be affordable and available in markets to individuals.
Utilisation	Physical	Refers to how a body makes use of various nutrients in food
		and concerns diets, food preparation, feeding practices and
		care, and the distribution of food within households.
Stability	Time	Refers to the fact that the three other dimensions must be stable
		over time to achieve food security.

Table 2: The dimensions of food security, adapted from FAO (2008)

Food insecurity can either be chronic (persistent and long-term), transitory (shortterm and temporary), or seasonal (a cyclical pattern of inadequate availability and access to food) (FAO, 2008). To resolve the issue of food insecurity, income growth, supported by investments in education, water, and health, as well as nutrition interventions are needed (FAO, 2008). Threats to food security differ depending on the employed scale, as locally, a shock may have impacts on the food security and livelihoods of farmers, but for the national or global scale, the impact is dependent on the nature of the threat (Sundström et al., 2014). For global impacts, the extent of effects depends specifically on the threatened commodity as, for example, a compromised corn production would affect more people than compromised pepper production (*ibid*.).

One can measure the vulnerability to food insecurity, which is defined by three critical dimensions (FAO, 2008). These are the vulnerability to an outcome, risk factors, and the inability to manage the risks (*ibid*.). Hunger, the painful or uncomfortable sensation if insufficient food energy is consumed, further acts as an identifier of food insecurity (FAO, 2008). However, it cannot be a standalone measure as there are more causes of food insecurity, for example a poor micronutrient intake (FAO, 2008). The same applies to malnutrition, as it is a potential outcome of food insecurity but could also relate to other, non-food factors, such as inadequate health services, unhealthy environments, or insufficient care practices (FAO, 2008). Poverty is often cited as a cause for hunger, but at the same time the lack of proper and adequate nutrition can be a cause of poverty, thus creating a vicious cycle where poverty leads to hunger, food insecurity and malnutrition, leading to poor cognitive and physical developments, leading to low productivity, in turn again resulting in poverty (FAO, 2008). In an urban context though, food security is not only relevant to the poor, as more wealthy residents also will be affected by major urban food supply disruption, limiting their access to food despite their financial ability to purchase nutritious and healthy food (Burton et al., 2013).

Food security can be assessed using numerous indicators, measurements of those, and scales, but a general consensus on what is best is lacking (Manikas et al., 2023). However, the often-used scales and indexes that measure food security are mainly aimed to be applied in development and emergency contexts (FAO, 2017) and thus do not offer great differentiation for countries, households, or individuals that are generally classified as food secure (Coates et al., 2007). As a result, this thesis will not use an already established scale or indicators to assess the role of allotments to urban food security, but instead will develop a different set of questions suitable for a semi-structured interviews inspired by common food security scales. These will lead to the collection of experience based indicators, which most studies that collected primary data also rely on (Manikas et al., 2023).

This chapter previously defined urban resilience as the capacity of an urban system to recover from disruption, for which when applied to cities, the access, availability, utilisation, and stability of food play a key role (Burton et al., 2013). Major challenges to urban food security and food supply are climate change, rising energy prices, global economic change and instability, loss of agricultural land, and an hindered access to food (Burton et al., 2013). Allotment gardening is an adaption that can enhance the resilience of urban food systems to existential disruption (Burton et al., 2013), showcasing the deep connections between urban resilience, food security, and UA (Elmqvist et al., 2019). It thus builds adaptive capacities, urban resilience, and sustainable modes of urban living (Burton et al., 2013; Langemeyer et al., 2021), where it is "a powerful urban food systems' resilience tool" (Haysom and Battersby, 2023, p. 364). Allotment gardens have been shown to have great potential for counteracting vulnerabilities and negative effects of global food supply chains, enhancing food security in periods of crisis (Langemeyer et al., 2021) and for making cities more food secure, by contributing to their overall resilience, as localised production counteracts the vulnerabilities of long supply chains to systemic shocks (Burton et al., 2013).

4. Methods

This chapter presents the methods used in this thesis. First, a methodological background is presented. This is followed by the method used for the systematic review. Afterwards, a description of semi-structured interviews, the interview design, choice of participants, and data collection and analysis is given. The last subchapters present the positionality and ethical considerations.

4.1 Methodological Background

This section will shortly present literature on the methods employed in this thesis, where first systematic reviews, and second semi-structured interviews will be explored.

4.1.1 Systematic reviews

Systematic reviews are carried out to review literature related to a particular, mostly evidence-based research question (Elsevier Author, 2022). They follow a clear protocol that is defined prior to the start of the review and contain multiple steps (*ibid*.). Typically, they are carried out by more than one author due to the amount of work, but more rapid approaches are feasible (Robson and McCartan, 2016).

Aspects of systematic reviews are a "clear and concise review and summary [, a] comprehensive coverage of the topic [, and the] accessibility and equality of the research reviewed" (Elsevier Author, 2022, 5th paragraph). They include 12 to 15 steps, see Pascoe et al. (2021), Robson an McCartan (2016), and Tawfik et al. (2019), which differ based on the topic and the number of researchers available. Tawfik et al. (2019) present the following steps: 1) defining the research question, 2) doing a preliminary search, 3) defining inclusion and exclusion criteria, 4) defining the search strategy, 5) searching available databases, 6) writing, approving, and registering a protocol, 7) a screening of title and abstracts of found literature, 8) full text screening, 9) expanded manual search based on the full text screening, 10) extraction of data and assessment of quality, 11) checking of data, 12) statistical analysis, 13) double checking of data, 14) writing, revision, and submission of a manuscript.

4.1.2 Semi-structured interviews

There are three types of interviews, structured, semi-structured, or unstructured (Robson and McCartan, 2016). Semi-structured interviews are widely used in social research and allow respondents to be more flexible in their responses which are guided by the researcher (*ibid*.). For this, the researcher develops an interview guide or schedule containing topics to be covered, key questions, associated prompts, as well as question wording and order, which can be adjusted and/or expanded during the interview (Robson and McCartan, 2016). After the introductory comments, commonly a short, structured part of questions follows to obtain standard demographic and/or factual biographical data of the respondents. Semi structured interviews thus employ a blend of closed and open-ended questions, the latter of which often expanded with follow-up questions (Adams, 2015). Questions are typically asked to gain knowledge about facts (what to people know), beliefs or attitudes (what do people think and feel), and behaviour (what do people do) (Robson and McCartan, 2016). Semi-structured interviews are conducted with one respondent at a time and are should take 30 minutes to an hour of time (Adams, 2015; Robson and McCartan, 2016). After an interview is completed, the obtained data needs to be gathered, which can be done by coding it. Coding concerns an identification of issues, topics, differences, and similarities (Sutton and Austin, 2015), as well as the categorisation of data segments "with a short name that simultaneously summarizes and accounts for each piece of data" (Charmaz, 2006, p. 58).

Advantages of semi-structured interviews include flexibility and adaptability in question wording, the possibility of follow-up questions and modifying the line of enquiry, the possibility to examine independent thoughts of individuals in a group, an investigation of underlying motives, and the potential for highly illuminating and rich material (Adams, 2015; Robson and McCartan, 2016). Disadvantages that they are time consuming and labour intensive, that there is a lack of standardization and thus also reliability, and that biases are difficult to overcome (*ibid*.). The issue of reliability can be overcome by following 4 criteria of "trustworthiness", which are credibility (confidence in accuracy of findings), dependability (consistency and repeatability of findings), transferability (findings are applicable in different contexts)), and confirmability (findings are based on the interviewees, not a motivation, bias, or interest) (Lincoln and Guba, 1985).

4.2 Systematic review of governance structures

The systematic review of legislation was conducted to gather and present an overview of the current legislation in Germany, and specifically Hamburg and the

case study site. The methodological background presented procedure of systematic reviews was slightly adapted for the task at hand and consisted of following steps 1 to 5, omitting step 6 as the thesis was already approved, modifying step 7 to a screening of only the title, as German policy documents do not have abstracts, following steps 8-11, and omitting steps 12 to 14 and instead summarising the results.

First the research question for the systematic review was defined as research question 1 of this thesis: What are the effects of the legal structures governing the use of urban allotments in Hamburg, Germany on food security and resilience? The preliminary search was done via Google, where policy and legislation that was specific to allotments in Germany and Hamburg was searched for. All current legislation and policies were decided to be included. The planned or future policy was only to be included if its adaption was foreseeable, meaning that at least one governmental unit must have passed the law. The search strategy was decided to gather all relevant documents in relation to the identified topics of interest. After starting the search with Google, the website of the German government and their online database for laws (www.gesetzte-im-internet.de) was used to identify legislation and policy in place for Germany, the website of the city of Hamburg and their database for laws (www.landesrecht-hamburg.de) was used for Hamburg specific policies.

4.3 Semi-structured Interviews with allotment gardeners

Semi-structured interviews were conducted with allotment gardeners in Hamburg, Germany. The goal of the interviews was to identify the contributions allotments to the food security of its members and to urban resilience. In the following, the interview design, choice of participants, data collection, and data analysis will be argued for in their respective subchapters.

4.3.1 Interview design

An interview guide was developed which contained questions regarding food security, urban resilience, and governance structures. The sequence of questions was derived from Robson and McCartan (2016), which was presented in the methodological background. First was an introduction in which the nature and purpose of the study is presented, a rundown of the following topics of interest, a short self-presentation, stating anonymisation, and asking for permission to voice-record the interview. This was followed by warm-up questions about general information about the allotment garden, the main interview assessing food security,

urban resilience, and governance. Lastly a cool-off ended the interviews. It was decided to conduct the interviews in German. Attention was paid that the interview would be around one hour, which was checked in a test with a friend who also had an allotment in the selected area. Here, special attention was also paid to question wording, so that they were not too long, biased, double barrelled, involving jargon or pressuring. The test led to reformulating one question and changes in the wording, e.g. asking respondents about plots and not garden. Afterwards the interviews guide was finalised with 22 questions.

As people appropriate for the interviews, member of the case study allotment garden club in Hamburg were selected. To approach potential participants, a board member of the Gartenfreunde Volkspark e.V. in Wandsbek was contacted by mail. They then offered to contact members and forward their details if they would like to participate in an interview. Of the forwarded eight potential participants, seven were interviewed and one interview was organised by myself.

4.3.2 Data collection and analysis

Key questions were stated to all interviewees, otherwise were individual experiences of interviewees allowed to direct the interview path. A translated, English version of the interview guide can be found in Appendix 1. All interviews were recorded by phone and subsequently transcribed, anonymised, and corrected. In addition to the voice-recording, notes were taken during and after the interviews containing date, time, place, and a checklist of key questions for documentation These were clarified directly after each interview.

The interviews were analysed using thematic coding. For this the transcripts were transferred into Excel where they were scanned and coded with notes in a separate column. This allowed the grouping together of codes to overarching themes across interviews. Lastly, the themes and quotes were then translated from German to English after considering that this way, the translation would have the least impact on the presentation of findings. Special attention was given to the fact that throughout the analysis and translations statements were kept true to the participants. As one of the respondents was a member in the allotment club board, statements relating to their position will be marked with board member after the quote. Also, they/them pronouns will be used in the following to hinder any identification of specific interview participants.

4.4 Positionality

An integral part of social research projects is to consider one's own positionality, especially when analysing interactions between the researched and the researcher. Positionality refers to the context forming the researchers identity and as part of that, their perception and understanding of the social world (Bukamal, 2022). This is important to consider as the identity, perception, and understanding greatly impact the interpretation process of research projects (*ibid*.).

My positionality was considered throughout the process of writing this thesis. I have been, for some years now, involved in activism surrounding food waste, and started allotment gardening in Hamburg only in January 2023. This is why for this research project I had to reconsider my critical stance towards the governing structures of urban food as data production and the environment in which data is conducted may influence a researcher in their projects. Also reflecting my positionality towards secondary data and interviews was important, as I grew up with gardening and growing food at home. This reflection of my learning and perceptions was also important when considering what questions to ask in the interviews as these could have been biased or misconstrued the secondary data evaluation. It was important to also view the benefits of the existing governance and let the interviewees present their own perception.

4.5 Ethical considerations

As this thesis employed interviews, consideration was also given to ethical aspects. The four principles of ethical research were followed in this study, namely harm to participants, deception, informed consent, and invasion of privacy (Bryman, 2012). Harm to participants was avoided as the identifies of participants were kept confidential and all transcripts were anonymised. Prior to the interviews, the interviewees were informed of the purpose and nature of the study, the type of questions asked, and the use of their answers. It was also possible for all interviewees to stop the interview at any time, and they were given time to think about questions if they wanted so. This ensured coherence to the principles of deception and informed consent. To not invade the privacy of any participants, they were free to not answer questions they deemed private without enquiry as especially food security can be a highly sensitive and personal topic.

5. Results

In the following, the findings of this project will be presented. First, results of the systematic review will be presented. Then, findings form the interviews, structured into the topics food security and urban resilience are displayed.

5.1 Governance structures of allotments in Hamburg

This section presents the findings of the systematic review of governance structures of allotments in Hamburg. In a screening of titles, 22 policies and laws were initially found, 12 of which were excluded based on their title. The remaining 10 were subsequently fully screened by looking for key words such as garden, allotment, nutrition, food, agriculture, city, and/or resilience. This search was then expanded to a manual search, which also included policy that was referred to in the full text screening. In total the reviewed policy amounted to 17 documents. If a relevance for the topics of interest was found, the rules/policies/prohibitions were noted and extracted. After all documents were reviewed, they were checked for currentness and reasonableness. Three documents, the statue/the garden regulations of the allotment garden under study, the main lease agreement, and the statue of Germanys federal association of allotment associations (BKD) were referred to in the fully screened documents but not publicly available. As these documents were not public, they had to be excluded from the systematic review.

Of the fully screened policy document 11 do not mention allotments, but provide regulations that must be followed when doing agri- or horticulture. Allotments are specifically regulated by the BKleinG, the Action plan on Sustainable use of Plant Protection Products (NAP), as well as by the statues and regulations of clubs and associations, like the leaflet for allotment use in Hamburg (LUAG). In Table 3, an overview of the fully screened documents is presented. A more detailed description of all documents can be found in Appendix 9 and in the following, documents that specifically refer to allotments will be presented regarding their effect on activities of allotment gardeners, urban resilience, and/or food security.

Document	Date (reform)	Scale	Gover- nance	Content
Federal Climate Protection Law (KSG)	2019 (2021)	Germany	Indirect	Ensures fulfilment of national climate protection targets and compliance with EU targets.
Federal Nature Conservation Law (BNatSchG)	1976 (2022)	Germany	Indirect	Legal basis for nature and landscape conservation as well as their management measures.
Hamburg Act on the Nature Conservation Act (HmbBNatSchAG)	2010 (2020)	Hamburg	Indirect	Supplement to the Federal Nature Conservation Act for Hamburg area.
Federal Soil protection Law (BBodSchG)	1999 (2021)	Germany	Indirect	Aims to ensure or restore the sustainable functioning of soil.
Key points for a reform of national soil protection law	2022	Germany	Indirect	Points of critique for reforming the federal soil protection law
Law on the organisation of the water balance (WHG)	1969 (2023)	Germany	Indirect	Main body of the German water law.
Hamburg Water Act (HWaG)	2005 (2012)	Hamburg	Indirect	German water law applied for Hamburg area.
Hamburg Wastewater Act (HmbAbwG)	2001 (2018)	Hamburg	Indirect	Definition waste water and its disposal.
Fertiliser Act (DüngG)	2009 (2022)	Germany	Indirect	Regulates fertilisers, soil additives, growing media, and plant aids.
Act on the Protection of Cultivated Plants (PflSchG)	2009 (2022)	Germany	Indirect	Serves to protect from hazards from the use of plant protection products.
Ordinance on the protection of trees and hedges (BaumschutzVO)	2023	Hamburg	Indirect	Definition trees and hedges as landscape features and their protection.
Action plan on Sustainable use of Plant Protection Products (NAP)	2013	Germany	Direct	Action plan to reduce the use of synthetic plant protection products in multiple sectors.

