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# Community Resilience through the Urban Commons

## A Social Simulation Exploration

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# Community Resilience through the Urban Commons

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## A Social Simulation Exploration

DISSERTATION

for the purpose of obtaining the degree of doctor
at Delft University of Technology
by the authority of the Rector Magnificus prof.dr.ir. T.H.J.J. van der Hagen
chair of the Board for Doctorates
to be defended publicly on
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by

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*This dissertation has been approved by the promotors.*

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# Part I

# INTRODUCTION

# 1

# Drafting urban community resilience

## 1.1 Cities thrive for more resilience

Cities are facing unprecedented urbanisation, and this trend is expected to continue over the next decades. The UN World Urbanisation Prospects indicate an increase from 56% (in 2016) to 68% (by 2050) of the urbanised world population. Cities represent a significant source of wealth and amenities (electricity, sanitation, better nutrition), which motivates parts of the rural population to migrate (Ritchie and Roser, 2020). However, the nature of cities and the pace at which urbanisation occurs are cause of multiple concerns.

Cities used to be built around centralised and rigid infrastructures, which are less prone to provide adaptability (Childers et al., 2014). At the same time, cities remain well-known complex systems (Batty, 2007; Heppenstall, Malleson and Crooks, 2016; Marshall, 2008), because of the mutual effects their inhabitants and the city's infrastructures and institutions have on each other. Adaptivity is the ability for a system to adapt itself in response to its environment. Cities are complex adaptive systems with positive-feedback mechanisms inducing non-linearity of response. These mechanisms could cause unexpected flips in urban systems. Complexity is reflected for example in the periodic political orientations of municipalities. This makes it difficult to predict policies and their institutional fabric in the mid- and long-term. As an example, the R-Urban project, a reference in terms of urban resilience located in Paris agglomeration, had to relocate to a nearby municipality (Petrescu, Petcou and Baibarac, 2016).

The human component of cities also represents a major source of struggle, in particular individuality. This is quite significant at the level of urban communities. Individuality is materialised by self-fulfilment, by which people carry to fruition their deepest desires or worthiest capacities. Individuals willingly act when they find, in

doing so, a form of self-fulfilment. Failure of urban community governance schemes can happen when motivations to perpetuate the collective effort are lacking. By governance, I mean a network of actors interacting around a collective problem within a set of social norms and institutions (see definition in section 1.4). Community governance relies on collective action. Just like for most collaborative strategies, the appropriate leverage, or selective incentive (Olson, 1971), needs to be found to engage the right actors. Collaboration is indeed a form of voluntary co-operation which "involves individuals or groups moving in concert in a situation in which no party has the power to command the behaviour of others" (Wondolleck and Yaffee, 2000). Conflicts may however arise from the way costs, revenues, responsibilities or roles are distributed among the actors. The increasing actors' interdependency may also disrupt the trust balance and cause opportunistic behaviours (Williamson, 1988). Finally one must consider the possible existence of conflicting values and interests. Calibrating those roles and interrelations, can give way to a set of rules leading to more resilient governance systems.

Because of the reasons given above, increasing the resilience of cities is not an easy task. It is a contested process including multiple stakeholders with diverse motivations and interests, across power dynamics, which necessarily requires trade-offs. The definition of urban resilience itself represents a challenge. It has been recently formulated as "[...] the ability of an urban system - and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales - to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity" (Meerow, Newell and Stults, 2016). The same authors further point to the critical questions which should be asked when dealing with urban resilience: resilience for whom? what? when? where? and why? This thesis investigates the potential of small-scale urban initiatives to solve local urban problems, to create or to manage tangible and intangible resources. Instead of being resource consumers, citizens become resource appropriators with responsibilities. In such a context, modes of co-operation appear locally around shared goals in the midst of possible internal or external disruptions.

## 1.2 Urban community resilience

Over the past decade, world stakeholders are becoming aware of the importance to trust and invest more at the local level in order to ensure safe and resilient urban habitats. Regarding disaster risk reduction, city mayors gathered at the Global Platform 2013 to give examples and arguments in favour of community and local government empowerment. Learning from the tragic events of the 2011 earthquake which largely hit Japan, one of the mayors then present declared that "disasters cannot be prevented solely by improving facilities and taking other 'hardware' approaches" and that "[s]uch situations require self-reliance among local residents and community bonds as well as disaster prevention and mitigation efforts via international collaboration" (UNDRR, 2013). One of the guidelines for the period 2015-2030 of the United Nations Office for Disaster Risk Reduction is precisely to "empower local authorities

and local communities to reduce disaster risk, including through resources, incentives and decision-making responsibilities, as appropriate" (UNISDR, 2015).

The message has been conveyed in recent research too: "A city without resilient communities will be extremely vulnerable to disasters. Human communities are the social and institutional components of the city, directing its activities, responding to its needs, and learning from its experience" (Kim and Lim, 2016, p. 17). Berkes and Ross, 2013 have identified two strands of literature on community resilience: one with a social-ecological perspective and one building on psychology of development and mental health. The first strand focuses on the capacity of a system to absorb and adapt to disturbances, by returning to a stable state, equal or different to the pre-disturbance state. The second strand highlights the ability of a community to deal with uncertainty through agency and self-organisation around a shared objective (Berkes and Ross, 2013). The social-ecological perspective is associated with more analytical concepts and is well adapted to describe communities closely interacting with their environment ; the community-centred perspective offers more applicability, especially when such interactions do not involve resource dependence.

Both place-based communities (e.g. cooperative housing) and spread-out communities sharing resource ties (e.g. urban vegetable gardens) can develop resilience (Berkes and Ross, 2013). Important drivers include for example: people–place connections; values and beliefs; knowledge, skills and learning; social networks; engaged governance (involving collaborative institutions); a diverse and innovative economy; community infrastructure; leadership; and a positive vision towards change. Recent research has provided many examples of specific resilience towards natural disasters risk reduction, and less on generalised resilience. In either case, more research focus is expected on power relations, agency, self-efficacy, values, behaviour (Berkes and Ross, 2013)and the institutionalisation of community-based activities to prevent their dying up over time. In the urban context, such institutions - formal, semiformal or informal - are seen as a critical driver of urban community resilience (Shaw et al., 2016). I will get back to the notions of institutions in section 1.4. Urban commons are clear and highlighted examples of community-based practices in cities which therefore have a great potential for urban community resilience.

## 1.3 The urban commons

The urban commons (UC) is an ubiquitous community-based practice which has interested researchers from various fields over the past decade. It inherits from the social issues described above within urban communities such as individuality or conflicts. The UC consists of shared material, immaterial or digital goods in an urban setting. Citizens and administration recognise UC as functional to the individual and collective well-being: the degradation of the urban commons is perceived as a loss (Urban Center Bologna, 2014). UC can be tangible such as public spaces, community gardens, locally-grown vegetables and waste disposal facilities, or intangible such as a sense of security, a sense of belonging, social networks, knowledge and mutual trust (Foster and Iaione, 2015; Parker and Johansson, 2011). The latter resources echo to the term *social capital*, which has gained a lot of interest during the 1990s. It is

defined as "resources that an individual can draw upon in terms of relying on others to provide support or assistance in times of need", requiring stable networks of social interactions within a given community (McGinnis, 2011, p. 176). Although social capital extends beyond the realm of the UC, it is often described as a "relational web" offering a fertile ground for the UC (Brain, 2019). Ostrom and Ahn, 2003, p. 4 "view social capital as an attribute of individuals and of their relationships that enhances their ability to solve collective action problems". Urban green commons is known to provide significant ecosystem services, which can help communities cope with natural or socio-economical disasters by providing livelihood support (Colding et al., 2013). Such natural buffers play a role in community resilience building (UNISDR, 2015).

The multiple tasks and environments offered by the commons give way to multiple motivations to participate: socialising, sustainability, learning or democracy are very often mentioned. The urban setting where the UC evolves represents zones of encounter, which encourage to spend time together. This is facilitated by the frequent existence of shared premises, such as sofas, a kitchen but also digital communication platforms. Such places are a breeding ground for trustful interactions, social cohesion and social learning. They contribute to, as well as rely on, collectively-produced knowledge, such as the online platform of the Sharing Cities Network (Sharp, 2018). The urban commons becomes a place of conviviality; generated, maintained and cared for by communities, which can overcome "market-driven, unsustainable, unequal and individualised approaches" (Agrawal, 2002; Tornaghi, 2017)and can enable re-capacitation. Community governance systems, a priori, allow for a reasonable level of self-organisation, learning and diversity, which make them potentially adaptive (Resilience Alliance, 2010). These are crucial conditions to ensure the resilience of integrated systems of people and their natural environment (Folke et al., 2005), such as the urban commons.

## 1.4 Urban commons community governance

As explained above, the UC has a great potential to drive community resilience. Communities gather around a shared goal, with its multiple individual or collective incentives, they set up a physical or digital place and they agree on a governance system to reach the shared goal. To frame the social interactions taking place within a community, institutions are often called upon. These may alleviate some of the social issues mentioned earlier, such as conflicting values or a lack of incentives to contribute. (Schauppenlehner-Kloyber and Penker, 2016; Webster, 2007; Foster and Iaione, 2019).