Table 3: Summary of found documents that govern allotments, their date and date of the latest reform, scale, type of governance, and content.

Federal Allotment	1983	Germany	Direct	All-round definitions for
Garden Law (BKleinG)	(2006)			allotments and their contents.
Statue of the Landesbund	2023	Hamburg	Direct	Association statue that defines
der Gartenfreunde in				Hamburg's federal allotment
Hamburg (LGH) e.V.				association and its rules.
Leaflet on the use of	2021	Hamburg	Direct	Defines horticultural &
Allotment Gardens in				recreational use and further
Hamburg (LUAG)				regulations.
Leaflet on the use of	2019	Hamburg	Direct	What water connections and uses
water supply and				are allowed in allotments in
wastewater disposal				Hamburg.
(LUWW)				
Leaflet on hedge	2011	Hamburg	Direct	Hedge regulations, as these are
maintenance (LHM)				separate to plots and paths.

The overarching goal of the NAP is to reduce the use of chemically-synthesised plant protection products in various sectors, including home gardening and allotments (BMEL, 2013). The policy aims to mitigate health risks from pesticide exposure in allotments, especially for vulnerable groups like children and the elderly by raising awareness, improving user protection, collecting data on pesticide practices, and enhancing knowledge and guidelines for integrated pest management. If the NAP successfully reduces pesticide use in allotments, it then does not only actively influence allotment gardening practices, but also contributes to resilience and food security, by promoting biodiversity, soil health, and crop resilience.

The BKleinG defines allotment gardens as serving for non-commercial horticultural use and recreation (Bundestag, 2006, para. 2). While it does not explicitly mention food security or resilience, it provides security of tenure for allotment gardeners, helping to support the long-term viability of allotment gardens as a source of food production and as a green space in urban areas. The BKleinG furthermore states that in use of allotments must consider interests of environmental protection, landscape conservation and nature conservation (Bundestag, 2006, para. 3), protecting ES provided by allotments that contribute to urban resilience.

The Landesbund der Gartenfreunde in Hamburg (LGH) e.V. is the umbrella association for allotment clubs in Hamburg and has the purpose to promote allotment gardening in Hamburg through cooperation with organisations and city authorities regarding the social and national political importance of allotment gardening, especially in the context of long-term regional planning (LGH, 2023, para. 2). The LGH also realises tasks that arise from the main lease agreement with
the city of Hamburg or lease agreements with private lessors of allotment garden land (*ibid*.).

The LUAG defines allotment use as the use of leased land for the cultivation of horticultural products with a charitable and social function (LGH, 2021). It states that the acquirer of an allotment is entitled to a plot that is free of defects and must use at least one-third of a plot for growing fruits, vegetables, and/or herbs for personal consumption (ibid.). This requirement promotes food security, as it ensures that all allotment holders contribute to local food production. The LUAG acknowledges that allotments now serve more for leisure and recreation, while also providing positive effects for the city such as refuge for animals and plants, preservation of small biotopes, and improvement of the urban microclimate that contribute to urban resilience. Allotment gardens are also recognized as important green spaces that enhance quality of life and mental well-being for city dwellers. Permanent residence in allotment gardens is prohibited, with exceptions only made immediately after the 2nd world war (LGH, 2024). This ensures allotment sites remain focused on their primary purpose of UA and recreation rather than housing. Lastly, the LUAG limits the use of plant protection products to what is necessary prohibits the use of herbicides like high doses of calcium cyanamide, salt or other chemicals to control weeds, promoting organic and sustainable garden practices.

The Leaflet on the Use of Water Supply and Wastewater Disposal Facilities on Allotments (LUWW) prohibits water connection and flushing toilets, baths, showers, or similar in allotments (LGH, 2019). This helps ensure a sustainable water management and environmental protection in Hamburg's allotment sites.

The Leaflet on Hedge Maintenance (LHM) defines regulations for maintaining hedges in allotment gardens, including keeping a final height of 1.1 m, trimming annually to avoid impairing garden enthusiasts, visitors, and, in emergencies, ambulances, and the recommendation to use native deciduous shrubs (LGH, 2011). It also prohibits the cutting down of hedges and other woody plants between March 1st to September 30th (*ibid*.). With this, the LHM aims to ensure that allotment sites remain publicly accessible green spaces and provide nesting and food sources for birds, supporting resilience.

5.2 Perceived contributions of allotments to food security and urban resilience

In total were eight members of an allotment club in Hamburg-Wandsbek, Germany interviewed. The first interview was on the 28.01.2024, the last on 24.03.2024. They were conducted in person in multiple locations. Two were done in the plot of the interviewee, five in cafés, and one at home. The interviews lasted mostly around 45 minutes, the shortest 29 and the longest 60 minutes. Table 4 presents the dates, locations, durations, and length of plot rental of each interview and respondent.

Respondents	Date	Location	Duration	Plot since
Respondent 1	28.01.2024	Home	39 min	1 year
Respondent 2	05.02.2024	Café	60 min	25 years
Respondent 3	05.02.2024	Café	51 min	3 years
Respondent 4	07.02.2024	Café	45 min	0.5 years
Respondent 5	11.03.2024	Café	46 min	>30 years
Respondent 6	14.03.2024	Plot of respondent	44 min	1 year
Respondent 7	23.03.2024	Plot of respondent	29 min	12 years
Respondent 8	24.03.2024	Café	57 min	10 years

Table 4: Date, location, interview duration and time of plot lease of the interview respondents

The following describes the results from the eight interviews, sorted in thematic areas. First, general information about the plots of the respondents is given, followed by the relation of allotments to food security. Then the contribution of allotments to urban resilience is presented, including governance.

5.2.1 General information of the respondents and their allotment

The participants had their allotment plots for varying amounts of times where the shortest was half a year and the longest more than 30 years at the time of the interviews. The plots size ranges from 360 m^2 of respondent 4 to 500 m^2 of respondents 2, 5, and 6. Respondents 5 and 7, took over the plot from their parents, where respondent 5 said that "My mum had the garden" and respondent 7 stated: "I grew up here". Three other respondents (1, 3, and 8) maintained their plots together with friends, where respondent 3 said that "when the opportunity arose to do it as a group of three, it was of course brilliant", the remaining with their families. Most respondents lived close to their allotment, in the case of respondent 1 for example, the plot was located "about 600 metres from our house". The maximum distance mentioned in the interviews was 30 minutes by respondent 5 who, because of that, also did not grow any vegetables on their plot.

5.2.2 Food security

Table 5 provides a short summary of the interview findings regarding food security.

Торіс	Findings			
Food	Answers were mixed:			
availability	- Some had more food but not enough to significantly impact their diets (R1).			
	- Some did not have more food as food also available elsewhere is grown			
	(R8) or because of infestations limiting harvests (R5).			
	- Some stated an increased availability of fresh produce (R8) and increased			
	availability of food where the origin is known/that is homegrown (R7 and			
	8).			
	Allotment gardening highlights the extensive supply chains within the food			
	system (R6).			
	Three respondents (1, 2 and 4) believed size of an allotment is enough to cover			
	your own demand and this only challenged by one respondent (R5).			
	Seasonal availability of food from the allotments was no issue, as respondents			
	all preserved parts of their harvest.			
Food access	No respondent was dependent on food from the allotment, but rather stated that			
	is rather more expensive to cultivate food in allotments due to costs of time,			
	water, seeds, and soil (R1 and 3).			
	Allotments provided seasonal supplementation in summer and autumn months			
	where they substituted what is normally bought in stores.			
	For one respondent, the allotment gave access to foods otherwise not available			
	as they consume wild herbs (R8).			
	In times of war and crisis, allotments were stated to potentially have a decisive			
	influence (R3).			
Food	Allotment provided respondents with tasty, high-quality food (R6, 7, 8 and 1)			
utilisation	and a high level of trust in the food (R1).			
	The feeling of self-sufficiency that allotments provided was stated as not			
	substitutable and unmeasurable in money (R8).			
	Four respondents processed food differently since allotment gardening (R1, 3,			
	6, 8) and all but respondent 5 would not preserve food if they allotment			
	gardening.			
	One respondent had an increased consumption of fresh food due to the increased			
	availability (R8).			
Food quality	Respondents had strong, negative connotations to synthetic plant protection and			
	fertilisers.			
	Instead cutting, plant symbioses, or dish soap were used as plant protection (R5			
	and 6) and compost, hon shavings, horse manure, or nettle slurry were used as $f_{1}(1) = (D_{2}^{2} + A_{1}^{2} + A_{2}^{2})$			
	[ertiliser(K2, 3, 4, 5, 6, 7, 8)].			

Table 5: Summary of findings regarding food access, availability, utilisation, and quality

Respondent 3 used bought compost, and respondents 2, 4, 5, 7, and 8 used their own compost as fertiliser.
Overall, no synthetic plant protection and fertiliser was stated to be used by the respondents, however they believed other gardeners to rely on it.
The board takes soil or water samples if suspicions of illegal substance usage in the allotment site arise and have these tested by the environmental authority. If suspicions prove true, the gardeners are reported to the police.

All participants stated that they grow at least some type of food on their allotment plot, however, as shown in Table 5, answers were mixed when the respondents were asked, whether the allotment has changed their availability of food. Respondent 1 had more food, however they "wouldn't say that it made up a large proportion of my diet". On the other hand, respondent 8 reported an increased availability of home-grown food, but that they "don't grow anything in the garden that you couldn't buy in the supermarket or at the market". Gardening made respondent 6 "even more aware" on long transportation routes of produce in supermarkets, especially "when you stand in the supermarket and see all these shelves with all the things that are available". The opinion that the size of an allotment plot could sustain the gardeners was shared by multiple respondents, where one of those said:

We have 400 square metres, of which we can't and don't really want to use 400 square metres for growing food, but even if you only use 100 square metres of that for growing food and do it effectively, I think that you can really eat almost exclusively what is available if you are prepared to adapt your diet a little bit to what can be harvested at the time. – Respondent 1

And was only challenged by respondent 5 saying "I don't think anyone can make a living from it, given the size of the plot". None of the respondents had an issue dealing with the seasonal availability of produce from the gardens, as they preserved their harvests. One described their process as follows:

Mostly when we harvest, we either process fresh or I freeze and then have things for the current year [...]. So I pickle beetroot, can courgettes or freeze them. From the berries, the blackberries, the raspberries, we usually eat them like that, we don't get so much that I could do anything with them. But I juice the redcurrants and jostaberries [...], that I can make jelly, that I can make sauces. – Respondent 7

None of the respondents indicated that they were financially dependent on food from allotments, but rather that the cultivation was more expensive than getting food in a supermarket, saying "it really is more expensive to grow your own vegetables on an allotment" (Respondent 3). Most gardeners stated that in the during "summer and autumn, I can benefit a lot from it" (Respondent 2). Also, it was shared that the food cultivated in the allotments substitutes what is normally bought, as for example respondent 8 said that "certain things are practically exchanged in the season in which they grow in the garden". Therefore, access

changed regarding where the gardeners would get their produce and increased the price of it. Respondent 8 was the only participant who stated that the garden gave them an access to food which they could not buy elsewhere, as they "also eat a lot of what is considered wild herbs", like nettle, dandelion, and goutweed. Respondent 3 furthermore added that allotments may have a decisive influence on food access within the urban context, "[i]f we were to return to times of war and crisis" and that they "were glad that we had it" during the COVID-19 pandemic.

Many respondents stated that they had more high-quality food because of allotment gardening in their diets, as for example, respondent 6 described the quality of apples from their plot as "completely different". For many, the taste was a further characteristic of the quality food they produced in their allotments where respondent 7 for example described the taste of vegetables from their plot as follows: "We have often noticed that the things you get from the garden taste different. Like radishes are sharper, tomatoes have more flavour, potatoes are firmer, more yellow". Respondent 1 also "just washed the carrot from the garden and ate it", which they otherwise would peel because they "trust the food more" when cultivated by themselves. For respondent 8, the feeling of self-sufficiency was also not substitutable, saying: "I would say that the emotional quality of providing for yourself is a factor that you can't convert into money". Four respondents also shared, that they processed food differently since renting a plot, for example respondent 3 who had "only been canning since I started gardening.", as prior "there was no need at all". Also, for respondent 6 the quantity of the harvest made it necessary to preserve "so that it does not go to waste" (Respondent 6).

Respondents stated to not use synthetic fertiliser or plant protection, for example saying "we don't use any chemicals at all" (Respondent 8), except respondent who said "I fertilise, yes, but only organic fertiliser. So [...] I buy compost from the recycling centre." As shown in Table 5, all respondents stated to not use synthetic plant protection on their allotment, however a disagreement within a plot regarding pesticide management was reported, where the pesticide treatments of a fellow gardener with iron oxide impeded not only pests but also beneficial organisms. They said:

the snails go is to the flowering plants, to the flowers. And [fellow gardener], who is responsible for the flowers, actually takes countermeasures. And [they do] so violently [...]. So it kills the snails. We also have slugs. [...] And they eat snail eggs. So, they're a completely different species to a normal slug. And they have become rare. And the slugs love the iron oxide too, of course. Just like the snails. And that means we also kill the slugs. – Respondent 3

So, even though respondent 3 does not support using chemical plant protection, their fellow plot gardener uses it to not only treat pests, but also harms beneficial organisms, in this case slugs. Other respondents also believed gardeners in the

allotment site to use synthetic plant protection, saying: "I wouldn't say that just because it's an allotment garden, it's all particularly eco- and nature-friendly" (Respondent 8).

5.2.3 Urban resilience

Table 6 provides a summary of the interview findings regarding urban resilience. Key points will be elaborated afterwards with quotes from the respondents.

Table 6: Summary of findings regarding urban resilience, structured by the principles for resilient ecosystem service management

Торіс	Findings		
Diversity and	Many animals and plants were reported in the allotment site, old varieties of		
redundancy	plants were cultivated (R5 and 8), and animals like bees were kept (R4)		
	Allotments are one of the few places in cities where fruit can grow (R5), are		
	green lungs of cities (R6 and 5), and are biotopes and habitats in cities (R3, 4,		
	and 8).		
	The management approach was stated as decisive on whether the gardens		
	contribute to animal and plant conservation (R3, 6, and 7).		
Slow variables	Negative impacts on slow variables from allotments stated were that		
and feedbacks	regulations are not always followed (R6, 1, and 7) and that increased use of		
	fertiliser affects soil and water quality negatively (R7).		
	Positive impacts on slow variables from allotments stated were limited		
	coverage and compaction of soil (R1) that allows for water drainage (R4),		
	enhancing water quality (R2), and improving soil quality (R4 and 6), while		
	providing cooling (R8).		
	Positive management was believed to outweigh non-beneficial management		
	(R6) however the impact compared to conventional agriculture was stated as		
	small (R3).		
SES as CAS	No respondent necessarily saw allotments as CAS and the gardening		
	facilitated no change in perception about interactions and connections within		
	systems for respondents 1, 7 and 5.		
	A change in perception occurred for respondents 2 and 3.		
Learning and	Learning was facilitated via a newsletter (R5), a magazine (R6), protocols of		
experimentation	board meetings (R6), the governing association (LGH) (R6), informal		
	exchanges in neighbouring plots (R8 and 7), and taking place		
	intergenerationally (R5). But only on certain topics (R3).		
	Learning of ecological consequences of activities in allotment gardens was		
	encouraged from the board (R2)		
	Respondents felt like they can freely experiment in their plots when staying		
	within regulations, but respondent 3 was restricted by their plot hierarchy.		

	The club was stated to neither explicitly be promoting nor to be hindering		
	experimentation (R5).		
Stakeholder	Decisions are made democratically (R1 and 2) and assistance on enforcement		
involvement	is provided (R5), however are gardeners outside the board not involved in		
and	decision making (R3).		
participation	Communication from board to gardeners was seen as not sufficient (R3) and		
	one respondent was not sure whether criticism of decisions by club members		
	would be heard (R8).		
	Involvement of gardeners on a political level was mentioned, where a group		
	of gardeners fight decisions that are non-beneficial (R2).		
	The process for renting an allotment was described (R2).		
Governance	Governance structures were reported as		
structures	- non-transparent, not accepted, and not sufficient (R5)		
	- too many and too bureaucratic (R1)		
	- people in leadership positions taking themselves too seriously (R1 and 3).		
	- good from the association (R5)		
	The city removing allotments for housing was stated as an issue (R5), however		
	was also support from the city mentioned as it manages the water supply		
	allows gardeners to have low water costs (R2).		
	A decline in people willing to do voluntary work threatens the continued		
	existence of the club structure (R2).		
Knowledge and	No respondent stated to know all the regulations that apply for allotments,		
impact of legal	however confidence was voiced in knowing where to obtain more information		
regulations and	if needed (R1 and 5).		
guidelines	Level of affectedness was mixed across respondents:		
	- two were strongly affected (R2 and 3)		
	- three were slightly affected by the regulations (R6, 8, and 1).		
	- three were not affected (R4, 5, and 7).		
	Most respondents did not wish to change any of the regulations, as		
	- they do not know the effects of new regulations (R7).		
	- understand the need of the regulation despite being personally impeded		
	(R3 and 6).		
	- regulations are beneficial for diversity and thus an enrichment (R7 and 1).		
	The distances for trees planted to allotment borders (R8), the 1/3 regulation		
	(R5) and hedge height regulations (R3 and 4) were appreciated by		
	respondents.		
	Changes in regulations were voiced regarding hedge regulations (R3 and 4),		
	animal husbandry (R8), and the dismantling and handover procedure (R3).		

When asked about animal and plant conservation in allotments, there were strong, positive responses like:

Well, I can't count how many animal species there are, from butterflies to herons and so on, it's incredible. Hedgehogs. I can't even count how many animal species there are in our allotment. [...] I think it's important that there are allotment gardens in the cities. Because we preserve nature in this way, because they also help to create more plants. Through pollen and bees and that is incredibly important. – Respondent 2

The diversity of plants was further noted by respondent 6, who stated "you can really see when we walk through here that there are all kinds of plants" and respondent 4 mentioned the role of gardeners in creating diversity as interested gardeners "go to the garden centres and see what interesting plants there are, and then they also seed themselves somewhere else" referring also to plants that are normally not present in cities. However, the extent of the contributions from allotments was stated as depending on its management as respondent 3 also saw allotment plots in which every "wrong weed [... is] being plucked" and respondent 7 observed "some gardens where I think to myself, hmm, well, there's a lot of lawn, a lot of nothing on it".

Negative impacts on slow variables were seed by gardeners in the sense that fertiliser use was described as a crucial management point saying: "if the fertiliser goes into the groundwater, then the water quality drops" (Respondent 7) and that illegal substances could be "could be tested in the Osterbeck with the help of the environmental authority" (Respondent 2 - board member). However, were also positive examples given, as gardeners reported to actively work to "make sure that the soil is loose, that you give the water the chance to seep in, that it's not compacted" (Respondent 6) and that the water of a well in the allotment site was tested, which showcased some of the ES allotments provide:

Then he gave me a sample and I had it analysed in the lab and the results were excellent. So it's almost similar to our drinking water, which is purified. [...] But I just want to say that what is in the soil, is already good. [...] It also shows in the water, which is good. – Respondent 2 (board member)

Respondent 8 also highlighted the impact on temperature that allotment sites have, as "when it's 30 degrees and you come out of any garden area, you get the feeling as soon as you get out onto the street that you've got a jump in temperature". Overall, the impact of allotment management on impacts slow variables and feedbacks was believed to be both positively and negatively, however were positive management approaches believed to "outweigh[] the black sheep" (Respondent 6) and that the overall management has improved in recent years due to updated regulations (Respondent 3). However, respondent 3 believed that the impact "of allotment gardens compared to agriculture is small".

The respondents were asked if their perception of connections and interactions within allotment system changed since allotment gardening. Respondents 2 and 3

stated that their own perception had changed a lot since gardening in their allotment, saying "It is a different matter when I read in the newspaper that we have an insect die-off. Or when I actually see it." (Respondent 3) and that the tasks of allotment gardening have led to a change in attitude and perception:

I have developed a lot. I have acquired a lot more knowledge. I've engaged with everything a lot more. My whole attitude has changed. [...] But the connection with a small piece of nature has changed a lot of things. – Respondent 2

Furthermore, respondents reported getting a "completely different feeling towards nature", which respondent 5 stated a general impact of being an allotment gardener as they said that "caring for and handling of plants has an effect on people".

Regarding the continuous learning and sharing of knowledge within the allotment club, most respondents mentioned an informal, personal exchange of knowledge among neighbouring plots, saying for example: "I know my neighbours here and chat with them: how do you do it, how do we do it? That's where the exchange clearly takes place. But now to say, what do I know, there are some back there? That's rare" (Respondent 7). Learning was reported to be facilitated through a magazine from the association called 'Der Gartenfreund' (Engl: the gardening friend), however only certain topics were put forward, which respondent 3 stated by saying "recycling is promoted and so on, but I haven't noticed such organic standards and ecological thinking in the allotment garden so far". Respondent 5 also noticed intergenerational learning, where parents teach their children about food producing. They stated: "I also think that the trend among many young people is to rent a plot, so that the children can learn where our food actually comes from, or how something grows" (Respondent 5). This was confirmed by respondent 6 who got an allotment because: "We also wanted our daughter to have this opportunity to grow up with nature. See what grows, when does what grow, how does it work at all."

Most respondents stated to be able to freely experiment on their plot, as long as it stays within the regulations. Respondent 8 summarized this by saying, that there is free experimentation "in the knowledge that this is not our field in the countryside, where it doesn't matter what grows where and so on". Respondent 7 also reported experimenting with what plants can grow on their plot and said "So an experiment where you say you've planted something and you say, no, that won't work, no, we won't do that again next year" and that "nobody interferes with what you do on the plot". Respondent 3 was the only one who stated to be limited in their experimentation, but not because of regulations from the allotment club or board, but of their own plot specific decision-making structure:

Yes, well, I'm limited by the fact that there are several of us doing it. [...] And then there's the added complication that my fellow gardener is actually the main gardener. [...] But apart from that, if I was doing it on my own, I don't think any board or anything like that would interfere. – Respondent 3

Most respondents stated, that they believed all relevant stakeholders get involved in decision making processes in the club. Respondent 1 for example stated that they "think they try to do it very democratically" which was also confirmed by respondent 2 (board member) who stated decisions of the board are based on a democratic majority voting. One respondent stated that club members were not heard in decision processes and were also mostly not even informed what decisions were made, saying:

I have the feeling that the board decides, does and implements things without me even realising it. So that. I might see it when I'm walking through the garden or something. [...] I think the board's information policy needs a lot of improvement. In this respect, also the other way round, if something is to be decided or something, then I don't realise that anyone outside the board is being asked. – Respondent 3

Also, the process that must be followed to get an allotment were described by the board member:

If you want to have an allotment garden site here, you first have to become a member. And I have raised the threshold to test the seriousness. Who is seriously interested in an allotment garden site? And then a $10 \in$ administration fee, because I also have to send letters. [...] then [the applicant] would have to make a drawing. How do I visualise the garden? I can see that straight away. If it's a pool and trampoline, then he knows, all right, there's no point, is there? And they must provide a drawing and answer my questions. – Respondent 2 (board member)

The answers regarding the adequacy of governance structures were, once again mixed, where it was stated by respondent 5 as not sufficient because they "believe that they [the board] don't dare, or perhaps they have too much negative experience" to enforce their governance on gardeners. Governance of the city of Hamburg was critiqued by respondent 5, for removing allotments in favour of housing, but also positively mentioned by respondent 2, as it provides allotments with cheap water "because we don't have any wastewater. [...] That's why the water is very cheap, that's why you could get by with 17 euros a year for water costs in the garden". Two respondents found it hard to differentiate whether the governance system was an issue, or the people in leading positions, saying:

But whether the structure is the problem, or whether you say that if you think about it 30 years into the future and you have people who are a bit open-minded and organised differently or don't think that because they've been doing it for 50 years, they somehow know better or something. So whether that's a structural problem, I can't say. – Respondent 8

Another struggle regarding the allotment site's governance was a decline in people who want to do voluntary work, with respondent 2 saying: "we are finding fewer and fewer volunteers who, like me, identify with some kind of voluntary work."

All respondents knew some of the legal regulations that apply to their allotment, with respondent 2 summarising the stated ones from all interviews:

So there is the Federal Allotment Garden Law [...]. And then there are also leaflets and guidelines from the regional association Hamburg for the use of an allotment garden site, so of an allotment garden or plot. [...] And then there are the statutes and garden regulations. – Respondent 2

As with the knowledge of the statues, also degree of which respondents were affected by the regulation differed. Most of the other respondents were only slightly affected by the regulations, where respondent 8 for example stated that they "don't feel restricted by the rules per se" and are only affected little, because they "don't have a garden that's just a lawn with a children's trampoline". In the opinion of respondent 5, the old board "gave all the liberties, so when the new board came in some years ago, other gardeners "who were used to this absolute generosity and non-management, I guess, were perhaps a little offended by the new board, which took a closer look" (Respondent 5).

Only three changes regulations were voiced by the interviewees, where two will be highlighted in the following. Hedge regulations were named by two respondents, where the issue for respondent 3 was that other allotment gardeners were able to bypass the height rules, by planting "a second row of trees or hedges" and for respondent 4 that the hedges are "just a field maple that's been planted as a hedge" which does not produce and flowers or berries. They stated that "for the insect world, I would like to see a different regulation" (Respondent 4). Respondent 3 would like a change in the dismantling regulations that are in place, when a plot lease is terminated, and the garden is prepared for the next tenant. They find rule problematic, not only because the dismantling can be costly for gardeners, but also see it as the reason for why many allotment gardens in Hamburg lie fallow, as they said:

I know from others, there are lots of plots that are empty. And you can't lease them either. Quite simply because people can no longer manage them. [...] And then they wanted to give it up, the garden. But then came this valuation. And that would have cost thousands. And so they said, no, I don't have the money. And then the garden is simply, and they just keep paying their rent. It costs 300 euros. Which is much cheaper. And that's the reason why so many plots in Hamburg lie fallow. – Respondent 3

They furthermore elaborated that if there is no activity on a plot for multiple consecutive years, "then there is the possibility of compulsory purchase, so to speak. And then the club also covers the costs" of removing structures before a new tenant. However, in their opinion it should be in the hands of the new tenant to decide "whether they want to take it over and continue to live with it" and have the new tenant take on "the obligation of possibly having to cut them down when he moves out" (Respondent 3).

6. Discussion

This chapter discusses the results in relation to previous research and the theoretical framework outlined in chapter 3. A presentation of this thesis' limitations will end the chapter.

6.1 Systematic review of governance structures

The systematic review led to a screening of 17 laws and policies that govern allotments in Hamburg. This shows the connection between allotments and the government's role in regulating and overseeing their operations, which is also stated by Colding at al. (2022b). Six documents were found that directly governed allotments, with four issued by Hamburg's umbrella allotment organization, the LGH, giving it much authority over allotment utilisation in Hamburg. A compliance with country law was stated within the LUAG, which aligns with Colding and Barthel's (2013) description of allotment associations enforcing their own rules within country laws.

In the US, community gardens often face challenges like expensive water access, exclusive plot fees, and insecure land access from municipalities (Delshad, 2022). Steps outlined by for successful municipal support of community gardens were affordable and reliable land access, an extension of municipal water lines, and an allocation of capacities for logistical support (*ibid*.). The BKleinG in Germany allows reasonable plot fees and requires municipalities to provide substitute land if terminating allotments (Bundestag, 2006). The LGH was also stated as the main lessor of municipal land for allotments in Hamburg, which aligns with literature stating that city authorities providing land for urban gardens (Kotsila et al., 2020). The studied site had access to municipal water lines at an affordable cost, as described in an interview. Lastly, regarding administrative support from the municipalities, there was no documentation found that suggested that the city of Hamburg assists either the LGH nor specific allotment clubs in regards to their plot management. However, cooperations between the allotment clubs/association and the city, suggest that while there is no explicit documentation found regarding administrative support from the municipality, some form of administrative or

logistical support is likely being provided by the city to the allotment gardens. This positions the studied allotment site in a way that eliminates the difficulties often faced in the US by providing reasonable priced and long-term secured land, cheap and effective water supply, and resources of the city for monitoring.

Overall, the governance documents address a wide range of topics, from soil protection, water balance, to the federal allotment law. However, despite the range of topics addressed, significant effort is required to bring them all together, as there is currently no centralised location of documents for allotment gardeners. This challenge was not only relevant in the data collection for the systematic review, but also to gardeners in allotments, as was noted by one interviewee. The respondent explained that the scattered nature of the documents places a burden on the small and declining pool of board members willing to engage in voluntary work.

Three reviewed documents, namely the BKleinG, the LUAG, and the LHM, indirectly mentioned the contributions of allotments to urban resilience, such as biodiversity, recreation, and microclimate management. However, the recognition given to the contributions of allotments was mostly limited to the immediate local area, failing to acknowledge the full multitude and scope of ES produced by allotments, which aligns with Langemeyer et al. (2015) who state that the full potential of ES provision of urban gardens is not accounted for enough in urban planning. Also, ES that are not within the found documents, but stated in literature, are for example: increasing air quality, dampening noise, contributing to overcoming flooding or heavy rainfall events, or being place for environmental education (BMUB, 2015).

Furthermore, no development, management, or future use plans for allotments from the city of Hamburg were identified in the systematic review, and food production was not a focus of the documents. It is unclear whether this is due to an absence of such plans or because a lack of public accessibility. This a matter that requires further inquiry, but is consistent with the rarity of urban food policies in large German cities that is stated in literature (Doernberg et al., 2019; Langemeyer et al., 2021).