The notion of institutions, originally defined in sociology as collective ways of acting or thinking, encompassing legal forms, conventions and customs (Durkheim, 1894), has since the 1980s embraced elements of both sociological and economic traditions. I use throughout this thesis the definition derived from the field of institutional economics, which is particularly relevant at the scale of small communities governing shared resources, such as the urban commons. Institutions are meant in this thesis as an ensemble of rules, prescriptive or constraining, set by a group of in-

dividuals in order to organise repetitive and structured interactions (Ostrom, 1990). Some are formal, such as rules, laws or constitutions, whereas others are informal, such as norms. Institutions may be confused with the idea of organisations, which can instead be seen as arrangements of multiple institutions.

Institutions are described extensively in Ostrom's work on Common Pool Resources. The Social-Ecological Systems (SES) framework (Ostrom, 2009a) for example offers a very useful review of existing systems and policies to sketch their calibration at two levels: social system (governance structure) and its environmental dependencies.

Governance systems are made of formal and informal institutions that describe the actions and interactions of the different decision-makers. Formal institutions, such as laws or property rights, are codified; while informal institutions reflect social and behavioural norms. Institutions have a coercive effect in the sense that they act upon us from the outside. In brief, institutions regulate social interactions. Studying the mechanisms of success of the urban commons requires the investigation of the institutional dynamics and emergence within urban systems. Urban co-management resilience strongly relies on institutional structures which help not only guarantee long-term urban actors collaboration, but also flexibility towards adaptation (Schauppenlehner-Kloyber and Penker, 2016).

Like in the case of Common-Pool Resources (CPRs), a frequent issue of the urban commons is known as free-riding (Foster, 2011; Votsis and Haavisto, 2019; Ostrom, 2000). Free-riding occurs when a member of a community desists from the collective effort of managing a public service or resource. Community governance can solve this issue by reorganising the actors as a multi-level system (Ostrom, 1990). Through the analysis of multiple case-studies where a common-pool resource (CPR) was collectively managed across generations, Nobel laureate E. Ostrom found that decentralising decision-making processes facilitates the access to and use of local knowledge and excludes untrustworthy individuals. It also generates disaggregated feedback from the system and well-targeted rules, which in addition seem more legitimate since they come from the individuals they apply to. Thanks to numerous case studies of collective resources management across the world, especially regarding fisheries, forestries and irrigation systems, Ostrom further proposed 8 Design Principles which should guarantee the robustness of collective CPR management (Agrawal, 2002; Ostrom, 2009b; Cox, Arnold and Tomás, 2010).

However, it is still unclear how institutions such as Ostrom's Design Principles impact the governance of the urban commons. The urban commons represents more than a CPR: beyond the resource management component, it has a strong social dimension which can not be subtracted, for example a sense of conviviality, recreation, education and well-being. It nurtures learning notably through knowledge co-production, a well-described driver of urban adaptability and resilience (Folke et al., 2005; Camps-Calvet et al., 2015; Schauppenlehner-Kloyber and Penker, 2016; Elmqvist et al., 2019). Particularly in higher income regions, the social functions of community gardens, a well-described example of urban commons, are more often prevailing (Rogge, Theesfeld and Strassner, 2018).

In addition, urban commons governance faces challenges, such as land congestion and overconsumption (Foster and Iaione, 2019). Land accessibility and the

public/private dichotomy are a predominating issue in the urban context, and can, for example, be analysed through the lens of property rights bundles (Webster, 2007; Schlager and Ostrom, 1992; Davy, 2014). The plurality of property/use relations is still under-described in science. Other challenges of the urban commons deserve attention: for example their governance structure (Corsín Jiménez, 2014; Foster, 2011; Giannini and Pirone, 2019; Petrescu, Petcou and Baibarac, 2016), financial difficulties (Bresnihan and Byrne, 2015; Huron, 2015; Radywyl and Bigg, 2013) and social tensions (Colding et al., 2013), either through internal conflicts (Cooke, Landau-Ward and Rickards, 2019; Gilmore, 2017) or lack of volunteer participation (Blomley, 2008; Grabkowska, 2018; Huron, 2015; Ling et al., 2014; McShane, 2010; Teli et al., 2015). Little theoretical work has been done on the urban commons, although many examples of their management exist. As Sheila Foster puts it, we should "bring theory to a practice that has become ubiquitous in cities [...] and provoke a more sustained examination of the relationship between public and private actors in managing common urban resources" (Foster, 2011, p. 63). It seems that, although the urban commons shows a great potential to drive urban community resilience, they are still bound to the effectiveness of institutional arrangements in guiding forms of participatory behaviour. More light is needed on the institutional mechanisms in the governance of the urban commons which increase or lower the resilience of their respective communities.

# 2

# Thesis objectives and method

## 2.1 Problem definition and research question

The urban commons is applied through prevalent field practices, discussed in many fields of research which give way to a mosaic of individual cases or theoretical essays about the urban commons. However, there currently lacks a structured characterisation and theory on the urban commons. Additionally, there exists very little work on the possible contribution of the urban commons to higher urban resilience.

My first objective is to build a theoretical understanding of the commons, through a comprehensive summary of the urban commons characteristics and institutions, which should also benefit practitioners. The urban commons stands out from the Common-Pool Resources field, in the sense that it revolves not only around shared resources (tangible or not), but also around the generation and appreciation of sociability which relates well to the notion of social capital. Because of that, Ostrom's theories and principles for collective action may not directly apply. As Ostrom and Ahn, 2003 suggested, it is important to investigate the relations between the different forms of social capital when working on collective action.

My second objective is to assess the urban commons' potential for urban community resilience, both from a theoretical and an empirical perspective. Resilience has a positive societal connotation and has gained significant interest over the past decades, especially under a hastened pace of urbanisation, future climate uncertainties and the instability of financial markets (Meerow, Newell and Stults, 2016; Patel et al., 2017). Resilience-building is also a contested process in a context where multiple stakeholder may have different interests within complex power dynamics. This thesis studies resilience under the lens of adaptability. I choose to work at the community level of resilience, which is relatively neglected in literature, compared to socio-ecological and psychological approaches, and still deserves attention among

the other levels of resilience (Berkes and Ross, 2013). I restrict the meaning of community to the individuals involved in an urban commons initiative. Communities are interesting for their capacity to reach resilience mostly through their internal social interactions, potentially without external help. Learning being another driver of urban adaptability, it is also important to assess the mechanisms of knowledge co-production in the urban commons. I will therefore explore the questions of participation, social interactions, learning and knowledge within the urban commons, and experiment on the conditions which trigger more community resilience.

Therefore, the goal of this thesis is first to provide a clear overview of the urban commons throughout the world, in terms of typology and practical characteristics. Secondly, this thesis investigates the mechanisms internal to the urban commons which can trigger more community resilience. The final outcome is a framework of urban community resilience, grounded both in theory and field practice. The central research question is:

**How can the urban commons contribute to community resilience?**

This question is treated in a relatively constrained geographical and temporal scale. The temporal scale ranges from the second half of the $20^{th}$ century up to now, in order to capture the later developments of this phenomenon, which traces back to the Middle Ages. Although we describe urban commons characteristics from worldwide examples in Chapter 3, we restrict the geographical scale to Western Europe to enable modelling assumptions when it comes to cultural habits and motivations in communities. I will reflect on the possible extension of the empirical work on the other parts of the world in the synthesis. Several questions help answering the central question:

1. What are the urban commons characteristics and what are their governance challenges
2. What are the behavioural and institutional dynamics in the urban commons
3. What is community resilience and how can it be supported through behavioural and institutional dynamics in the urban commons
4. How does knowledge support community resilience in the urban commons

These sub-questions are answered progressively in four chapters, as shown in Table 2.1.

| | Research question | | | |
|---|---|---|---|---|
| Chapter | (1) | (2) | (3) | (4) |
| 3 | X | X | | X |
| 4 | | X | | |
| 5 | | X | X | |
| 6 | X | | | X |
| 7 | X | X | X | X |

Table 2.1 – Thesis questions addressed across the chapters

## 2.2 Research approach

The Institutional Analysis and Development (IAD) framework (Ostrom, 2005) has been developed to study the management and ongoing collective action in Common-Pool Resources (CPR) systems. It provides a solid and well-referenced canvas for experiments in various CPR situations. It is particularly effective when building theories and models that analyse the performance of institutional arrangements in parallel with human behaviour (Ostrom, 2014; Schlager and Cox, 2018; Cole, Epstein and McGinnis, 2019). To investigate the governance challenges, in particular the institutional and behavioural dynamics, of the urban commons, which at first sight is similar to CPR, I ground the development of this thesis in the IAD structure.

To build a reliable community resilience framework based on the urban commons, I populate it both with qualitative and quantitative arguments which are associated to IAD's components. The qualitative dimension gives a practical view of the framework's system: physical traits, community attributes and institutions. I explore this dimension firstly with a comprehensive literature review on the urban commons which, beyond clarifying its typology, aims to highlight its main characteristics and challenges. Secondly, I collect data about urban commons initiatives, via case-study interviews and the use of an existing database. The quantitative approach enables a detailed analysis of behavioural trends (IAD's action situation) through usual statistical methods (e.g. comparison of populations, correlation tables, decision trees). The samples to be thus analysed come from social simulations performed via agent-based modelling (ABM). This method allows deeper parameters exploration because simulations don't involve real people, but instead simulated realistic agents. Having this in mind, ABM is used in this thesis to (1) characterise a complex system of individuals performing collective action, (2) study unknown behavioural trends without specifically looking for equilibria, and (3) embrace agent's behavioural diversity. I investigate two widespread types of urban commons: urban community gardens (chapter 4) and an urban cooperative (chapter 5).