6.2 Contributions of allotments to food security

This thesis assessed how allotments contribute to food security in urban settings through interviews with allotment gardeners, given that local food production and storage are stated to foster urban food security (Barthel and Isendahl, 2013). The interviews revealed that allotment gardening increased respondents' food availability, with some reporting a significant increase. Furthermore, the interviews

showed that respondents perceived the positive impact of urban food production on food chain equity and reduced externalities as they valued their homegrown food and the proximity of production highly. Hebinck et al. (2021) also state a positive contribution to food chain equity for all urban food practices, aligning with this finding. Also, the short transportation was appreciated by gardeners, which somewhat counteracts the non-considering of environmental externalities of food imports that takes place in urban land use planning (Langemeyer et al., 2021).

All respondents cultivated food such as berries, vegetables, and herbs on their allotment plots, and by that contributed to local food production through allotment gardening. This aligns with many studies on food production in urban gardens and allotments (Colding et al., 2022a, 2022b; Dietrich, 2014; Langemeyer et al., 2021; Kliem and Kulmann, 2022). The proximity of allotments to respondents' homes, with the furthest reported distance being 30 minutes by public transport, furthermore reduced vulnerability to global food supply disruptions, a benefit of UA also stated by Langemeyer et al. (2021), and supported local production, which is in literature further stated to reduce transportation costs (Burton et al., 2013; Colding and Barthel, 2013).

Some respondents felt their allotment plots could produce enough food to meet their own consumption needs. This finding aligns with the literature on urban food practices and the increasing regional self-sufficiency in such settings, where these can supplement traditional agricultural systems (CoDyre et al., 2015; Hebinck et al., 2021; Kliem and Kulmann, 2022). A study in Stuttgart showed that a single allotment plot could provide sustenance for over nine people, given similar rules of allocation as in Hamburg (Kliem and Kulmann, 2022), confirming respondents' perceptions. The literature further suggests that Hamburg has significant potential for self-sufficiency through organic agriculture and plant-based diets when excluding private and allotment gardens (Joseph et al., 2019). Including allotments could significantly enhance this potential, as, when applying the assumptions regarding cultivation area made in Stuttgart by Kliem and Kulmann (2022), Hamburg's allotment gardens would contribute an additional 1.7 km² of agricultural land, thereby addressing a significant constraint to regional self-sufficiency that was stated by Joseph et al. (2019).

The respondents did not indicate any dependence on allotment-grown food for financial reasons. While this finding does not directly contradict Augustin and Rosol's (2023) statement that some Germens depend on free or cheap food, it does not support their findings either. This discrepancy may be attributed to the limited sample size or sensitivity around disclosing food insecurity. However, the finding is consistent with existing literature that states that food production is not the primary focus for many urban gardeners (Kliem and Kulmann, 2022; Kowarik et

al., 2016). One respondent noted the potential of allotments to ensure food access during crises, which is also suggested by literature that highlight the role of local food sources in urban resilience (Barthel and Isendahl, 2013; Dietrich, 2014; Langemeyer et al., 2021). German policy, specifically the LFGB, may permit the marketing of allotment produce during crises (BMEL, 2022a), which is normally only permitted for personal use (Bundestag, 2006). This respondent also recalled that they were very glad to have the allotment during the COVID-19 pandemic, as they would not have to go food shopping in supermarkets, which is again consistent with Colding et al. (2022b) who state that experiences in nature support wellbeing in times of crisis, such as the COVID-19 pandemic.

Respondents furthermore believed allotment produce was tastier, fresher, and higher quality, increasing trust and consumption of nutrient-rich foods like unpeeled carrots. Respondents also reported an increased intake of fresh produce, due to the quantities available. This could be linked to the fact that visual and haptic contact with plants encourages healthier eating (Kliem and Kulmann, 2022). Preserving surplus produce further diversified diets and reduced waste, addressing a downfall of the current commercial food system that is also found in literature (Burton et al., 2013; FAO, 2013). The sense of wealth and autonomy that harvesting one's own foot provides (Kowarik et al., 2016) was also noted in one interview where the feeling of growing food for oneself was described as almost unaffordable. Food production and utilisation in allotments is also characterised by working together (Burton et al., 2013). This was the case for all interviewees as three managed their plots with friends and five with their families, including husbands, wives, children, or even grandchildren.

The results of this thesis showed that while the respondents were not dependent on their allotments for food access or availability, the act of gardening influenced both aspects and led to different food utilization. These urban food practices are reported to not only increase food security and capacities for adaption in times of crisis (Langemeyer et al., 2021), but also ecological resilience (Hebinck et al., 2021).

6.3 Contributions of allotments to urban resilience

Urban commons, like allotments, are institutions that regulate urban societal and natural resources (Colding et al., 2022a), increasing urban resilience by providing ES and locally produced food (Kliem and Kulmann, 2022; Langemeyer et al., 2021). The desired mix of ES from allotments in Germany, such as food production, relaxation, and recreation, is legitimised by policies and regulations. The following will contextualise the findings for each principle of ES management for resilience. Overall, an ES management for resilience should be balanced with flexibility,

allowing for adaptation to changing conditions while ensuring the system continues to provide the desired, needed, and legitimised ES.

6.3.1 Maintain diversity and redundancy

This thesis found that allotments contribute to maintaining diversity and redundancy, the first principle of resilient ES management, in multiple ways. Allotments consist of individually managed plots, that provide a variety of habitats, that support a variety of animals. Respondents strongly perceived biodiversity in animals like birds, insects, mammals, and worms, which aligns with the literature stating that the urban landscape requires different habitats fir different animal species (Colding et al., 2022b) and that allotments have a special function for biodiversity (Dietrich, 2014). Respondents also viewed allotments as urban spaces where crops like fruit trees can grow. They thus diversify food sources - a further contribution of allotments to urban resilience recognized in literature (Bundesinstitut für Bau-, Stadt- und Raumforschung, 2019; Colding et al., 2022a, 2022b; Dietrich, 2014; Langemeyer et al., 2021). However, some respondents were unsure about plant diversity, noting some plots prioritize children's activities and are strict with what may and may not grow. This does not necessarily contrast literature stating urban gardens' horticultural use creates habitats that increase biodiversity, like Kliem and Kulmann (2022), but contradicts with Dietrich (2014) who states that also the intense soil management, which often characterises allotments, can cause restrictions for certain plant and animal species. Overall, the multitude of species, varying plot utilization, and interacting institutions contribute to urban diversity and thus provide a basis for adaption.

For German allotments, redundancy is likely ensured through governing laws mandating each plot to have a similar composition including vegetables, fruit trees, shrubs, and lawns like the BKleinG and the LUAG. This leads to repetition across plots where the same types of plants and features are not guaranteed, but expected. Furthermore, the LHM promotes native plant species for hedges to support native animals, see LGH (2011), which contributes to increased redundancy as these species are limited in number and likely to be repeated across plots. Expanding such regulations to general plot management could broaden the redundancy further.

Biggs et al. (2012) note that excessive redundancy in management structures can impair management for resilience through power struggles or contradictory regulations. This study found no contradictory regulations, but struggles between gardeners and city planning over allotment site removal for housing and initiatives against policy regulations were mentioned in interviews. Though both issues were stated as (at least somewhat) resolved, but directly involving allotment gardeners more in the political dialogue might be a way to decrease tensions between policy

and gardeners. Furthermore, the complexity from high redundancy and diversity can hinder effective information processing pathways (Biggs et al., 2012). Interviews revealed some gardeners were unaware of changes like public bed establishments, potentially due to too many involved groups or lacking communication structures.

6.3.2 Manage slow variables and feedbacks

Respondents highlighted two key areas of slow variable management: soil quality and biodiversity. To enhance soil quality, they reported to loosen soil, use organic fertilizers, and have limited compaction. For biodiversity, they reported cultivating a variety of plant species, establishing wildlife habitats, and promoting the presence of pollinators. They particularly noted that preventing soil compaction is crucial for water management, as the less soil is compacted or covered, the more it contributes to the infiltration of water and the preservation of groundwater. Additionally, slow social variables, like legal systems, are in literature stated to impact ES (Biggs et al., 2012), which aligns with results of this study, as it was found that the BKleinG regulates land use to prevent excessive soil coverage, the BBodSchG sets standards for soil health, and the HWaG focuses on safe-guarding water resources.

This study found reinforcing feedbacks that support good gardening practices in knowledge sharing and biodiversity enhancement. The knowledge sharing through newsletters, magazines, and neighbour interactions reinforces collective knowledge of the allotment club. Even though none of the respondents stated that sharing knowledge was important for improving their gardening skills, some said that interesting information was shared that they liked to read again and that they needed to improve their knowledge to increase or to optimise their harvests. Regarding biodiversity, diverse plants attract pollinators and organisms that support greater biodiversity, as reported by gardeners observing flowering, diverse plant species, pollinators, and seed dispersal by birds. This again aligns with literature saying that flowers contribute to biodiversity (Colding et al., 2022b), that the ecological functions of allotment gardens especially consist of their potential to strengthen biodiversity (Dietrich, 2014), and that the horticultural use in allotments increases biodiversity (Kliem and Kulmann, 2022). Respondents also told how they grow plants, like flowers, roses, or fruit trees, for pollinators and described that as something environmentally interested gardeners do.

To effectively avoid regime shifts in SES, stabilizing feedbacks that maintain the system need to be managed without obscuring them, as this erodes resilience (Biggs et al., 2012). Gardeners in allotment gardens engage in balancing feedbacks, as for example natural predators, such as slugs that eat snails, which were the main pest reported by gardeners. These natural predators act as a dampening feedback that

regulates pest populations. Additionally, most gardeners utilize compost as a fertilizer that replenishes soil nutrients depleted by cultivation. Furthermore, allotment clubs can exclude and reassign plots from non-managing gardeners, which serves as another stabilizing feedback mechanism. This practice helps regulate the effects of non-management, such as the growth of invasive species, loss of diversity, pollution of the urban setting, or the spread of pests or diseases. By excluding members who fail to manage their gardens, the system's stability is kept.

While existing practices provide balancing feedbacks, there are opportunities for improvement. One suggestion is to introduce education regarding natural predator control, which could help maintain the dampening feedback provided by natural predators. This study also did not find continuous or enforced monitoring, as a monitoring of water or soil was reported to occur only if suspicions of product misuse within the site arise. Thus, implementing regular soil or water quality monitoring could benefit allotment clubs by allowing them to adjust management strategies. This proactive approach could also be applied at higher governance levels, as a critique of the BBodSchG was its focus on reacting to immediate risks rather than acting proactively. The interviews also revealed strong stabilizing feedbacks in allotment gardens, such as soil nutrition and biodiversity enhancement, with plot management protected by the BKleinG. However, these could be further strengthened by initiatives increasing knowledge on soil nutrient management or diverse plant species. Biggs et al. (2012) also propose maintaining regulating ES as an estimate for managing slow variables, which could be established and implemented by the LGH, as they govern individual allotment clubs in Hamburg and have available resources to assess a broader picture. Monitoring across levels is also stated to ensure recognition of nature conservation, sustainability, community, and citizen recreation that allotments provide across levels (Kliem and Kulmann, 2022), and would thus also target a downfall of the governance documents that were assessed in this study.

6.3.3 Foster an understanding of SES as CAS

This study found that allotments supported holistic views, with respondents reporting a changed feeling towards nature and getting a view on nature they would not obtain otherwise. However, none of the respondents specifically mentioned having a CAS worldview, despite describing slow variables and management practices that resemble feedback management. As there is only limited evidence available that the resilience of a system is directly enhanced by CAS thinking (Stockholm Resilience Centre, 2015), it's lack also does not necessarily impede resilience of the allotment site. It may however lead to stagnation (Biggs et al., 2012) which would leave the site vulnerable to disruption and unable to effectively

adapt. An important step towards fostering a CAS thinking in the studied site may be to establish monitoring, which would enable the according management approaches to be taken if threshold, like for example pollution levels, are crossed. Again could the LGH or even the BKD, which oversee Hamburg's allotment clubs or Germanys allotment associations respectively, be responsible for implementing this monitoring system. These associations are strategically positioned to conduct regular checks on, for example soil or water quality, across sites, analyse the results, and develop appropriate management strategies. The LGH in particular was in an interview stated to have access to experts who can provide guidance on management issues in allotments. Furthermore, the LGH can effectively communicate monitoring implications to gardeners through their already established communication channels, such as the magazine that is distributed to gardeners. This would ensure that valuable information reaches gardeners directly, promoting a more informed management approach across allotment sites. This monitoring system would also align with adaptive management, which is also a recognised way of enhancing resilience and avoiding undesirable transformation (Folke et al., 2010).

6.3.4 Encourage learning and experimentation

In SES, learning refers to individuals acquiring new or modifying existing skills, knowledge, values, or behaviours, and social learning occurs through groups or communities (Biggs et al., 2012). Respondents reported social learning through chats with neighbouring gardeners, newsletters, magazines from the association, and the option to consult experts from the association. The allotment site design, that prohibits enclosures to neighbouring plots as stated in the LUAG, furthermore supports observing and modelling practices, though not mentioned in the interviews. It is however a learning practice that takes place in allotments located in Sweden, as found by Barthel et al. (2010). The low hedges, that are typical for allotments, also allowed one respondent to observe practices of other gardeners for their own implementation. Intergenerational learning, with children learning from parents, was also mentioned in interviews. Barthel and Isendahl (2013) find that gardeners have knowledge that has often passed over generations, aligning with this finding. Overall, the different learning types found in the studied site highlight the in literature stated critical role of allotments in retaining and transmitting ecosystem management and food growth memories (Colding and Barthel, 2013; Dietrich, 2014) and their contribution to environmental learning (Colding et al., 2022a). The assumption of Biggs et al. (2012) that knowledge is always incomplete, which facilitates the need for learning, was shared by gardeners, like respondent 2 who stated one can never learn enough in the field of gardening. CoDyre et al. (2015) also state that to achieve the full self-provisioning potential of urban gardens,

gardening skills need to be increased, further aligning with respondent 2's statement.

In the interviews, experimentation was described as testing processes to determine the plants that could be successfully cultivated, providing gardeners with plotspecific knowledge. While experimentation occurred on individual plots, trust in the allotment site's leadership was reported as lacking, with comments about the board not enforcing rules or being stagnant. This erosion of social capital impedes site level experimentation. According to Biggs et al. (2012), experimentation requires leadership, trust, networks, and resources, but when this social capital is diminished, it must be rebuilt before experimentation can occur successfully. In the allotment site, this lack of trust in the sites immediate governance has made sitewide experimentation challenging and to move forward, either a building of social capital within the community or a provision from other scales is needed. An example proposed by respondents was changing the leadership system to a different model than a club structure, necessitating increased connections and cohesion within the site first. The interviews further showed that while the club provides options for experimentation on individual plots, this can be impeded by leadership structures on those plots, such as a respondent needing approval from their plot's main gardener.