The overall research process is visible in Figure 2.1.

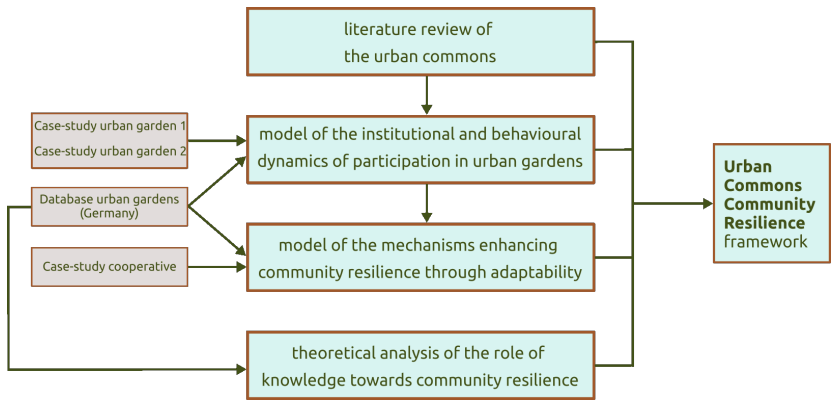


Figure 2.1 – The research process

The approach described above is operated as follows.

I start with characterising the urban commons and extracting their important institutional features through a systematic literature review. To embrace the multiplicity of the use of the urban commons in scientific literature, I collect bibliographic information and build the review with the help of an assemblage approach (chapter 3).

I then use the results of this review, along with empirical data on urban community gardens coming from two cases in Rotterdam (Netherlands) and a database of 123 urban community gardens in Germany, to build an agent-based model (chapter 4). This model, grounded in institutional and behavioural theory, describes the dynamics of volunteer participation in urban community gardens.

This model is further adapted to enable exploring the system conditions favourable to adaptability in the urban commons, notably in terms of social capital (Folke et al., 2005) and involvement (Kim and Lim, 2016), in a cooperative located in Amsterdam (chapter 5). This second model conceptualises social capital in order to propose an evaluation of community resilience.

I then ground this empirical study with a further analysis of the role of knowledge co-production and sharing on urban community resilience, based on the earlier urban commons literature review and on additional information extracted from the database of German community gardens (chapter 6).

Finally, I generalise my results into a concluding framework on urban commons community resilience (chapter 7).

## 2.3 Contributions of the thesis

### 2.3.1 Scientific relevance

This study provides strong foundations for theorising urban commons governance at a community scale, based on co-management principles mainly described by Economy Nobel Prize Elinor Ostrom. It also contributes to the growing field of empirical studies on the urban commons. I describe the urban commons diversity and how this differentiates them from traditional Common-Pool Resources (CPRs). The outputs of this description follow a clear and practical structure, which can be reused by both scientists and practitioners.

I also contribute to the field of social simulations, by proposing a computational model which bridges behavioural theory and institutional theory. This is the first time that Ostrom's Design Principles are modelled, a fortiori with ABMs. We have done so to study the effects of certain institutional arrangements, expressed as combinations of these principles, on the volunteer participation rate in the urban community gardens. We further applied this method to test hypotheses regarding the conditions inducing more community resilience within the urban commons.

This thesis also contributes to the resilience discourse by putting a simple definition of community resilience in practice through social simulations. The main outcome of this thesis is a framework, inspired from Ostrom's Socio-Ecological Systems (SES) framework, that describes the first- and second-tier variables affecting com-

munity resilience (seen as one possible instance of Interaction/Outcome in the SES framework).

Finally, each chapter in part II provides clear indicators for further research in the respective domains addressed.

### 2.3.2 Societal relevance

The wide development and care for the urban commons in cities, both from the Global North and Global South, indicates a general interest for this topic among practitioners. Chapters 3 and 6 aim to equip practitioners with relevant and the most up-to-date information on the urban commons, to empower them in their response to societal needs (e.g. in case of welfare state drawback) and help their initiative thrive. Such initiatives represent alternative ways of governing local urban spaces and resources, to possibly reach more community resilience. Community engagement is indeed known to help social integration. For example, a Californian case made possible for the kids involved in an urban farm to create a savings account which might help them afford college education one day, along with creating a positive environment in a city known for its high crime rate. Community projects also raise awareness among children by getting them involved or just by proposing side activities and games. The educational benefits of such experiences are huge: in terms of developed skills but also to help the next generations shape sustainable cities and perhaps better societies. However, the urban commons is also a source of potential conflicts, internal or external, and this thesis assembles some of the issues which urban communities may face, both through real-life examples and modelling.

This thesis also contributes to urbanism, by feeding the current discourse on making better cities through well-being, space re-appropriation and conviviality. Citizens are no more simple pawns on a chessboard, but resource appropriators and managers. It thus addresses key points that are missing in the "smart cities" discourse, presently mostly technology- and capital-driven. The human component is often forgotten, and our stressing of the social benefits of engaging in the urban commons is an open invitation to bring citizens back into the design of our future cities.

## 2.4 Reader's roadmap

Chapter 3 is an extensive literature review of the urban commons which assesses the diversity and relevant challenges of such initiatives in a practical way (Feinberg, Ghorbani and Herder, 2021). It also points to key institutions which are further studied in this thesis.

Chapter 4 presents an agent-based model of the behavioural dynamics of volunteer participation within a frequent case of urban commons: community gardening. It tests the effects of multiple institutional arrangements on the duration of the volunteer participation, and on social outcomes such as perceived trust and cohesion (Feinberg et al., 2021).

Chapter 5 adapts the previously build model in order to focus on the community

factors influencing the emergence of trust and social cohesion within an off-the-grid cooperative in Amsterdam (Feinberg, Ghorbani and Herder, 2020).

Chapter 6 further explores the role played by knowledge on community resilience, by outlining the prevailing media and scales of commons-based knowledge co-production. It is based on the earlier chapter's publications and additional literature.

Chapter 7 proposes a synthesis of the previous chapters, where I build a framework for urban commons community resilience. It is submitted for publication. Chapters 8 and 9 are respectively the synthesis and conclusion of the thesis.

# Part II

# URBAN COMMONS EXPLORATION

# 3

# Diversity and challenges of the urban commons: a comprehensive review

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Abstract– This study is a comprehensive literature review about the field of the urban commons and its diversity, which we investigate through the lens of the *new commons*. Acknowledging a potential for adaptive capacity in the urban commons, we classify its traits into ecosystem, socio-economic and institutional factors. To make our work more practical, we further arrange them as benefits, challenges or supports. Our literature review highlights the need to further study the institutions which have an impact on the urban commons, as well as the individual and collective behaviour mechanisms at stake in the emergence and management of this commons. In addition, more light needs to be shed on the property-regimes relevant to the urban commons, with a focus on the access or use rules, rather than on ownership.

## 3.1 Introduction

The urban commons has gained a growing interest over the past decade, both in the field and in the scientific community. An urban commons represents shared material, immaterial or digital goods in an urban setting (Urban Center Bologna, 2014). It is beneficial for the individual and collective well-being, and the degradation of the urban commons is perceived as a loss. It is built around the social issues of

participation, collective action and self-organisation which are reflected through the term commoning: collectively creating, using and managing the commons (Linebaugh, 2008). The city forms a complex ecosystem of places, people and machinery, bound by institutions. An urban commons is produced and reproduced through the encounter of the city ecosystem's elements (Borch and Kornberger, 2015). Such encounters contribute to the creation of shared understandings through repeated interactions and practices (Wessendorf, 2014), which induce social learning (Wenger, 2010a); a key element to adaptation (Armitage et al., 2011).

Multiple studies have highlighted the urban commons as a potential carrier for urban resilience (Camps-Calvet et al., 2015; Colding et al., 2013; Mundoli, Manjunatha and Nagendra, 2017). Although both socio-ecological and socio-technical networks intervene in the adaptability of urban systems (Meerow, Newell and Stults, 2016), the most recent paradigm of resilience thinking is about social-ecological resilience, with adaptability rather than robustness as its key characteristic (Quigley, Blair and Davison, 2018). Studying the urban commons from the perspective of its socio-ecological components, therefore, appears valuable, notably for the practitioners who worry about the survival of their initiatives.

Although diverse fields address the urban commons, there hasn't been a thorough investigation of its diversity, nor of its internal and external characteristics which influence its access, use and management. Beyond building a state-of-the-art review of the diversity of the urban commons currently observed and studied, we point to the benefits that an urban commons brings to cities, and to the challenges of this emerging field which call for future agendas in urban commons research.

## 3.2 Theoretical lens on the urban commons

### 3.2.1 Common, commons and commoning

We distinguish three frequently used terms: common, commons and commoning.