Risks to ES resilience exist in how learning occurs. Influential actors like the club and association shape the learning process through newsletters and magazines, potentially impeding successful long-term management if topics like organic standards or ecological thinking are lacking, as mentioned in an interview. Institutional conditions act as facilitators and barriers to learning at different levels, guarding against dysfunctional or maladaptive learning that my impede resilience (Biggs et al., 2012). An example this thesis found is the NAP, where institutional measures review and develop regulations on synthetic plant protection product use, preventing the spread of knowledge relying on these products. Additionally, rules and regulations provide a clear framework for permitted experimentation areas, as the general allotment layout and permitted buildings are predefined in governing documents like the BKleinG.

6.3.5 Broaden participation

Participation refers to the active engagement of relevant actors in the governance and management of SES (Biggs et al., 2012) and thus refers to governance within the allotment site. To participate in an allotment garden, which means renting an allotment plot, the following steps, which were found in the systematic review and interviews, must be fulfilled: An application, a processing fee payment, a questionnaire, and a plot sketch must be submitted to the club. After joining the club and paying membership fees, then a valuated and defect-free plot is provided.

Respondents described democratic board decision-making and informing members through meeting protocols, which aligns with the democratic influence found in urban green commons (Colding et al., 2022a). Colding et al. (2022a) also state a non-member exclusion as a feature of urban green commons, which also aligns with findings of this thesis, as only members of the allotment club receive meeting protocols, magazines, and newsletters. However, not all gardeners seemed included in this information cycle, as one respondent also stated to be unknowing of decisions, like the aforementioned establishment of public beds. Participation of stakeholders with active ES management interests or relevant knowledge are further features of resilient ES management described by Biggs et al. (2012) that were present in the studied site Every gardener has interests in managing ES like relaxation or food cultivation and holds local knowledge like soil quality details. Diverse stakeholder participation is stated to improve legitimacy, shock detection and interpretation capacity, and to facilitate monitoring and enforcement (Biggs et al., 2012). While governance legitimacy on the studied site was already elaborated on, an increased member inclusion in decision-making could improve it. Especially as this was something that a participant actively critiqued. More participatory processes could also increase transparency in leadership structures (Biggs et al., 2012), another issue raised.

The allotment site under study lacks social capital that links the gardeners to their governance (the board). Biggs et al. (2012) state that ES degradation is risked, when participation fails to increase social capital. The need for building social capital can be derived from the reported non-acceptance of the board and the missing trust in its decisions. An outcome of the lacking interactions of the gardeners and the board could be that new regulations of the site, like for example integrated pest management practices, are not effectively communicated and thus not enforced or that more participatory governance structures can't be tested. This risks the continuation of management practices that negatively affect the sites resilience. Also, the groups included in participation processes must be considered, as shortterm gains can degrade long-term resilience (Elmqvist et al., 2019). One respondent mentioned allotments grouping people from different backgrounds, including those wanting quick results in food cultivation, which could lead to increased synthetic inputs and decreased resilience if included more in management while increasing participation in governance. Despite legal compliance requirements, negative resilience impacts would be possible. Devolving resource management responsibilities without enforcement authority can also degrade ES resilience (Biggs et al., 2012). However, in this case, the allotment clubs' decentralized management responsibilities are protected against degradation by federal and state laws like BNatSchG, BBodSchG, BaumschutzVO, and HmbBNatSchG, representing the highest authority and effectively allocating authority for comanagement.

6.3.6 Higher levels of governance

This study found hierarchical governance on multiple levels: allotment tenants who are responsible for their plots, the allotment club as well as Hamburg's allotment association (LGH) and city laws governing the site, and the federal association of allotment associations (BDK) and federal laws influencing all lower levels. This division into club and association structures is an important allotment characteristic (Kliem and Kulmann, 2022) and allows a green space management that is not executed by but in cooperation with the city. The different governance systems outline what is allowed in allotments to fulfil ES management objectives like protection of plants, trees, soil, and water.

A governance struggle on city level referred to in the interviews was the removal of an allotment site in favour of housing mentioned by respondent 5, which is a challenge of allotments that is also recognised in literature (Bundesinstitut für Bau, Stadt- und Raumforschung, 2019; Kotsila et al., 2020). This challenging position of allotments needs to be shifted so that urban planning accounts for their impacts recreating urban space (Hebinck et al., 2021; Kotsila et al., 2020), and their reconnection of residents to life-supporting systems, and integration of food production back into the urban (Barthel and Isendahl, 2013). Kotsila et al. (2020) also reported that allotment gardeners often lack organization to influence policies they depend on, though one respondent revealed German gardeners successfully changed unfavourable policies and thus contradicting this finding.

While allotments' historical presence theoretically allowed time for capital and trust building, concerns about board execution and transparency were voiced. This indicates that the system in place may be limited in its effectiveness and could be improved. However, respondents were not sure if the system or the people within leadership positions are the issue. Finding volunteers for board positions was also reported as a challenge, as these positions are, in a German assessment of allotments, stated to require substantial free time and commitment (Bundesinstitut für Bau-, Stadt- und Raumforschung, 2019). This suggests that designs, which better fit new contexts, may be needed in struggling sites.

Respondents were also asked whether they wanted to change any of the governance structures or the regulations imposed on them, where specifically the proposed change regarding the plot valuation and clearing might be effective. A study of allotment gardens in Germany found that in large and growing cities, the demand for allotment gardens often exceeds the supply available (Bundesinstitut für Bau-, Stadt- und Raumforschung, 2019). Thus, regulations that discourage people from terminating their allotment due to the fear of costs and efforts of dismantling existing structures could be adjusted. This would increase the number of plots available for new tenants, thereby better meeting the high demand for allotments.

6.4 Limitations

This study is limited by its scope and the time available it, which led to a small number of interviews and a shortened policy review. A further limitation of the policy review is that potentially important documents, like the club statue, were not publicly available, and, because of that, could not be assessed and reviewed. Also were all except one respondent sourced by a board member of the studied site. Even though a mixture of people, backgrounds, ages, and garden management practices was tried to be achieved, this has likely had some influence on the results of this thesis. Lastly, the participants who agreed to be interviewed for this thesis, likely already had an interest in resilience and food security contributions of allotments, limiting the applicability of the thesis' results. This means that having more gardeners available for interviews could have yielded different results, not only regarding management practices like fertiliser and plant protection product usage, but also regarding the cultivation of food.

7. Conclusion

This thesis set out to explore an allotment in Hamburg, Germany, as a case study in terms of urban resilience and food security issues, to provide insights into the policies surrounding these topics, and the extent to which practices in a German allotment site contribute to urban resilience and the food security of gardeners. For this, two research questions were formulated: 1) What are the legal structures governing the use of allotments in Hamburg, Germany on food security and urban resilience and how are they perceived? And 2) How does an allotment garden in Hamburg, Germany contribute to the food security of its members and to urban resilience?

This thesis also identified multiple governance documents for allotments in Hamburg across different levels to answer the first research question. These ranged from federal laws like the BKleinG or the BNatSchG, to state laws like the HmbBNatSchG, to regulations issued by Hamburg's umbrella allotment organization. This thesis found that German allotment are positioned in a way that eliminates difficulties urban gardens often face in the US, but that the scattered nature places a burden on the small and declining pool of board members, and that the recognition given to allotments fails to acknowledge the full scope and multitude of ES provided by allotments. Having possibilities for local food production and storage is known to foster food security in urban settings and the results of this thesis illustrate a similar situation in Hamburg, thereby answering the second research question. Interviews with allotment gardeners revealed that they had an increased food availability, awareness of food sources, utilization of fresher and higher-quality produce, and practices like preserving surplus food contributing to their food security. While not financially dependent on allotments, food production and social activities in the allotments were beneficial to the gardeners interviewed in this study in terms of food access, utilization, and social aspects around food. The interviews showed that allotments contribute to urban resilience through several mechanisms aligned with resilient ES management principles, where 1) diversity and redundancy are maintained through varied plot uses, biodiversity, and diversification of urban food sources, 2) reinforcing feedbacks like knowledge sharing and biodiversity enhancement, as well as dampening feedbacks like maintaining soil fertility are facilitated, and 3) learning through newsletters, neighbour interactions, and intergenerational knowledge transfer about ecosystem management and food growth is enabled. The interviewed allotment gardeners were also aware of the governing documents that directly mentioned allotments, however not of regulations that specify on agricultural or horticultural land use. Specific regulations were appreciated by them and only three changes to the regulations were wished for.

For the allotment site under study, this thesis finds that an involvement of gardeners in the urban political level could reduce tensions of long-term land use planning. This could foster an understating of benefits of allotments outside of recreation, like their contributions to food security. Also, expanding CAS thinking in the site is a leverage point that may enhance management for resilience for multiple resilience management principles. Lastly, the trust in the sites governance as well as a stronger presence of regulations that foster important slow variables like soil quality could increase the resilience of the studied allotment and the contributions to urban resilience.

Future research can build upon the implications of this study and the presented results. First, a broadened review of governance documents could be executed, that includes also policies that were not assessed or excluded based on the defined criteria in this study. This may yield findings regarding future use, management, or development plans that were not found in this study. Second, an assessment of city self-sufficiency potentials that includes specifically allotments would bring insights into the contributions of urban gardens to these potentials and their capacity to support food security in times of crisis. Third, interviewing more allotment gardeners may also reduce a mayor limitation of this thesis and yield other or more generalisable results in terms of contributions of allotments to food security, urban resilience, and the perception of governance structures. Fourth, aspects of resilience that were not assessed in this thesis like infrastructure or water management be explored in other studies. Lastly, as respondents identified that it was more expensive to grow food in allotments than to buy it in supermarkets, it would be interesting to examine if this yielded new perspectives on food pricing in these markets and in what ways allotments would influence food shopping practices, due to the negative connotations to synthetic plant protection and fertilisers.

References

- Adams, W, 2015. Conducting Semi-Structured Interviews. In: Newcomer, Kathryn; Harty, Harry P.; Wholey, Joseph S. *Handbook of Practical Program Evaluation*. Fourth Edition, Jossey-Bass.
- Andersson, E., Grimm, N.B., Lewis, J.A., Redman, C.L., Barthel, S., Colding, J., Elmqvist, T., 2022. Urban climate resilience through hybrid infrastructure. Current Opinion in Environmental Sustainability. 55, 101158. https://doi.org/10.1016/j.cosust.2022.101158
- Augustin, H., Rosol, M., 2023. Beiträge kommunaler Planung für mehr Ernährungssicherheit in deutschen Städten. Angewandte Geographie. https://doi.org/10.1007/s00548-023-00840-7
- Barthel, S., Folke, C., Colding, J., 2010. Social–ecological memory in urban gardens—Retaining the capacity for management of ecosystem services. Global Environmental Change 20, 255–265. https://doi.org/10.1016/j.gloenvcha.2010.01.001
- Barthel, S., Isendahl, C., 2013. Urban gardens, agriculture, and water management: Sources of resilience for long-term food security in cities. Ecological Economics Sustainable Urbanisation: A resilient future 86, 224– 234. https://doi.org/10.1016/j.ecolecon.2012.06.018
- Benton, T. G., Bieg, C., Harwatt, H., Pudasaini, R., Wellesley, L., 2021. Food system impacts on biodiversity loss - Three levers for food system transformation in support of nature, Energy, Environment and Resources Programm. Chatham House.
- Berkes, F., Colding, J., Folke, C. (Eds.), 2002. Navigating Social-Ecological Systems: Building Resilience for Complexity and Change. Cambridge University Press, Cambridge. https://doi.org/10.1017/CBO9780511541957
- Biggs, R., Schlüter, M., Biggs, D., Bohensky, E. L., BurnSilver, S., Cundill, G., Dakos, V., Daw, T.M., Evans, L.S., Kotschy, K., Leitch, A.M., Meek, C., Quinlan, A., Raudsepp-Hearne, C., Robards, M.D., Schoon, M.L., Schultz, L., West, P.C., 2012. *Toward Principles for Enhancing the Resilience of Ecosystem Services*. The Annual Review of Environment and Resources 37, 28. https://doi.org/10.1146/annurev-environ-051211-123836
- BMEL, 2023. Düngung. https://www.bmel.de/DE/themen/landwirtschaft/pflanzen bau/ackerbau/duengung.html (2024-04-07).
- BMEL, 2022a. Lebensmittel-, Bedarfsgegenstände- und Futtermittelgesetzbuch (Lebensmittel- und Futtermittelgesetzbuch - LFGB). https://www.gesetzeim-internet.de/lfgb/ (2023-03-08).
- BMEL, 2022b. Nationaler Aktionsplan zur nachhaltigen Anwendung von *Pflanzenschutzmitteln* https://www.bmel.de/DE/themen/landwirtschaft/pfl anzenbau/pflanzenschutz/aktionsplan-anwendungpflanzenschutzmittel.html (2024-04-07).
- BMEL, 2013. National Action Plan on Sustainable Use of Plant Protection Products. Federal Ministry of Food and Agriculture. https://food.ec.europa.eu/system/files/2019-03/pesticides_sup_nap_deu_e

n.pdf

- BMEL, BMUV, BMF, Bundesrat, 2021. Verordnung über die Anwendung von Düngemitteln, Bodenhilfsstoffen, Kultursubstraten und Pflanzenhilfsmitteln nach den Grundsätzen der guten fachlichen Praxis beim Düngen (Düngeverordnung - DüV). Düngeverordnung vom 26. Mai 2017 (BGBl. I S. 1305), das zuletzt durch Artikel 97 des Gesetzes vom 10. August 2021 (BGBl. I S. 3436) geändert worden ist.
- BMUB, 2015. Grün in der Stadt: Für eine lebenswerte Zukunft Grünbuch Stadtgrün. Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit, Bonn.
- BMUV, 2022. Key points for a reform of national soil protection law. https://www.bmuv.de/fileadmin/Daten_BMU/Download_PDF/Bodenschut z/eckpunktepapier novelle bodenschutzrecht en bf.pdf
- z/eckpunktepapier_novelle_bodenschutzrecht_en_bf.pdf Bryman, A., 2012. *Social Research Methods*, 4th edition. Oxford University Press.
- Bukamal, H., 2022. Deconstructing insider-outsider researcher positionality. Br. J. Spec. Educ. 49, 327–349. https://doi.org/10.1111/1467-8578.12426
- Bundesinstitut für Bau-, Stadt- und Raumforschung (Ed.), 2019. Kleingärten im Wandel: Innovationen für verdichtete Räume, Dezember 2018. Bundesinstitut für Bau-, Stadt,- und Raumforschung im Bundesamt für Bauwesen und Raumordnung, Bonn.
- Bundesregierung, 2023. Gesetzentwurf der Bundesregierung: Entwurf eines Bundes-Klimaanpassungsgesetzes (KAnG). https://www.bmuv.de/fileadmi n/Daten_BMU/Download_PDF/Glaeserne_Gesetze/20._Lp/kang_gesetz/E ntwurf/kang_entwurf_bf.pdf
- Bundestag, 2023. Gesetz zur Ordnung des Wasserhaushalts (Wasserhaushaltsgesetz - WHG). Wasserhaushaltsgesetz vom 31. Juli 2009 (BGBl. I S. 2585), das zuletzt durch Artikel 7 des Gesetzes vom 22. Dezember 2023 (BGBl. 2023 I Nr. 409) geändert worden ist.
- Bundestag, 2022. Gesetzt über Naturschutz und Landschaftspflege (Bundesnaturschutzgeetzt - BNatScG). Bundesnaturschutzgesetz vom 29. Juli 2009 (BGBl. I S. 2542), das zuletzt durch Artikel 5 des Gesetzes vom 8. Mai 2024 (BGBl. 2024 I Nr. 153) geändert worden ist.
- Bundestag, 2021. Gesetz zum Schutz vor schädlichen Bodenveränderungen und zur Sanierung von Altlasten (Bundes-Bodenschutzgesetz - BBodSchG). Bundes-Bodenschutzgesetz vom 17. März 1998 (BGBl. I S. 502), das zuletzt durch Artikel 7 des Gesetzes vom 25. Februar 2021 (BGBl. I S. 306) geändert worden ist.
- Bundestag, 2006. *Bundeskleingartengesetz*. Bundeskleingartengesetz vom 28. Februar 1983 (BGBl. I S. 210), das zuletzt durch Artikel 11 des Gesetzes vom 19. September 2006 (BGBl. I S. 2146) geändert worden ist.
- Bundestag, Bundesrat, 2022. *Düngegesetz*. Düngegesetz vom 9. Januar 2009 (BGBl. I S. 54, 136), das zuletzt durch Artikel 2 Absatz 13 des Gesetzes vom 20. Dezember 2022 (BGBl. I S. 2752) geändert worden ist.
- Bundestag, Bundesrat, 2012. Gesetz zum Schutz der Kulturpflanzen (Pflanzenschutzgesetz - PflSchG). Pflanzenschutzgesetz vom 6. Februar 2012 (BGBl. I S. 148, 1281), das zuletzt durch Artikel 2 Absatz 15 des Gesetzes vom 20. Dezember 2022 (BGBl. I S. 2752) geändert worden ist.
- Bürgerschaft der Freien und Hansestadt Hamburg, 2023. Hamburgische Baumschutzverordnung (BaumschutzVO). Verkündet als Artikel 1 der Verordnung zur Neuregelung des Hamburgischen Baumschutzrechts vom 28. Februar 2023 (HmbGVBl. S. 81).
- Bürgerschaft der Freien und Hansestadt Hamburg, 2020. Hamburgisches Gesetz zur Ausführung des Bundesnaturschutzgesetzes (HmbBNatSchAG). Verkündet als Artikel 1 des Gesetzes zur Neuregelung des Hamburgischen