The term *common* describes the foundation of shared material and symbolic resources based on which humankind can live together: it spans from natural resources to digital wealth (Hardt and Negri, 2009). The common is a perspective of a societal transformation involving practices of mutual sharing and collaboration.

The *commons*, singular noun, represents mutual goods which result from institutional dynamics and arrangements built on the foundation of the common (Teli et al., 2015). Under certain conditions, the commons resembles the common-pool resources (Foster and Iaione, 2015) which are characterized by non-excludability and rivalry (Ostrom, 1990), with an additional "social value or utility" (Foster and Iaione, 2015, p. 288). It can take multiple forms, as mapped by Hess, 2008, with different ownership regimes (see subsection 3.2.2, 3.2.3).

*Commoning* is the practice which links a resource to its nearby community of users (Foster and Iaione, 2019). It produces the commons (Noterman, 2016), Multiple scholars anchor the commons to property relationships, whereas commoning is perceived as a process which exceeds property and capital issues (Cooke, Landau-Ward and Rickards, 2019; Leitner and Sheppard, 2018). Commoning thus becomes

a creative force, a potential to generate new forms of urban spatiality (Eynaud, Juan and Mourey, 2018; Linebaugh, 2008; Montagna and Grazioli, 2019; Ruggiero and Graziano, 2018).

We here define the commons as *a system consisting of a resource, its users, the institutions binding them and the associated processes.* The term urban commons first evokes a paradox. Historically, the commoners expelled from common lands formed the nowadays city dwellers (Huron, 2015; Thompson, 1966). Living in cities with waged labour, they contributed to capitalism which opposes commoning. The urban commons is therefore produced by the collective practice of commoning, to "govern the resources necessary for life" (Huron, 2018), in a predominantly capitalist environment. With increasing urban cultural diversity (Colding and Barthel, 2013), the urban commons merges multiple potential motivations and take many shapes, many of which belong to the new commons (Hess, 2008), introduced next.

### 3.2.2 The commons map

Hess, 2008 classifies the commons across the following sectors: cultural, knowledge, markets, global, traditional, infrastructure, neighbourhood, medical and health commons. These "new commons" cover their multiplicity. It is in our view the most recent, exhaustive and popular classification of all types of commons, notably taking into account digital technologies. We postulate that the urban commons spreads across these sectors, bridging their tangible and intangible elements. In Hess' classification, each of the sectors consists of various types of commons. Our literature study reveals that most of these sectors are relevant in the urban context. We have therefore adapted this map in Figure 1 for the urban commons context.

We added two concepts that were highlighted in our initial literature corpus (Appendix 1, see subsection 3.3.2) but were missing in Hess's classification. "Parks and Greenery", in the neighbourhood commons sector, is particularly relevant in the urban context. It was mentioned by 30 articles within our initial corpus (Appendix 2, see subsection 3.4.1). Urban parks and neighbourhood greenery are in our view too specific to belong to the traditional commons sector, for example within the forest type. They play a larger role in the neighbourhood life, which is why we appended this new commons type within the neighbourhood sector. We also added "Experts Knowledge" within the knowledge sector to characterise the formation and spread of commoning initiatives in the urban context. It is addressed in 20 articles of our initial corpus. Several new commons types, indicated in light font in Figure 1, were not encountered in our corpus. Finally, we have renamed the neighbourhood commons type relating to the homeless. We find it a misleading term, which we understand is meant by Hess as the space or habitat used by homeless people, which becomes a resource (Staeheli and Mitchell, 2006). We have renamed it consequently homeless habitat (Figure 3.1). Thus adapted, Hess' classification illustrates rather well the diversity of the urban commons.

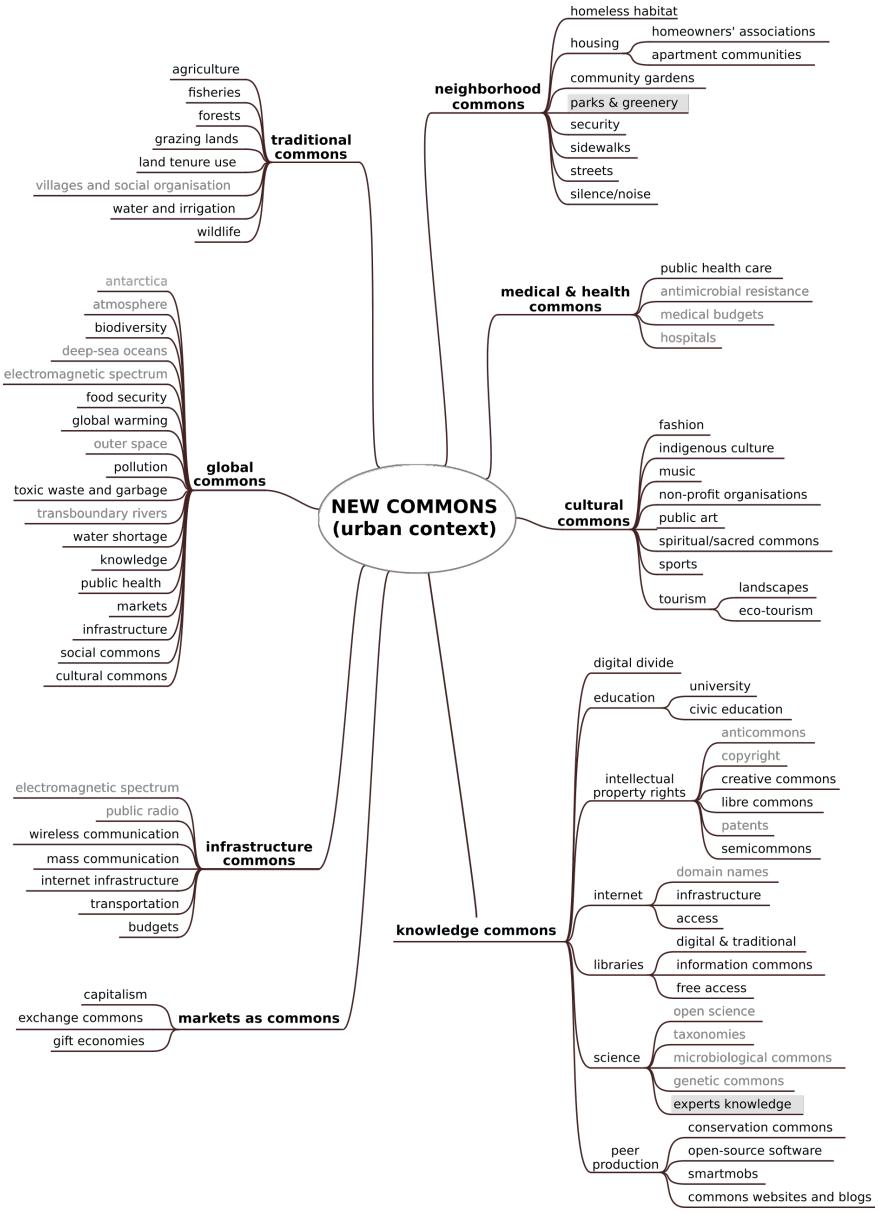


Figure 3.1 – The new commons in the urban context, adapted from Hess (2008). Highlighted are the commons types added by us. In light grey font are the new commons not found in our literature review.

### 3.2.3 Property

More attention is needed on the urban commons diversity and its access rules - restricted or shared access (Davy, 2014). The urban commons occurs on both public and private land, thanks to specific property-regimes and access rules, as explicitly mentioned by 37 articles of our corpus.

The leading theory mentioned about property-rights regarding the commons is about property rights bundles (Schlager and Ostrom, 1992): it spreads the possible rights (access, withdrawal, management exclusion, alienation) across diverse key positions (owner, proprietor, claimant, authorised user, authorised entrant). The enforcement of these property rights bundles is done through property rights regimes (Colding et al., 2013)

- open-access regime (also called res nullius): no-one can be excluded unless by prohibitive costs (e.g. urban biodiversity (Colding and Barthel, 2013));
- state property regime: the property is owned by the state in the name of all citizens (e.g. Central park in New York (Hess, 2008; Sevilla-Buitrago, 2014));
- common property regime: the property is owned by a group of individuals (e.g. R-Urban strategy in the Paris area (Petrescu, Petcou and Baibarac, 2016));
- private-property regime: the property is owned by a private owner or a group of legal owners (e.g. collective use of private yards in Minneapolis (Lang, 2014), privately-leased land in Sydney harbour (Boydell and Searle, 2014)).

Rose, 1996 has made a distinction about public property: it is a good either owned and managed by a government body, or a good collectively owned by society. When defining public space according to this definition (Bruun, 2015), the issue is not a binary one (ownership or no ownership), but rather a complex combination of rights. In a given urban commons, all property rights bundles and regimes may co-exist, as rights and responsibilities are spread across the diversity of actors interacting with the commons. It is the commoners' criteria of exclusion and inclusion which condition the openness of a given commons (Noterman, 2016). The distinctions above guide the analysis of our corpus.

## 3.3 Methodology

### 3.3.1 Justification of the review

The urban commons appears in many fields of research (Figure 3.2). After social sciences, environmental sciences and urban studies fields, engineering and computer sciences account for around 11% of our corpus articles, reflecting the importance of digital communication technologies in the contemporary urban commons. The diverse fields of research potentially suggest a multiplicity of the urban commons.