Landesrechts auf dem Gebiet des Naturschutzes und der Landschaftspflege zuletzt geändert durch Gesetz vom 24. Januar 2020 (HmbGVBl. S. 92)

- Bürgerschaft der Freien und Hansestadt Hamburg, 2018. Hamburgisches Abwassergesetz (HmbAbwG). Hamburgisches Abwassergesetz (HmbAbw G) In der Fassung vom 24. Juli 2001 zuletzt geändert durch Artikel 5 des Gesetzes vom 23. Januar 2018 (HmbGVBl. S. 19, 27)
 Bürgerschaft der Freien und Hansestadt Hamburg, 2005. Hamburgisches
- Bürgerschaft der Freien und Hansestadt Hamburg, 2005. *Hamburgisches Wassergesetz (HWaG)*. Hamburgisches Wassergesetz (HWaG) in der Fassung vom 29. März 2005 zuletzt geändert durch Artikel 12 des Gesetzes vom 4. Dezember 2012 (HmbGVBl. S. 510. 519).
- Burton, P., Lyons, K., Richards, C., Amati, M., Rose, N., Desfours, L., Pires, V., Barclay, R., 2013. *Urban food security, urban resilience and climate change*. National Climate Change Adaptation Research Facility, Gold Coast.
- BV HH, n.d. Entwicklung im Bereich der Kleingärten im Bezirk Wandsbek. https://bv-hh.de/wandsbek/documents/entwicklung-im-bereich-derkleingaerten-im-bezirk-wandsbek-4261 (2023-10-23).
- Charmaz, K., 2006. Constructing Grounded Theory A Parctical Guide through Qualitative Analysis. SAGE Publications. ISBN-10 0-7619-7352-4.
- Climate ADAPT, 2022. Four pillars to Hamburg's Green Roof Strategy: financial incentive, dialogue, regulation, and science. https://climate-adapt.eea.europa.eu/en/metadata/case-studies/four-pillars-to-hamburg2019 s-green-roof-strategy-financial-incentive-dialogue-regulation-and-science (2024-05-13).
- Coates, J., Swindale, A., Bilinsky, P., 2007. Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide. Version 3. https://doi.org/10.1037/e576842013-001
- CoDyre, M., Fraser, E.D.G., Landman, K., 2015. *How does your garden grow? An empirical evaluation of the costs and potential of urban gardening*. Urban For. Urban Green. 14, 72–79. https://doi.org/10.1016/j.ufug.2014.11.001
- Colding, J., Barthel, Stephan, 2013. *The potential of 'Urban Green Commons' in the resilience building of cities*. Ecological Economics, Sustainable Urbanisation: A resilient future 86, 156–166. https://doi.org/10.1016/j.ecolecon.2012.10.016
- Colding, J., Barthel, Stephan, Ljung, R., Eriksson, F., Sjöberg, S., 2022a. Urban Commons and Collective Action to Address Climate Change. Social Inclusion 10, 103–114. https://doi.org/10.17645/si.v10i1.4862
- Colding, J., Giusti, M., Haga, A., Wallhagen, M., Barthel, Stephan, 2020. *Enabling Relationships with Nature in Cities*. Sustainability 12, 4394. https://doi.org/10.3390/su12114394
- Colding, J., Samuelsson, K., Marcus, L., Gren, Å., Legeby, A., Berghauser Pont, M., Barthel, S., 2022b. *Frontiers in Social–Ecological Urbanism*. Land 11, 929. https://doi.org/10.3390/land11060929
- Delshad, A.B., 2022. Community gardens: An investment in social cohesion, public health, economic sustainability, and the urban environment. Urban Forestry & Urban Greenery 70. https://doi.org/10.1016/j.ufug.2022.127549
- Dietrich, K., 2014. Urbane Gärten für Mensch und Natur: eine Übersicht und Bibliographie, BfN-Skripten. BfN Bundesamt für Naturschutz, Bonn. https://www.bfn.de/sites/default/files/BfN/service/Dokumente/skripten/skr ipt386.pdf
- Doernberg, A., Horn, P., Zasada, I., Piorr, A., 2019. Urban food policies in German city regions: An overview of key players and policy instruments. Food Policy 89, 101782. https://doi.org/10.1016/j.foodpol.2019.101782

- Egerer, M., Fouch, N., Anderson, E.C., Clarke, M., 2020. Socio-ecological connectivity differs in magnitude and direction across urban landscapes. Nature Research. 10, 4252. https://doi.org/10.1038/s41598-020-61230-9
- Elmqvist, T., Andersson, E., Frantzeskaki, N., McPhearson, T., Olsson, P., Gaffney, O., Takeuchi, K., Folke, C., 2019. Sustainability and resilience for transformation in the urban century. Nature Sustainability 2, 267–273. https://doi.org/10.1038/s41893-019-0250-1
- Elsevier Author, 2022. Systematic Literature Review or Literature Review. https://scientific-publishing.webshop.elsevier.com/research-process/syste matic-literature-review-or-literature-review/ (2023-11-20).
- FAO, 2017. Integrated Food Security Phase Classification Evidence and Standards for Better Food Security. https://www.ipcinfo.org/fileadmin/user upload/ipcinfo/docs/1 IPC Brochure 2017.pdf.
- FAO, 2013. Food Wastage Footprint. Impact on Natural Resources. Summary Report. https://www.fao.org/4/i3347e/i3347e.pdf.
- FAO, 2008. An Introduction to the Basic Concepts of Food Security. United Nations. https://www.fao.org/fileadmin/user_upload/eufao-fsi4dm/docs/concepts_guide.pdf
- Folke, Carl, Carpenter, S.R., Walker, B., Scheffer, M., Chapin, T., Rockstrom, J., 2010. *Resilience Thinking: Integrating Resilience*, Adaptability and Transformability. Adapt Transform Ecology & Society 15(4): 20. http://www.ecologyandsociety.org/vol15/iss4/art20/
- GAFS, 2023. Global Food and Nutrition Security Dashboard. https://www.gafs.info/map/?state=Advice&country=Global&indicator=N CD BMI 25A (2023-10-23).
- Gladek, E., Fraser, M., Roemers, G., Muñoz, O.S., Kennedy, E., Hirsch, P., 2017. *The Global Food System: An Analysis.* WWF Netherlands. https://www.metabolic.nl/publications/global-food-system-an-analysispdf/
- Guitart, D., Pickering, C., Byrne, J., 2012. Past results and future directions in urban community gardens research. Urban Forestry & Urban Greenery 11, 364–373. https://doi.org/10.1016/j.ufug.2012.06.007
- Hamburg.de (n.d.) Hamburg's Kleingärten green homes away from home. https://www.hamburg.com/residents/green/13889376/kleingaerten/ (2023.10.20).
- Hamburg.de, 2023. *Hamburg-Wandsbek* https://www.hamburg.com/residents/ne ighbourhoods/11750532/wandsbek/ (2023.10.19).
- Harms, H., Schubert, D., 1989. Wohnen in Hamburg: ein Stadtführer zu 111 ausgewählten Beispielen, Stadt, Planung, Geschichte. Hans Christians Verlag. 978-3767210790.
- Hawes, J.K., Goldstein, B.P., Newell, J.P., Dorr, E., Caputo, S., Fox-Kämper, R., Grard, B., Ilieva, R.T., Fargue-Lelièvre, A., Poniży, L., Schoen, V., Specht, K., Cohen, N., 2024. Comparing the carbon footprints of urban and conventional agriculture. Nature Cities 1, 164–173. https://doi.org/10.1038/s44284-023-00023-3
- Haysom, G., Battersby, J., 2023. Urban Food Security and Resilience, in: Béné, C., Devereux, S. (Eds.), Resilience and Food Security in a Food Systems Context, Palgrave Studies in Agricultural Economics and Food Policy. Springer International Publishing, Cham, pp. 355–388. https://doi.org/10.1007/978-3-031-23535-1 11
- Hebinck, A., Selomane, O., Veen, E., de Vrieze, A., Hasnain, S., Sellberg, M., Sovová, L., Thompson, K., Vervoort, J., Wood, A., 2021. *Exploring the transformative potential of urban food*. Urban Sustainability 1, 1–9. https://doi.org/10.1038/s42949-021-00041-x

- Holling, C.S., 2001. Understanding the Complexity of Economic, Ecological, and Social Systems. Ecosystems 4, 390–405.
- Joseph, S., Peters, I., Friedrich, H., 2019. Can Regional Organic Agriculture Feed the Regional Community? A Case Study for Hamburg and North Germany. Ecol. Econ. 164. https://doi.org/10.1016/j.ecolecon.2019.05.022
- Jumle, V., 2022. *Germany's food supply depends on these countries*. Tagesspiegel. https://interaktiv.tagesspiegel.de/lab/german-imports-from-rice-to-chocola te-germanys-food-supply-depends-on-these-countries/ (2023-10-20).
- Kliem, L., Kulmann, M., 2022. Reiche Ernte in Berliner und Stuttgarter Gärten -Nahrungsmittelproduktion in Gemeinschaftsgärten, Kleingärten und auf Mietäckern in Berlin und Stuttgart. GartenLeistungen Arbeitsbericht, Berlin. https://www.ioew.de/fileadmin/user_upload/BILDER_und_Downl oaddateien/Publikationen/2022/Kliem_Kuhlmann_2022_Reiche_Ernte_in _Berliner_und_Stuttgarter_Gaerten.pdf
- Kolbe, C., 2022. Selbstversorgung im Zweiten Weltkrieg: Die große Gartenschlacht. Spiegel. https://www.spiegel.de/geschichte/selbstversorgu ng-im-zweiten-weltkrieg-die-grosse-gartenschlacht-a-21e1e300-1710-41dc-9e53-4c74caf034ec
- Kotsila, P., Hörschelmann, K., Anguelovski, I., Sekulova, F., Lazova, Y., 2020. Clashing temporalities of care and support as key determinants of transformatory and justice potentials in urban gardens. Cities 106, 14. https://doi.org/10.1016/j.cities.2020.102865
- Kowarik, I., Bartz, R., Brenck, M., 2016. Ökosystemleistungen in der Stadt: Gesundheit schützen und Lebensqualität erhöhen. Naturkapital Deutschland - TEEB DE, Leipzig Berlin. 978-3-944280-35-6.
- Langemeyer, J., Madrid-Lopez, C., Mendoza Beltran, A., Villalba Mendez, G., 2021. Urban agriculture a necessary pathway towards urban resilience and global sustainability? Landscape & Urban Planning 210. https://doi.org/10.1016/j.landurbplan.2021.104055.
- LGH, 2024. Fragen und Antworten zu Hamburger Kleingärten (Dauerbleibe). https://www.gartenfreunde-hh.de/vereine/haeufige_fragen/ (2024-04-08).
- LGH, 2023. Satzung Landesbund der Gartenfreunde in Hamburg e.V. https://www.gartenfreunde-hh.de/ueberuns/lgh-satzung/
- LGH, 2021. Merkblatt zur Nutzung von Kleingärten in Hamburg. https://www.gart enfreunde-hh.de/vereine/infothek/merkblaetter-dokumente/
- LGH, 2019. Merkblatt über die Nutzung von Wasserversorgungs- und Abwasserbeseitigungsanlagen auf Kleingartenparzellen. Landesverbund der Gartenfreunde in Hamurg e.V. https://www.gartenfreundehh.de/vereine/infothek/merkblaetter-dokumente/
- LGH, 2011. Merkblatt zur Heckenpflege. Landesverbund der Gartenfreunde in Hamurg e.V. https://www.gartenfreunde-hh.de/vereine/infothek/merkblaet ter-dokumente/
- Lincoln, Y.S., Guba, E.G., 1985. Naturalistic Inquiry. SAGE Publications. 978-0803924314
- Loorbach, D., Frantzeskaki, N., Avelino, F., 2017. Sustianability Transitions Research: Tranforming Science and Practice for Societal Change. Annual Review of Environmen & Resources 42, 599–626. https://doi.org/10.1146/annurev-environ-102014-021340
- Manikas, I., Ali, B.M., Sundarakani, B., 2023. A systematic literature review of indicators measuring food security. Agriculture & Food Security12. https://doi.org/10.1186/s40066-023-00415-7
- Pascoe, K.M., Waterhouse-Bradley, B., McGinn, T., 2021. Systematic Literature Searching in Social Work: A Practical Guide With Database Appraisal. Research on Social Work Practice 31, 541–551. https://doi.org/10.1177/1049731520986857