An urban system is indeed complex: its components exist not by themselves, but in their interaction with others and under many externalities (Foster and Iaione,

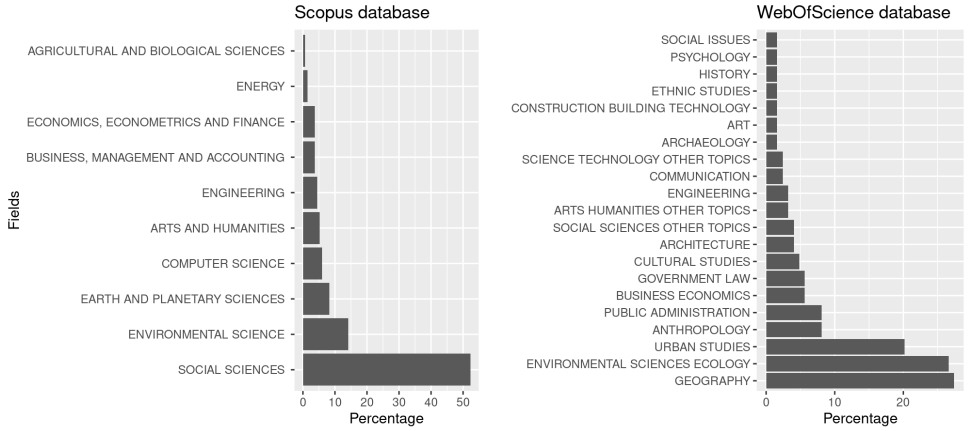


Figure 3.2 – Weight of each research field in our urban commons corpus, expressed as a percentage of all articles and books, either in Scopus (left) or WebOfScience (right) database

2015; Radywyl and Bigg, 2013). In real life, urban commons initiatives do not necessarily affect one another directly. However, at a meta level, the knowledge on the urban commons is built through continuous additions and exchanges of information. The knowledge about the urban commons is a patchwork built on multiple inputs from multiple science fields and practice. These inputs can be based on past experience, on reason and on pure testimony. Therefore, we take an assemblage thinking approach for our review. Originally developed in A Thousand Plateaus (Deleuze and Guattari, 1980), this approach has since then allowed taking a wider perspective in social complexity studies (DeLanda, 2006).

Assemblage thinking is "a mode of relational thinking that approaches an object of interest, and theorizes about it, not as a pre-existing whole (an essence) but as a whole emerging from the coming together of heterogeneous, co-existing and co-functioning components that creates agency, an assemblage" (University of the Aegean, 2017). The "known" of the urban commons is thus forged by the "knower". With the assemblage approach, we intend to embrace the heterogeneity projected above in a transparent process towards the "known".

### 3.3.2 Method of Analysis of the Urban Commons Literature

Given the anticipated heterogeneity (Figure 3.2), we study the urban commons under the lens of Hess's adapted map (Figure 3.1) to build an assemblage of knowledge on the urban commons.

In a first search using Google Scholar, we isolate several keyword synonyms with the notion of urban commons for further article selection: "urban green commons", "urban ecological commons", "cultural commons" and "digital commons". The last two expressions must be linked to the keywords city or urban. We then opt for a snow-ball search in Scopus, WebOfScience and Proquest's ABI/INFORM database, to only select relevant peer-reviewed publications. We select our initial corpus

Table 3.1 – Summary of the practical analysis of our urban commons corpus

| | BENEFITS | CHALLENGES | SUPPORTS |
|---|---|---|---|
| **institutional** | | • governance structure: rigidity, bureaucracy<br>• autonomous governance<br>• land availability and access<br>• group size and scaling-up | • direct/indirect institutional support<br>• beneficial multi-actor co-operation |
| **socio-economic** | • livelihood<br>• economy: value co-creation and shield to crises<br>• recreation and health<br>• collective identity<br>• empowerment | urban commons as a response to neo-liberal threats<br>• social tensions<br>• conflicting values and norms<br>• financial viability<br>• knowledge quality and mismanagement | • civic consciousness<br>• media communication<br>• expert and peer knowledge provision |
| **ecosystem** | • ecosystem services: biodiversity, soil fertility, de-pollution, climate mitigation | • urbanisation: scarce land and pollution<br>• evolving interactions of urban society with urban greenery | |

by browsing all peer-reviewed articles with abstracts or titles containing the exact expression "urban commons", or recurrent synonyms of urban commons as found through Google Scholar.

After including the additional keywords in the initial query, ensuring they are meant in an urban context and removing the possible duplicates, we obtain a total of 167 results from Scopus, WebOfScience and Proquest (ABI/INFORM), spanning from years 1979 to 2019.

We build our analysis on a theoretically recognisable 2-dimensional structure. As we have already observed the potential of the urban commons to trigger adaptive capacities, our first dimension follows a framing that is often used to evaluate adaptive and collaborative resource management systems (Conley and Moote, 2003; Plummer and Armitage, 2007) with three components: ecosystem, socio-economic and institutional factors. Our second dimension categorises our results across three practical characteristics: benefits for cities or communities, challenges and what can support the urban commons.

## 3.4 The urban commons in practice

We provide through Table 3.1 a roadmap of our literature review analysis.

The number of research articles which refer to each argument are mentioned in [brackets] in the coming subsections. The detailed count is accessible in appendix 3.

### 3.4.1 Urban commons types

All new commons sectors in Hess's typology are almost equally represented in the urban commons discourse (details in appendix 2) , exceptions made for a minority of infrastructure commons, markets as commons and medical health commons (Figure

3.3). Those are generally public services under the responsibility of the welfare state (Susser and Tonnelat, 2013; Foster and Iaione, 2015). As for the Market Commons, there are only few cases of locally made goods being sold, exchanged or gifted: shopping centres (Berge and McKean, 2015), Smart City initiatives (Leitheiser and Follmann, 2019; Teli et al., 2015), free space or products (Arora, 2015; Susser, 2017a; Susser and Tonnelat, 2013). Most of the urban commons are generated and used by the community itself. This credits our initial intention of observing the socio-ecological processes of the urban commons.

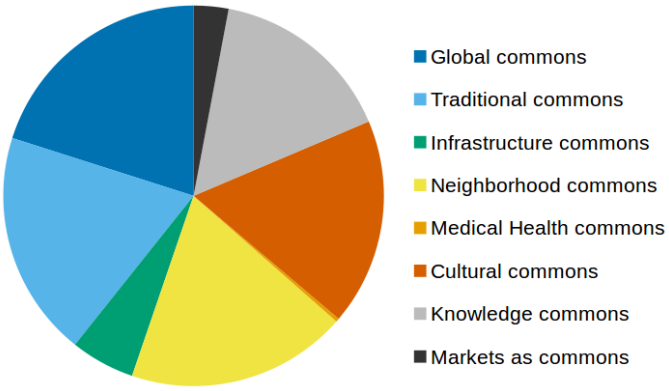


Figure 3.3 – Urban commons sectors by proportion of occurrence

Regarding the types of commons (Appendix 2), the four new commons types most recurring in the urban context, after our literature analysis, are: land use and tenure, indigenous culture, parks and greenery, and peer production of knowledge. From the predominance of land use and tenure in literature (76 studies in our corpus), we can infer that space is a key resource for commoning in the city. It is the primary tangible commons in cities, from which other commons directly derive: agriculture, parks, housing, education or infrastructure. It is the resource most affected by property-rights regimes. Given the growing urbanisation and the saturation of urban space (Di Feliciantonio, 2017b; Huron, 2015; Williams, 2018), we can understand to what extent the subsistence of a tangible urban commons is dependent on the availability of urban spaces. Indigenous culture belongs to the cultural commons and describes the lifestyle of urban citizens and their concerns for livelihood, which are the means to secure the necessities of life, and for alternatives to consumerist urban lifestyles (Bowers, 2009). Parks and greenery are associated with a quest for well-being, through recreational activities (Robson, Sinclair and Diduck, 2015) or connection to nature (Łapniewska, 2017). Finally, peer production of knowledge is a global term which often applies to digital technologies (Wi-Fi, online platforms) through which knowledge can be generated and shared among community users (e.g., Cantone, Motta and Marrelli, 2014). Art dissemination is another example of exchanged knowledge (Middleton and Crow, 2008).

### 3.4.2 Benefits

**Socio-economic factors**

**Livelihood support** This is a recurrent argument not only in developing countries, but also in developed countries when it comes to urban farming, gardening and some cultural practices. The urban commons provides populations with means of subsistence [66]: agriculture, fishing, irrigation, sacred practices, household uses (e.g., Derkzen et al., 2017). Additionally, 12 studies reported the health benefits of commoning: through the de-pollution role of green spaces or through the positive effect of recreation in urban spaces on physical and mental health (e.g. Shah and Garg, 2017).

**Recreation** The urban commons provides opportunities for recreation [19], connection with nature [18] and a global positive feeling [12] (e.g. Colding and Barthel, 2013).

**Identity** Commoning helps create both an individual and collective sense of identity: a social consciousness and system of values built progressively around experiences shared by different individuals [58] (e.g. Borch and Kornberger, 2015). It gives communities a way to deal with societal crises by triggering social resilience, which is the ability of social entities to cope with and adjust to environmental, political or social threats (Colding et al., 2013; Mundoli, Manjunatha and Nagendra, 2017; Schauppenlehner-Kloyber and Penker, 2016; Shah and Garg, 2017).