- Port of Hamburg, 2017. *Foodstuffs*. Port of Hamburg magazine. https://www.hafen-hamburg.de/site/assets/files/164719/hhm_pohhmagazin 3-17-eng-final-8.pdf
- Rekowski, S. von, 2024. Zahlen, Daten, Fakten.... BKD. https://kleingartenbund.de/zahlen-daten-fakten/ (2024-05-14).
- Ritchie, H., Rosado, P., Roser, M., 2022. *Environmental Impacts of Food Production*. Our World Data. https://ourworldindata.org/environmentalimpacts-of-food (2023-08-12).
- Robson, C., McCartan, K., 2016. Real World Research: A Resource for Users to Social Research Methods in Applied Settings, Fourth Edition. ed. Wiley, Chichester. 978-1-118-74523-6
- Röpke, G.-W., 1994. Wandsbeck informativ Das Buch. Heinevetter. 3-939272-51-1
- Sanz Sanz, E., Walthall, B., Napoleone, C., Vicente-Vicente, J.-L., Hinojosa, L., Piorr, A., 2023. Choosing modelling approaches for participatory food governance in city-regions. Comprehensive guidelines for a systemperspective selection. E Environmental Science & Policy 145, 139–150. https://doi.org/10.1016/j.envsci.2023.03.021
- Schafiyha, A., Knupp, L., 2023. Ranking 2023: Das sind die größten Städte Deutschlands nach Einwohnerzahl https://www.wiwo.de/erfolg/trends/ran king-2023-das-sind-die-groessten-staedte-deutschlands-nach-einwohnerza hl/27461152.html (2023-10-19).
- Sieveking, A.B.E., 2021. Food Policy Councils: Levers for Sustainability Transformation? Diss. Leuphana University of Lüneburg. https://pubdata.leuphana.de/frontdoor/index/index/docId/1188
- Steffen, W., Broadgate, W., Deutsch, Gaffney, O., Ludwig, C., 2015. *The Trajectory of the Anthropocene: The Great Acceleration*. The Anthropocene Review 1(18). https://doi.org/10.1177/2053019614564785
- Stockholm Resilience Centre, 2015. Applying resilience thinking: Seven principles for building resilience in social-ecological systems. https://www.stockholmresilience.org/download/18.10119fc11455d3c557d 6928/1459560241272/SRC+Applying+Resilience+final.pdf
- Sundström, J.F., Albihn, A., Boqvist, S., Ljungvall, K., Marstorp, H., Martiin, C., Nyberg, K., Vågsholm, I., Yuen, J., Magnusson, U., 2014. Future threats to agricultural food production posed by environmental degradation, climate change, and animal and plant diseases – a risk analysis in three economic and climate settings. Food Security 6. https://doi.org/10.1007/s12571-014-0331-y
- Sutton, J., Austin, Z., 2015. *Qualitative Research: Data Collection, Analysis, and Management*. CJHP. 68, 226–231. CJHP
- Tawfik, G.M., Dila, K.A.S., Mohamed, M.Y.F., Tam, D.N.H., Kien, Nguyen Dang, Ahmed, A.M., Huy, N.T., 2019. *A step by step guide for conducting a systematic review and meta-analysis with simulation data*. Tropical Medicine and Health 47. https://doi.org/10.1186/s41182-019-0165-6
- UN Atlas of the Ocean, 2016. *Human settlements on the Coast.* https://www.oceansatlas.org/subtopic/en/c/114/ (2024-05-13).
- United Nations, 2023a. The Sustainable Development Goals Report Special edition. https://unstats.un.org/sdgs/report/2023/?_gl=1*1c4yxga*_ga*MTk 5MDc4ODc4My4xNjc0NDgzNTQw*_ga_TK9BQL5X7Z*MTY5ODA2 NTM0Ny4xLjEuMTY5ODA2NTQyNS4wLjAuMA..

United Nations, 2023b. The 17 Goals. https://sdgs.un.org/goals (2023-11-20).

Universal Declaration of Human Rights, 1948.

Wesener, A., Fox-Kämper, R., Sondermann, M., Münderlein, D., 2020. Placemaking in Action: Factors That Support or Obstruct the Development of Urban Community Gardens. Sustainability 12, 657. https://doi.org/10.3390/su12020657

- Wettengel, J., 2023. German law to set rules for climate adaptation efforts at national and state level. Clean Energy Wire. https://www.cleanenergywire.org/news/german-law-set-rules-climate-adaptation-efforts-national-and-state-level (2024-01-29).
- Wittenberg, J., Gernert, M., El Bilali, H., Strassner, C., 2022. Towards Sustainable Urban Food Systems: Potentials, Impacts and Challenges of Grassroots Initiatives in the Foodshed of Muenster, Germany. Sustainability 14, 13595. https://doi.org/10.3390/su142013595
- World Bank, 2023. Urban Development. World Bank. https://www.worldbank.or g/en/topic/urbandevelopment/overview (2023-09-11).
- World Food Summit, 1996. The Rome Declaration on World Food Security.

Popular science summary

Large cities typically rely on the global food system of industrial agriculture, to feed more than half of the global population. For people living in cities, food security was always regarded as a key resilience feature and food security is again gaining recognition as a problem facing urban populations. As having possibilities for local food production and storage is known to foster food security in urban settings, this thesis explored contributions of an allotment site in Hamburg, Germany, to food security and urban resilience. For this, the following two research questions were formulated: What are the legal structures governing the use of allotments in Hamburg, Germany on food security and urban resilience and how are they perceived? And how does an allotment garden in Hamburg, Germany contribute to the food security of its members and to urban resilience? To answer these questions, first a systematic review of policy documents that concern allotments, food security, and/or urban resilience was carried out with a focus on Hamburg, Germany. In this, 17 governance documents were found, where 6 directly mentioned allotments. These positioned allotments in Hamburg in a way that eliminates struggles often faced by gardens in the US. However, due to them being scattered and not grouped in one place, an additional burden is placed on board members, who already struggle under the declining demand of people willing to participate in volunteer work. Also were no development, management, or future use plans for allotments from the city of Hamburg identified. To address the contributions of allotments to food security and urban resilience, eight semistructured interviews with members of an allotment site in Hamburg were carried out. These revealed that gardeners had an increased food availability, awareness of food sources, utilization of fresher and higher-quality produce, and practices like preserving surplus food. They further showed that allotments contribute to urban resilience through several mechanisms aligned with resilient ES management principles, where diversity and redundancy are maintained, feedbacks that keep the system stable are actively managed, and learning and experimentation are enabled. Also, gardeners were aware of some governing document, and voiced three changes to the regulations. This thesis finds that an involvement of gardeners in the urban political level reduce tensions of long-term land use planning and that the trust in governance as well as a stronger presence of regulations that foster slow variables could increase the resilience of allotment and their contributions to urban resilience.

Acknowledgements

I would first like to thank my supervisor Mike Jones, who has helped me greatly in putting together this thesis. Your comments and insights guided this project greatly and I am very thankful for your time and effort that you provided! I also would like to thank my examiner Malin Beckman and my opponent Maurine Luquet for the insightful comments and feedback they provided on this thesis.

I would also like to thank all respondents of the interviews who made time for sitting down with me and talking about their gardening. Your experiences and insights are the core of this study and I appreciate your participation greatly! Thanks also to Daniel, without whom I could not have done this research. I hope that you enjoy the findings of this thesis!

Lastly, I want to thank Olli and Jan, who, by getting an allotment, have inspired this project. I hope I can repay you two with by painting our arbour!

Appendix 1

Can you tell me a bit about yourself and how you came to start gardening on an allotment? How long have you had a plot and how big is it?

What plants do you have in your allotment plot and what kind of plants do you grow? Do you also have (trees, bushes, ponds, fruit, vegetables)?

Do you have more food available since you have an allotment plot? Does the seasonal availability of food from your plot affect you? If so, how does it affect you?

Where do you normally get your food and do you harvest much of it from your allotment plot?

Has the allotment affected your access to food? Have you ever had difficulty accessing good quality food and has access to an allotment affected this?

If you harvest food from the plot, do you process it differently since you have an allotment? Has gardening influenced your dietary diversity and if so, how? Do you think that growing food on the allotment plot has influenced the quality of your food?

How do you use plant protection and how do you fertilise your plot?

Would you say that allotments contribute to the conservation of different plants or animal species? If yes: How do allotment gardens contribute to this? How do you support it, for example?

Do you think allotment gardens support connections between elements of the urban ecosystem i.e. soil, water, and biodiversity? How? And what about your plot?

Since you started gardening, do you perceive connections and interactions between these systems differently? Do you also see this in your plot?
In your opinion, are soil quality, water availability and/or water quality also influenced by allotment gardens? How do you think they influence these processes? Do you consciously manage/control any of these processes?

Where did you get your gardening knowledge from? Was this encouraged in the allotment garden? Do you feel that you can experiment freely in your plot?

Do you think that all relevant interest groups can have a say in decisions concerning the allotment garden association and your gardening?

Do you think there are sufficient governance structures in your allotment garden association or for allotment gardens in general? Do you know the legal regulations for allotment gardens and how do they influence you? Would you want to change some of these regulations? If so, how would you change them and why?

Do you have anything else you would like to say at the end?

Appendix 2

The Federal Climate Protection Law (KSG) is a rather new law that shall ensure the fulfilment of the national climate protection targets in compliance with targets set by the European Union (Bundesregierung, 2023, para. 1). It is based on the Paris agreement, aiming to limit global warming to less than 2 °C (*ibid.*) and states that the contribution of the forestry sector, land use, and land use change to climate protection is to be strengthened (Bundesregierung, 2023, para. 3 a). For this, the primarily responsible ministry is responsible for submitting and implementing the necessary national measures (*ibid.*). This law thus only influences the governance and management of allotments indirectly.

The Federal Nature Conservation Law (BNatSchG) is the primary legal framework for protecting the diversity, character, beauty, functionality and recreational value of nature and landscapes in Germany. Its goal is to permanently safeguard nature and landscape due to their intrinsic value and as the basis for human life and health in responsibility to future generations (Bundestag, 2022, paras. 1, section 1 and 2). The law covers landscape planning, general protection of nature and landscape, protection of certain parts of nature and landscape, protection of wild animal and plant species and their habitats and biotopes, marine nature conservation, recreation in nature and landscape, as well as participation of recognised nature conservation associations. It states in the first paragraph that open spaces and their components in and close to settlements, like allotment gardens, must be preserved and, where non-existent, newly created or developed (Bundestag, 2022, paras. 1, section 6). For agricultural use the principles of GPP, defined in the BNatSchG, must be followed (Bundestag, 2022, paras. 5, section 2). The named principles of GPP in the BNatSchG are 1) cultivation must suit the site, ensuring sustainable soil fertility and long-term land usability, 2) natural features including soil, water, flora and fauna must not be impaired beyond what is necessary to achieve a sustainable yield, 3) balance between animal husbandry and crop cultivation is to be maintained, 4) grassland ploughing in erosion-prone areas, flood zones, high groundwater sites and moorlands is to be avoided, and 5) that fertilizers and plant protection products are to be applied in line with regulations and detailed records of their use are to be kept (Bundestag, 2022, paras. 5, section 2). Interventions in nature and landscape are defined as changes to the shape or use of land or groundwater level that may significantly impair the performance and functionality of the ecosystem or the landscape (Bundestag, 2022, paras. 14, section 1). However, agricultural, forestry and fishery land use shall not be regarded as an intervention if objectives of nature conservation and landscape management are considered. Thus, if compliance with the requirements of GPP from this law and the federal soil protection law are given, agricultural land use does not generally conflict with the objectives of nature conservation and landscape management (Bundestag, 2022, paras. 14, section 2). The main regulation of the BNatSchG for allotments are therefore that first, open spaces like allotments must be preserved or created when not already existent, and that second, agricultural land use following the principles for GPP are not regarded as interventions to nature and landscape and may be carried out.

As a supplement to the BNatSchG, the Hamburg Act on the Implementation of the Federal Nature Conservation Act (HmbBNatSchAG) was issued for the Hamburg area. This document adds a further point to the principles of GPP, namely that ploughing should be avoided on species-rich grassland sites (Bürgerschaft der Freien und Hansestadt Hamburg, 2020, para. 3). It also prohibits horticultural or arable land use along natural or near-natural areas of flowing or standing waters, within a distance of at least 7.50 m from the water's edge (Bürgerschaft der Freien und Hansestadt Hamburg, 2020, para. 9), which also allotment gardeners must follow.

The Federal Soil Protection Law (BBodSchG) governs soil protection in Germany and aims to protect and restore soil functions, prevent soil contamination, and remediate contaminated soils (Bundestag, 2021, para. 1). It addresses duties to avert soil damage and the reduction of damage, removing materials from or adding to the soil, the duties for preventive measures, as well as estimates for danger and inquiry orders. It furthermore establishes provisions for including new pollutants like PFAS in the Federal Soil Protection Ordinance and again refers to the principles of GPP. A key point of the BBodSchG is the precautionary duty of the property owner or user to avoid actions that are harmful of soil and change soil quality (Bundestag, 2021, para. 7). To fulfil the precautionary duty, soil impacts must be avoided or reduced insofar as this is also proportionate regarding the purpose of the use of the property (ibid.). For agricultural land use, the precautionary obligation is fulfilled by adhering to GPP. The principles of the food professional practice for safeguarding soil fertility and the performance of soil as a natural resource are 1) adapting soil cultivation to site-specific conditions including weather, 2) maintaining or improving soil structure, 3) avoiding soil compaction by considering soil type, moisture, and equipment pressure, 4) prevent soil erosion through site adapted practices, 5) preserving natural landscape features, 6) promoting soil biological activity, and 7) maintaining the typical soil humus content (Bundestag, 2021, paras. 17, section 1 and 2). The duties of the precautionary obligation also apply for allotment gardeners.

In systematic review, also a document with key points for the BBodSchG was found, issued by the federal ministry for the environment, nature conservation, nuclear safety, and consumer protection (BMUV, 2022). Here, the definition of the

natural soil functions is criticised for not including climate change mitigation and that requirements for climate biodiversity conversation and change adaption are not reflected (*ibid*.). Also, the subordinate nature of the BBodSchG is mentioned as a weak point, as it presents the risk that interests of precautionary soil protection are ignored because of this. The precautionary requirements are furthermore criticised for encompassing legal uncertainty and the consequent efforts for implementation and enforcement. Furthermore may the technical requirements of soil protection be offset in the context of weighing up, due to the absence of legally binding provisions. The document further states that, even though the BBodSchG relates to the good agricultural practice, their realisation and monitoring is close to impossible as the rules are not detailed enough. Lastly it is brought up, that authorities for soil protection are usually unaware of situations in which harmful soil change is a risk, as they are only informed once this change has occurred. Because of this is precautionary soil protection often subordinate to efforts for cleaning up new and existing contaminations.

The purpose of the Law on the Organisation of the Water Balance (WHG) is to protect water bodies as part of the natural balance, as the basis of human life, as a habitat for animals and plants, and as a usable asset through sustainable water management (Bundestag, 2023, para. 1). It applies to surface waters, coastal waters, groundwater, and in parts for marine waters (Bundestag, 2023, para. 2, section 1 and 2). The WHG states that water bodies shall be managed sustainably, to maintain and improve their functionality and performance by protecting them from adverse changes in characteristics, avoiding impairments, and by using them for the benefit of the public. The law further states that no permit or authorisation shall be required for the abstraction, pumping, extraction, or discharge of groundwater for the purposes of normal soil drainage on land used for agriculture, forestry, or horticulture (Bundestag, 2023, para. 46, section 1), thus including allotments in this permit-free use of groundwater. Another important part of this document, are definitions for wastewater removal, where waste water is water, whose properties have been altered by domestic, commercial, agricultural, or other use and the water that runs off with it in dry weather (Bundestag, 2023, paras. 54, section 1). This wastewater shall be disposed of in such a way, that the public good is not impaired (Bundestag, 2023, paras. 55, section 1). Other than that, there are no significant restrictions for urban food production or allotments.