Commoning additionally provides a strong sense of community empowerment [62]. For example, Community Land Trust housing projects include citizens in the development and construction phases (Aernouts and Ryckewaert, 2017; Bunce, 2016). Commoning is seen as a way to express or claim one's civic rights not only as an individual but also as a community. The gained autonomy gives the chance to shape products and services which best fit the community's interests. A key component for this are the democratic values which commoning promotes [56] (e.g. Łapniewska, 2017). The urban commons represents place-making opportunities [40] for citizens. Places are claimed or re-used in a way which fits a community's needs. Examples of this include meeting places (e.g.,Aernouts and Ryckewaert, 2017), gardening lots (e.g., Camps-Calvet et al., 2015), housing through squats (e.g., Di Feliciantonio, 2017b) or street contestation movements such as Occupy, Squares Movement, Indignados or Nuit Debout (Radywyl and Bigg, 2013; Stavrides, 2016; Susser, 2017a; Susser, 2017b).

These places also represent an opportunity for social integration [44], cultural diversity [45], education [35] and co-production [28]. They allow the expression of values such as mutual care, confidence, solidarity and a sense of security (e.g. Arora, 2015).

**Economy** The urban commons can help increase or create economic value in the neighbourhoods [23], through the provision of goods and services (e.g. Foster and Iaione, 2015).

The socio-economic context is usually a strong motivation for commoning [40], such as economic crises (Di Feliciantonio, 2017a; Huron, 2015), housing crises (Aernouts and Ryckewaert, 2017; Bunce, 2016) or the welfare state drawback (e.g. Camps-Calvet et al., 2015). In the case of economic depression, urban disinvestment, decay and fiscal cuts can happen, eventually leading to insufficiently maintained public parks and a weak provision of social goods: this is the welfare state drawback (Berge and McKean, 2015; Camps-Calvet et al., 2015). This phenomenon fuels the urban commons, as a replacement either bottom-up, such as in Cape Town (Colding et al., 2013), or through local politicians' initiatives, such as in Berlin after the collapse of the Berlin Wall (Colding and Barthel, 2013). Subsidiarity enables the local government to delegate some of its responsibilities to the citizens in order to provide lacking goods and services (e.g.McShane, 2010; Foster and Iaione, 2015). Opportunities also emerge from innovation and economic development, such as with the booming of information technologies through which the digital commons spreads (Rao, 2013).

#### Institutional factors

No direct institutional benefits of the urban commons were identified in our corpus. However, some factors described in Section 3.4.2 may contribute to shaping, improving or renewing institutions: e.g. empowerment, identity building and place-making.

#### Ecosystem factors

The urban commons provides major ecosystem services such as greenery-driven climate regulation [13], urban biodiversity preservation [18], soil fertility upkeep and air, water and noise pollution reduction [18] (Shah and Garg, 2017). To sum up, in addition to nurturing community empowerment and social production, the urban commons seems to offer all the ecosystem services types identified by the Resilience Alliance report (Resilience Alliance, 2010):

- provisioning: the urban commons provides products and goods;
- regulating and supporting: the urban commons involving greenery can regulate cities' pollution and the risk of natural hazards, and support the preservation of biodiversity and soil fertility;
- cultural: the urban commons often favours identity, cultural diversity, spirituality and recreation.

Numerous studies have mentioned that the urban commons supports resilience within urban communities [24].

### 3.4.3 Challenges

#### Socio-economic factors

**Political critique** A large part of our corpus contributes to the critique of neoliberalism [55]: socio-economic mechanisms are viewed as driven by the interests of

global finance capital, rather than by the interests of the society or, more generally, human rights (Harvey, 2014; Simpson, 2014). Neo-liberalism affects in many ways the urban commons (Kalb, 2017): resource enclosure [49], privatisation [49], commodification [27], gentrification (Bresnihan and Byrne, 2015; Newman, 2013), displacements [22] and alienation [21]. These serve as an argument for commoners to claim spaces in the city and reverse neo-liberalism (Hodkinson, 2012; Petrescu, Petcou and Baibarac, 2016; Ruggiero and Graziano, 2018). In some cases, enclosure or social exclusion may result from the commoning activities themselves (Cooke, Landau-Ward and Rickards, 2019; Parker and Schmidt, 2017) to ensure their functioning.

**Social tensions** A high potential for exclusion of specific users or groups of users exists [24], particularly in contexts or urban land congestion (Colding and Barthel, 2013). The exclusion rule may originate from the commoners themselves (Cooke, Landau-Ward and Rickards, 2019; Gilmore, 2017), the local government (Di Feliciantonio, 2017a; Di Feliciantonio, 2017b) or planners (Mundoli, Manjunatha and Nagendra, 2017). Access to the commons needs to be restricted in order to ensure a certain quality or target usage of the commons (Webster, 2007; Williams, 2018). Interests and uses of a commons may also evolve over time, eventually leading to urban redevelopments and exclusions of past users (Nagendra and Ostrom, 2014). This occurs especially in developing countries, where traditional communities depending on natural resources for livelihood become excluded when the land is redeveloped into a recreation area, with potential pollution issues arising. It is often wealthier populations who benefit from the redevelopments at the expense of the urban poor (e.g. Baviskar, 2011). This phenomenon is one of the main arguments of the critical discourse on smart cities and, more generally, on market-driven developments: the conversion of commons spaces into private or public spaces, usually implying an ecological loss and the intervention of external funding and speculation, hinders marginalised populations and has unclear sustainability achievements (Mundoli, Unnikrishnan and Nagendra, 2017).

However, it is also argued that no-one can be excluded from the commons, because it belongs not only to its immediate users, the commoners, but also to its potential future users; commoners become caretakers or guests of the commons (Bruun, 2015; Han and Imamasa, 2015). The boundaries of the urban commons, somewhat porous, are not always as clearly defined as those from the commons described by Ostrom (Hess, 2008; Parker and Johansson, 2011; Huron, 2017; Zapata and Zapata Campos, 2019), and therefore can be contested (Bresnihan and Byrne, 2015). We come back to this point in our discussion.

Another source of social tensions, which can also lead to exclusions, is the diverse cultures existing [31] (Bogadi, 2017; Di Feliciantonio, 2017b) and divergent interests or views [28] (D'Souza and Nagendra, 2011; Rao, 2013), potentially causing conflicts (Gilmore, 2017; Huron, 2015). Post-socialist countries witness a double discourse about the urban commons: it is conceived either for a collective or for a more conservative use (Grabkowska, 2018).

Social tensions may also result from an uneven distribution of resources or power [20] (e.g. Batliboi et al., 2016), amplified by the issue of contested or unclear bound-

aries, mentioned above. Regarding institutions, the local governments are still perceived as the "ultimate sovereign" (Foster, 2011, p.13). In modern Western societies, commoning may hardly be considered as a total emancipation from authorities and market, since both state and market are strongly woven into cities (Jerram, 2015). However, control does not always come from local governments, and can be exerted up to a certain extent by a minority of users, such as in club goods or private organisations (Colding et al., 2013).

**Values** Values are often put forward as a challenge [33]. The social norms built by our modern society may contradict with the values required to care for the urban commons. Primary and secondary education [3], for example, lack basic instruction about food production systems and sovereignty (Tornaghi, 2017), which could drive citizens to join community gardens. This type of education supports a socio-cultural change favourable to re-evaluate the urban commons (Grabkowska, 2018), and trigger resilience thinking (Petrescu, Petcou and Baibarac, 2016).

The lack of rooting or common norms is another downforce (Gilmore, 2017; Sobol, 2017). This can originate from policies oriented towards only individual incentives (e.g. home-ownership, median income) without considering collective efficacy (O'Brien, 2012). In addition, needs and norms evolve, as visible in the differentiated effects of urbanisation on urban communities (Derkzen et al., 2017).

Lastly, the urban commons can lack incentives [26] to attract or maintain its community. The reasons are multiple and relate to values or to the socio-ecological context [4]: lack of experience with commonality (Huron, 2015; Rocha et al., 2016), lack of interest (Middleton and Crow, 2008; Teli et al., 2015), no individual material or ownership benefit (e.g. Grabkowska, 2018), unattractive degraded resources (Ling et al., 2014; O'Brien, 2012), lack of recognition (Correa et al., 2018; Lang, 2014) or the absence of life-threatening conditions (Petrescu, Petcou and Baibarac, 2016). We could summarise these issues with: "everyone's responsibility is no-one's responsibility" (Blomley, 2008; McShane, 2010). Several scholars in our corpus insist on the importance of not looking at individual incentives per se, rather at their interaction with local customs and regulations (Łapniewska, 2017; Schauppenlehner-Kloyber and Penker, 2016). By doing so, they highlight a context specificity in collective-action problems (Ghorbani et al., 2013; Ostrom, 1990).

**Financial viability** The urban commons suffers from financial instability [22]. Institutional protection, source of direct or indirect financial help, seldom happens (Radywyl and Bigg, 2013), either by disinterest [7] (Scharf et al., 2019) or distrust [17] (Follmann and Viehoff, 2015; Sancho, 2014) of the state towards commoning. In this case, the commons often goes underground, making it less visible to the authorities, but also to citizens. This increases the financial burden on the existing commoners, especially when land needs to be rented or purchased (Bresnihan and Byrne, 2015; Huron, 2015). While legal barriers to subsidies need more investigation (Aernouts and Ryckewaert, 2017), recent research proposes to focus more on socio-economic concerns and contradictions within the community (Noterman, 2016), to prevent control aversion situations (Correa et al., 2018).

**Knowledge** Knowledge, from science or practice, generally acts as a support of the urban commons (see Supports subsection). However, 25 articles discuss certain issues, relating to knowledge retention by private actors (Becker, Beveridge and Naumann, 2015; Teli et al., 2015), by software proprietary systems (Crichton, Pegler and White, 2012) or within governed/governing partnerships (Schauppenlehner-Kloyber and Penker, 2016). Beside the problem of missing data, there is a risk of knowledge bias which may threaten the understanding of the interactions between society and the governance of a given commons (Unnikrishnan, Manjunatha and Nagendra, 2016). Urban communities may struggle with knowledge re-appropriation, for example about the personal narratives in the neighbourhood (Wise, 2013), about DIY network technology (Unteidig et al., 2017) or about urban food production systems, the knowledge of which has been externalised for a long time (Tornaghi, 2017). A second challenge regarding knowledge is that data management may be unsatisfactory, eventually leading to non-reliable (Teli et al., 2015) or incomplete (Camps-Calvet et al., 2015) user-generated knowledge, or to a non-inclusive use of spaces, as in the case of cultural heritage sites in Cyprus (Artopoulos, Charalambous and Wehmeier, 2019). Better designs of information flows can facilitate collective action (Łapniewska, 2017). Communication challenges occur: e-participation can suffer from too many users or superficial interactions (Rao, 2013; Sobol, 2017), a lack of exchanges between the various actors (Durusoy and Cihanger, 2016) and the unequal access to IT resources (Batliboi et al., 2016). Communication quality also alters the image given of the urban commons to the public or to the authorities, and therefore influences their support of the initiative (Chiu and Giamarino, 2019).

### Institutional factors

**Governance** A lack of institutional support is often described (e.g., Radywyl and Bigg, 2013, through the difficulties to reach and maintain collaboration and polycentricity [34]. Several institutional challenges potentially hinder the urban commons: a weak internal structure [20] can make it more vulnerable to changes of purpose imposed by the local political context (Giannini and Pirone, 2019). This weak structure may be a choice to stay open and allow possibilities of coexistence, or "compossibilities" (Corsín Jiménez, 2014).

Oppositely, a commons can struggle with rigid institutions [16]: these persist over time not taking into account circumstances which could, otherwise, make the commons more adaptive. This occurs through static urban design or bureaucratic stalling (e.g., Arora, 2015; Chatterton, 2016). Institutions may also be flagged as non-effective [15]: young and weak democratic structures (e.g. Grabkowska, 2018), improper implementation of governmental protection plans (Mundoli, Manjunatha and Nagendra, 2017) or of property rights (Ling et al., 2014) and the incapacity to prevent speculative real estate in case of city bankruptcy (Goldman, 2015; Safransky, 2017). In the case of Central Park in New York, a badly-managed public space leads to the formation of safe "socio-spatial bubbles" intended for the elite and bourgeoisie (Sevilla-Buitrago, 2014). The last two institutional issues are over-regulation [6], for example through monopolies (Webster, 2007), and fragmented institutions (e.g. Nagendra and Ostrom, 2014). Ironically, giving people roles disempowers

them (Radywyl and Bigg, 2013): instead of taking direct action, they tend to only make decisions. A hierarchical division of responsibilities may lead to ignoring the potential of citizens (Schauppenlehner-Kloyber and Penker, 2016). An excessive enforcement of cultural and institutional conventions, including public order and safety, may result in the formation of "atmospheric walls" which segregate the population, thereby diminishing the commoning possibilities (Borch and Kornberger, 2015).

Finding the appropriate level of autonomy [19] regarding the local authorities represents another difficulty: while some initiatives struggle to secure formal recognition [26] (e.g. Scharf et al., 2019), others enjoy a fruitful partnership with local authorities, which could turn into exacerbated inequalities (Unnikrishnan, Manjunatha and Nagendra, 2016) or co-optation by the state (e.g. Cooke, Landau-Ward and Rickards, 2019). In the latter case, the project is integrated in the agenda of a political party or of a NGO at the cost of its autonomy (Pithouse, 2014). A major form of control exerted over commoning practices is the granting of short-term land leases rather than ownership for the group of commoners (Bunce, 2016; Camps-Calvet et al., 2015). Such partnerships could restrict the freedom of action only to what benefits the government (Bresnihan and Byrne, 2015), meaning a partial or total loss of autonomy (Łapniewska, 2017).

Commoning practices often lack the authority to enforce their internal rules, such as sanctioning which may happen through municipal enforcement only (Schauppenlehner-Kloyber and Penker, 2016). This points to the issue of accountability [11]: commoners lack the institutional legal support which could help them make better decisions and ensure a good use of the resources. The issue closely relates to legitimacy. However, according to several commons critical thinkers, the creation of proper commons strongly relies on the involvement of the state (Cumbers, 2012; Harvey, 2014; Kalb, 2017).

A commons also undergoes external pressures. A government may act distrustfully towards individuals, for example through controlling a part of a city's population by inhibiting popular uses of space [17]. In a post 9/11 world, States tend to tolerate less groups that act collectively outside known institutional frameworks (Susser, 2017b). Sanitary reasons may also be evoked as a reason to hinder commoning (Gillespie, 2016; Vrasti and Dayal, 2016), as we have witnessed during the 2020 pandemic. The inhibition is performed through institutions such as "vigilante" monitoring in Paris (Newman, 2013), police patrolling (e.g., Sevilla-Buitrago, 2014), evictions of squatters (Di Feliciantonio, 2017a), stalled procedures for stigmatised populations (Aernouts and Ryckewaert, 2017) and internet surveillance (Rao, 2013).

**Land availability and accessibility** In a dense urban habitat, there is usually limited land availability [21]. High development pressure [20] drives challenges such as the commodification of space, strict definition of property, and competition with financial activities. Urban commons may even threaten each other (Huron, 2015; Petrescu, Petcou and Baibarac, 2016). The commons is often considered as "res nullius", which is the open-access property regime, as much unassigned as any other form of wasteland. Local governments may use this argument to appropriate these lands (Mukherjee and Chakraborty, 2016). 37 studies mention struggles with property rights, one of which is access: social reproduction, for example with urban

agriculture, requires access to resources such as water, waste and sewage (Tornaghi, 2017). The management of these property rights affects the commons, for example through street use regulation (Jain and Moraglio, 2014; Young, 2014), and may drive exclusionary regimes (Colding and Barthel, 2013; Garnett, 2012; Nagendra and Ostrom, 2014). For these reasons, it is often proposed to restructure the property rights in place (Blomley, 2008; Safransky, 2017).

**Scale** Scale is the last significant institutional challenge, expressed through the problems of size [8]. Larger groups may be chaotic, and smaller groups, although more convivial (Parker and Schmidt, 2017), can have an insufficient number of actors for effective stewardship of the commons (Nagendra and Ostrom, 2014). Scaling-up requires additional levels of bureaucracy, which can fence off most initiatives (Pithouse, 2014; Radywyl and Bigg, 2013).

#### Ecosystem factors

The urban commons faces urbanisation [25], i.e. the expansion and densification of the urban territory (Shah and Garg, 2017). Densification (Webster, 2007) and resource over-consumption [14] are the two major identified tragedies of the urban commons. They can be linked to the weak management of spaces by the authorities, also called regulatory slippage [7] (Foster, 2011). Urbanisation also has consequences in terms of land use change, degradation or pollution and encroachment (e.g. Derkzen et al., 2017). In India, unplanned urbanisation may irreversibly destroy peri-urban natural areas (Mukherjee and Chakraborty, 2016; Mundoli, Manjunatha and Nagendra, 2015; Rao, 2013). In other cases, speculation and short-term individual gains exert pressure on urban land (e.g. Huron, 2015): in smart cities, the commons tends to be converted into public or private goods under a technocratic use of the term resilience, in a more corporation-driven and capitalist perspective (e.g., Petrescu, Petcou and Baibarac, 2016; Teli et al., 2015). Newer land uses, turned towards recreation, Special Economic Zones or renewed transport infrastructure, also diminish the urban commons (Goldman, 2015; Rao, 2013; Unnikrishnan, Manjunatha and Nagendra, 2016). A general consequence of urbanisation is pollution, which for example in India directly affects the urban green commons (Nagendra and Ostrom, 2014). Urbanisation is also a driver of space saturation which causes competition, harmful to the urban commons (Di Feliciantonio, 2017b; Huron, 2015).

Regarding the biodiversity discourse, one study questioned the adequation of urban vegetation and legal zoning: plant mobility indeed crosses the existing parcels boundaries (Cooke, Landau-Ward and Rickards, 2019), which may require additional framing of the urban green commons.