The Hamburg Water Act (HWaG) expands on the WHG for the Hamburg area. It specifies the public use of water, where drainage and precipitation water may be discharged into surface waters from agricultural, horticultural, or residential land use, if it does not contain any harmful components and is not discharged by means of shared facilities (Bürgerschaft der Freien und Hansestadt Hamburg, 2005, paras. 9, section 1). It also states that public use does not apply to waters located in

courtyards, gardens, and parks that are not accessible to everyone (*ibid*.). The discharge of rainwater from land used for agriculture, horticulture, or exclusively for residential purposes, if it does not contain any harmful components, is authorisation-free for coastal waters (Bürgerschaft der Freien und Hansestadt Hamburg, 2005, para. 14 a). The HWaG states furthermore that requirements and conditions of use are permitted to ensure that water is used sparingly and to prevent and compensate for adverse effects (Bürgerschaft der Freien und Hansestadt Hamburg, 2005, paras. 16, section 1).

The Hamburg Wastewater Act (HmbAbwG) specifies on wastewater disposal in Hamburg, where wastewater refers to water that has been contaminated or altered through domestic, commercial, agricultural, or other use, as well as water that flows from precipitation on built or paved surfaces, further including also liquids that escape and are collected from waste treatment, storage, and disposal facilities, groundwater that is not subject to the discharge prohibition, and precipitation water that leaks from building drainage systems and seeps into construction pit backfills (Bürgerschaft der Freien und Hansestadt Hamburg, 2018, paras. 1, section 2). It shall be disposed of in such a way that the public good is not impaired, so that human health is not jeopardised, and that there is no risk of water and soil pollution or any other detrimental change in their properties (Bürgerschaft der Freien und Hansestadt Hamburg, 2018, paras. 1, section 1). Otherwise, the law does not enforce specific regulations on wastewater from horticultural use or agriculture. But the HmbAbwG is one of the legal instruments used to incorporate Hamburg's "Green Roof Strategy" which is set to install 100 hectares of green food surface throughout the city, thus influencing urban food production in taking place on greened roofs (Climate ADAPT, 2022), thus posing relevance for urban food production different from allotments.

The Fertiliser Law (DüngG) regulates requirements for placing on the market and application of fertilisers, soil additives, plant aids, and growing media (BMEL, 2023; Bundestag, Bundesrat, 2022). Its goal is to ensure proper nutrition of plants, to maintain or sustainably improve soil fertility, to prevent or avert risks to human and animal health and the ecosystem that may arise from the production, marketing, or use of fertilizers, and to ensure the sustainable and resource efficient use of nutrients in agricultural production (BMEL, BMUV, BMF, Bundesrat, 2021, para. 1). Fertilisers are defined as substances which are intended to supply nutrients to crops to promote growth, increase yield, improve quality, or that maintain or improve soil fertility, excluding carbon dioxide and water (BMEL, BMUV, BMF, Bundesrat, 2021, para. 2). These may only be used if they are of a type which was authorised by the European Community or the European Union or meet the requirements of the act (BMEL, BMUV, BMF, Bundesrat, 2021, paras. 3, section 1). Excluded are agents that have arisen, exist, or have been produced as plant

substances in the context of plant production or agriculture on the operation itself (*ibid*.). Substances may only be applied in accordance with GPP, which serves to supply plants with the necessary nutrients and to maintain and promote soil fertility, particularly to ensure the supply of high-quality products to the population (BMEL, BMUV, BMF, Bundesrat, 2021, paras. 3, section 2). The GPP furthermore regulates that the type, quantity, and timing of application must be geared to the needs of the plants and the soil (*ibid*.). This law thus places regulations on the use of fertilisers and similar media, also in allotments.

The goal of the Act on the Protection of Cultivated Plants (PflSchG) is to protect plants, particularly cultivated plants and plant products from harmful organisms as well as to prevent hazards that may arise from the use of plant protection products or other plant measures for human health, animal health, and for the ecosystem (Bundestag, Bundesrat, 2012, para. 1). It states that plant protection may only be carried out in accordance with GPP (Bundestag, Bundesrat, 2012, para. 3). For plant protection this means 1) compliance with the general principles of integrated pest management, 2) maintenance of the health and quality of plants and plant products through preventive measures, 3) prevention of the introduction or spread of harmful organisms, 5) defence against if control of harmful organisms, 6) promotion of natural mechanisms, and 7) measures to protect against and prevent risks that may arise from the use storage and other handling of plant protection products or measures (ibid.). The PflSchG also authorises the Ministry for Environment and Agriculture to report, permit or limit the cultivation or occurrence of specific plants or the use of specific plant protection products, equipment, or methods (Bundestag, Bundesrat, 2012, para. 6). It furthermore includes an action plan on the sustainable use of plant protection products (Bundestag, Bundesrat, 2012, para. 4).

The Ordinance on the Protection of Trees and Hedges in the Free and Hanseatic City of Hamburg (BaumschutzVO) defines that trees are protected as landscape features if they have a trunk circumference of at least 80 cm, the trees are multistemmed and at least one trunk has a circumference of at least 50 cm, or are in groups or rows of at least three trees whose crowns touch or merge into each other and one of them has a trunk circumference of at least 50 cm, while only trees with a trunk circumference of at least 30 cm are protected under this ordinance (Bürgerschaft der Freien und Hansestadt Hamburg, 2023, paras. 1, sentence 1). Hedges are protected as landscape features protected under this ordinance if they are over 80 cm tall (Bürgerschaft der Freien und Hansestadt Hamburg, 2023, paras. 1, sentence 2), but fruit trees, other than walnut or chestnut, are not (Bürgerschaft der Freien und Hansestadt Hamburg, 2023, paras. 1, sentence 3). It is prohibited to remove protected trees, hedges, or parts of them and to fell, destroy, cut, damage, or otherwise impair their growth, continued existence, or function (damage or impairment shall also include that disturbance of the root zone) (Bürgerschaft der

Freien und Hansestadt Hamburg, 2023, paras. 4, section 1). Disturbances are excavations, backfilling, the laying of pipes or cables, the construction of buildings, the sealing of the soil with asphalt, concrete, or other water- and air-impermeable materials, polluting or compacting the soil, lowering, or damming groundwater during construction work, spreading substances that impair growth, in particular de-icing salts or herbicides, and lighting or leaving fires burning (Bürgerschaft der Freien und Hansestadt Hamburg, 2023, paras. 4, section 2). Trees which are planted or growing on allotment plots, are also protected under these regulations.

The overarching goal of the NAP is to reduce the use of chemically-synthesised plant protection products. It presents starting points, goals, and measures for the use of plant protection for multiple sectors, including home gardening and allotments (BMEL, 2013). As the status quo of allotments and home gardening the NAP identifies a particular risk to human health, especially children and the elderly, due to the proximity to treated plants, stored products or packaging, and a lack of professional knowledge regarding the appropriate use of plant protection products (ibid.). It furthermore states a lack of nationwide data on the actual use of plant protection products in this sector. Formulated measures to reduce these risks and knowledge gaps are 1) raising awareness, 2) improving the protection of users, bystanders, and the environment, 3) reviewing the approval criteria for plant protection products, 4) collecting data on plant protection practices, and 5) improving the professional knowledge and the development and introduction of specific guidelines for integrated pest management. It was also planned to further develop the content and structure of the NAP which was started in 2022, but no update has been published yet (BMEL, 2022b).

The BKleinG is the basis on which all allotment clubs in Germany operate (Bundestag, 2006, para. 2). It, as mentioned in the introduction, defines allotments in Germany as a garden that serves the user for non-commercial horticultural use, and recreation while being a garden that is in a complex in which several individual gardens and communal facilities (ibid.). The BKleinG furthermore states that in the management and utilisation of allotments, interests of environmental protection, landscape conservation and nature conservation are to be considered (Bundestag, 2006, para. 3). It also permits to permanently live on the allotment plot and the arbour must not be suitable for it according to its nature. The lease price for allotments is allowed to be the maximum of four times the local rent for commercial fruit and vegetable growing in relation to the total area of the allotment garden site (Bundestag, 2006, para. 5). It states that the lease for an allotment garden is granted for an indefinite period (Bundestag, 2006, para. 6) and can only be terminated under two reasons. These are first, the tenant fails to pay rent within two months of being reminded, or second, the tenant or by him tolerated people commit serious breaches of duty which particularly disrupt the peace in the allotment garden community profoundly (Bundestag, 2006, para. 8). The BKleinG further states that, in case a permanent allotment garden is terminated by the municipality, the municipality must, if possible, provide or procure suitable substitute land (Bundestag, 2006, para. 14). It is furthermore defined that expropriations are only possible if they are required for the public good, its purpose cannot be achieved in another reasonable way, and a reasonable offer, with regards to the rent, has been made (Bundestag, 2006, para. 15). In the application of this law, the Free and Hanseatic city of Hamburg is also considered a municipality (Bundestag, 2006, para. 19).

The LGH is the umbrella association for allotment clubs in Hamburg. It itself is a member of the Bundesverband der Kleingartenvereine Deutschlands (BKD, English: federal association of allotment garden societies in Germany:) e.V. and members can be allotment clubs, "gardening friends", natural persons or partypolitically and denominationally neutral associations as supporting members (LGH, 2023, para. 3). The term gardening friends (German: Gartenfreunde) refers to members of allotment clubs. The purpose of the association is the promotion of allotment gardening in Hamburg, which is realised through close cooperation with authorities and organisations, regarding the social and national political importance of the promotion of allotment gardening in Hamburg and the task of promoting all allotment gardening, especially in the context of long-term regional planning (LGH, 2023, para. 2). The LGH furthermore realises tasks that arise from the main lease agreement with the city of Hamburg or lease agreements with private lessors of allotment garden land (ibid.). The statue furthermore states that clubs affiliated to the LGH are grouped into district groups, which are dependent subdivisions and not associations with legal capacity (LGH, 2023, para. 4).

The LUAG is handed out by the LGH and is the most defining document for the use of allotments in Hamburg. It defines allotment use as the use of leased land for the cultivation of horticultural products and states that the allotment system in Hamburg has a charitable and social function (LGH, 2021). It furthermore states that the acquirer of an allotment is entitled to a plot that is free of defects (*ibid*.). To ensure this, an inspection and valuation of the plot is carried out which includes the calculation of the price or transfer fee for the next tenant. The document furthermore defines the key term 'allotment utilisation' which refers to the combination of horticultural and recreational use that is specific to allotments in Germany. The horticultural use is stated as a central feature of an allotment garden and shall stipulate the diverse cultivation of horticultural products such as fruit, vegetables, herbs, and flowers for personal use. The LUAG further refers to the garden regulations, which are part of the statutes and the tenancy agreement in Hamburg's allotment garden associations and not publicly available, that further stipulate the horticultural use of the plot. It is also explicitly stated that a one-sided orientation of the plot must be avoided and that a mere use for recreational purposes

is not deemed sufficient. A further core principle that the LUAG states is the 'onethird regulation' which is binding for all tenants of allotment gardens and derived from the term allotment utilisation. Here, as a rule, one-third of a plot shall be used for the cultivation of horticultural products, one-third for ornamental plants and lawns, and one-third for structural features like arbours, terraces, paths, or composts. Overall are plot structures that support and promote biodiversity in the city stated as ideal, smaller plot areas may and should be left to develop naturally, and bee pastures, areas of dead wood in trees, and animal retreat areas should be specifically included in the design of the plot. The LUAG also acknowledges that the self-sufficiency function that allotments historically had is now increasingly replaced by a use for leisure, recreation, and counterbalance to work. It furthermore states that allotment sites in Hamburg are mostly located on municipal land are to be made available for private use at a socially acceptable rent and offer positive effects in the located areas. Named are the serving as refuge for animals and plants in the city, the preservation or creation of small biotopes in the city, the positive impact on the urban microclimate, and the recreation for city residents. It states that these positive effects are to be supported in the design and use of an allotment plot.

For arbours and makeshift homes, the LUAG states that in each plot, one arbour is permitted, where the board determines the final location. The primary use of arbours shall be to store garden tool and produce, and facilities and equipment that enable permanent residence are prohibited. As makeshift homes were allowed to be built on allotment sites immediately after the 2nd world war (due to the housing shortage at the time) (LGH, 2024), these exceptions and contracts are no longer possible today. However, the original tenant retains the right of residence for as long as they wish to live there (*ibid*.). The right of residence expires when the owner moves out or dies, and the buildings are then typically demolished so that normal arbours can be erected.

Regarding the perimeter fencing, the LUAG states that allotment garden sites are areas intended for private use and are a part of the green infrastructure. Thus, an allotment garden site should also be accessible and usable by the public. Changes and alterations to the plot boundaries (including the installation of additional gates, fences, etc.) are not permitted. Also are enclosures to neighbouring plots, like hedges or walls not permitted and only filigree fences up to 1 m against animals are allowed. The LUAG furthermore states that plant protection products are to be limited to what is necessary and may only be used in consultation with the association's technical advisory service. The use of herbicides like high doses of calcium cyanamide, salt or other chemicals to control weeds is prohibited.

The LUWW is valid only for the Hamburg area (LGH, 2019). It states that according to the garden regulations water connections within the allotment and the

installation of flushing toilets, baths, showers, or similar in the allotment are prohibited (*ibid*.). It also provides more information on what types of water connections, wastewater disposal, or toilets (dry toilets, dry separation toilets, or camping toilets) are permitted, also for allotments in water protection zones.

The LHM defines hedges as living, green boundary elements that separate plots from paths (LGH, 2011). They are furthermore part of the leased area and usually common property and not private property of the plot renter, meaning that they must be designed and maintained in accordance with the instructions of the board of the allotment club (ibid.). It is recommended to use native deciduous shrubs as they offer birds better nesting and retreat space while also serving as a source of food. The LHM furthermore gives instructions for care after planting, yearly care, and additional measures. The defining regulations to follow are that 1), the final height is 1.1 m, 2) an annual hedge trimming is necessary so that garden enthusiasts, visitors, and, in emergencies, ambulances are not impaired by the unhindered growth of the hedges, 3) it is forbidden to cut down hedges and other woody plants or to plant them between March 1st to September 30th, and 4) that the hedges are protected according to the BaumschutzVO. It is also to be considered that allotments are green spaces which are accessible to the general public, meaning that the gardens should be visible from the outside to allow walkers to take part in their beauty.

Publishing and archiving

Approved students' theses at SLU are published electronically. As a student, you have the copyright to your own work and need to approve the electronic publishing. If you check the box for **YES**, the full text (pdf file) and metadata will be visible and searchable online. If you check the box for **NO**, only the metadata and the abstract will be visible and searchable online. Nevertheless, when the document is uploaded it will still be archived as a digital file. If you are more than one author, the checked box will be applied to all authors. You will find a link to SLU's publishing agreement here:

• <u>https://libanswers.slu.se/en/faq/228318</u>.

 \boxtimes YES, I/we hereby give permission to publish the present thesis in accordance with the SLU agreement regarding the transfer of the right to publish a work.

 \Box NO, I/we do not give permission to publish the present work. The work will still be archived and its metadata and abstract will be visible and searchable.