### 3.4.4 Supporting the urban commons

#### Socio-economic factors

**Socio-cultural background** Opportunities span across several aspects: civic and well-being concerns [25], shared norms [22], a pre-existing street culture [15], existing links and proximity [14] and diversity [9]. A public democratic culture supports the

urban commons (Arora, 2015; Wise, 2013). The most relevant discourse is the call for urban justice or for the right to the city, or an overall tradition of organised opposition through practices of activism [14] (e.g., Becker, Naumann and Moss, 2017). Indignados and Occupy discourse have helped producing a commoning consciousness (Susser, 2017b), leading to shared norms, which result in collective efficacy (O'Brien, 2012): culture industries and artistic neighbourhoods are the drivers of urban regeneration (Frenzel and Beverungen, 2015; Vrasti and Dayal, 2016). Traditions of collective care or collective attachment to a place are an example (e.g., Datta, 2013; Derkzen et al., 2017). Finally, a diversity in community members, expressed for example through an explicit anti racial-focused or immigrant-opposed discourse, provides a fertile ground to commoning (Colding and Barthel, 2013; Susser, 2017a).

**Media technologies** Media coverage provides a strong communicative and organisational support [19], both offline and online. Digital technologies may be used to engage a community around an issue [22], such as public transportation, education or activism (Crichton, Pegler and White, 2012; Crow et al., 2008; Rao, 2013; Teli et al., 2015).

**Expert and peer-produced knowledge** Knowledge strongly supports commoning [22]. Two types exist in our corpus: expert knowledge [20] and knowledge generated through commoning [27]. High-quality data helps to formulate adequate and relevant policies (Shah and Garg, 2017), or to ensure evaluation and monitoring (Ni'mah and Lenonb, 2017) or to help kick-start or manage an urban commons initiative (Gilmore, 2017; Lang, 2014; Łapniewska, 2017; Petrescu, Petcou and Baibarac, 2016). Knowledge can also be co-generated through and for community engagement (Aernouts and Ryckewaert, 2017). Social learning, experimentation and knowledge transfers are expected to help achieve resilience (Chatterton, 2016; Schauppenlehner-Kloyber and Penker, 2016), such as through mutual exchange with other initiatives, which helps building adaptive capacity. Overall, more knowledge about the urban commons increases potential participation and social resilience (Mundoli, Manjunatha and Nagendra, 2017; Shah and Garg, 2017).

### Institutional factors

Institutional support comes directly (aimed at a specific commoning initiative) or indirectly (as part of a larger discourse or set of policies).

**Direct support** It may originate from social organisations (Di Feliciantonio, 2017a), local governments (e.g., participatory budgeting in Poland (Grabkowska, 2018; Łapniewska, 2017) and in Brazil (McFarlane, 2011)), or from the public through petitions (Follmann and Viehoff, 2015) and donations (Giannini and Pirone, 2019). The formal recognition of the commons, directly leads to financial support [15] or logistic help [28], such as providing spaces or initiating the design phase. In Quebec, a street Wi-Fi network has been approved as a bottom-up urban commons precisely because the municipality failed in setting partnerships with private telecommunication companies (Middleton and Crow, 2008).In the case of housing,

direct support is needed for the provision of decent housing for low-income people (Huron, 2018). In São Paulo, Brazil, part of this housing is organised by the housing movements, or co-op organisations. However, property remains the keyword when it comes to housing access (D'Ottaviano, 2018). Laws and treaties The environmental discourse [13] is a good example of indirect support; the related legislation concerns issues of soil and water remediation, biodiversity, greening the city or renewable energy which also affect urban land. Germany's Renewable Energy Sources Act from 2014 (Deutsches Bundesministerium für Wirtschaft und Energie, 2014) promotes decentralised energy systems, of which citizen initiatives in Berlin and Hamburg have benefited (Becker, Naumann and Moss, 2017). In India, the Smart Cities Mission, launched in 2015, has among its objectives to ensure a clean and sustainable environment (Mundoli, Unnikrishnan and Nagendra, 2017). However, in some cases, these treaties lead to resource access restrictions, negatively impacting the lives of nearby communities: the Ramsar intergovernmental treaty for wetland protection is one of them (Derkzen et al., 2017).

**Polycentricity** A multiplicity of actors [25], often shaped into a decentralised governance system, can drive adaptive capacity ((Becker, Naumann and Moss, 2017; Gilmore, 2017; Mundoli, Manjunatha and Nagendra, 2017). Typical actors are the local government, social organisations, NGOs, knowledge or design experts, cultural partners, companies and of course citizens (Aernouts and Ryckewaert, 2017; Batliboi et al., 2016; Nagendra and Ostrom, 2014; Ni'mah and Lenonb, 2017; Rocha et al., 2016). A close interaction between a community and its local government is generally observed as beneficial [19]: it generates urban rejuvenation programs (D'Souza and Nagendra, 2011), fosters tactical urbanism solutions (Batliboi et al., 2016; Radywyl and Bigg, 2013) or participatory budgeting (Grabkowska, 2018; Łapniewska, 2017), offers autonomy and legal protection to commoners (e.g., Aernouts and Ryckewaert, 2017; Schauppenlehner-Kloyber and Penker, 2016) and helps ensure continuity (Rocha et al., 2016).

#### Ecosystem factors

The global environmental discourse, including ecosystem issues, drives certain policies supporting the urban commons at multiple levels: international to municipal. We have described them together with the institutional factors in subsection 3.4.4.

## 3.5 Discussion

We have found a high variety of urban commons types in our literature body of 167 papers. The context of the urban commons greatly matters when referring to benefits, challenges or supports (Vitale, 2010): a geographical focus, a local or national institutional focus, or a socio-economic focus can help understand why commoning happens and along which dynamics. We have seen examples of contestation movements, claims to social or environmental objectives but also of urban poor relying on the commons for their livelihood.

Unlike in the traditional commons literature, boundaries are not always clear in cities (Zapata and Zapata Campos, 2019): "[m]aybe this is what is urban about the urban commons: this attention to the needs of as-yet-unknown members, and a willingness to keep boundaries somewhat porous" (Huron, 2017, p. 1065). Urban commons initiatives are not bound to physical or digital infrastructures. What makes them new commons is not the physical infrastructure, the floor, the walls, the shops or any other visible amenity that may become a "collective good", but the atmospheres created by users passing by or gathering: a transit space created by informal socialising (Löfgren, 2015). This is in line with the idea of a city as assemblage, a collective composition (McFarlane, 2011). We highlight the need to rethink what commons means in the urban context, because of urban complexity and many existing informal arrangements. "[T]hicker, more ethnographic accounts of the commons" (Blomley, 2008, p. 320) are needed. By using Hess' frame of non-traditional Common-Pool Resources, or new commons, we embraced a significant part of this diversity in our review.

Commoning practices embody the dynamics of the urban commons which currently lack in Hess's classification. Through such practices, more cases are perpetuated and therefore, more knowledge is generated. Commoning covers other types of communalities such as streets and transit places (Löfgren, 2015) which become urban commons through action (Bruun, 2015; Harvey, 2014).

In the philosophy of Lefebvre, 1968; Lefebvre, 1974, the city represents a social space, in the sense of a complex social construction (Smith, 1998; Huron, 2015). How space is used (or socially produced, in Lefebvre's terms) through practices, matters more than space itself, thus "redefining identity and collective strategies" (Le Galès, 1998, p. 502). Urban space thus becomes the output of shared visions of the world (Moss, 2014), and offers good opportunities for the commons (Harvey, 2014; Huron, 2015). In this perspective, the urban space should remain accessible, for example through the idea of "social function of property" (Foster and Iaione, 2015, p. 307), in which a State grants private ownership but with an obligation to guarantee its social function. When the urban space is no longer accessible (Sassen, 2015), it becomes the object of claims. All publications from our literature review brought valuable input to this assumption, and property rights are seen as a major challenge. Under various neo-liberal threats, market-driven, urbanisation-driven or both, Lefebvre's idea of "right to the city" resonates through the urban commons.

### 3.5.1 Critical points in the literature corpus

Two points stood out in our corpus. The first one is knowledge. While expert-generated or peer-produced knowledge is generally considered a support to the commons, multiple studies warn about the quality, extensiveness and management of this knowledge. In addition, learning driven by commoning may trigger adaptive capacity of the involved communities, but education is sometimes subject to cultural norms, which may retain the social resilience potential (Grabkowska, 2018; Tornaghi, 2017).

The second point is governance. Commoning initiatives propose an alternative governance approach, independent from conventional urban planning, which brings

issues of legitimacy and accountability. Maintaining the initiative's activity over time may require various forms of institutional support, which raises concerns on their autonomy, on their trust relationship with local authorities, on the effectiveness of such partnerships and on the unequal access to formal help (Bianchi, 2018; Foster and Iaione, 2015; Giannini and Pirone, 2019). Democracy in such institutional arrangements is still debated. Another issue is the internal management structure of urban commons initiatives. It may be unstructured to favour openness to change and possibilities, but this also makes these initiatives more vulnerable (to forced changes). Nonetheless, a solid structure with too rigid institutions hinders the capacity to adapt, as illustrated by formal roles given to participants, which eventually disempower them by locking them in non-productive decision-making processes (Radywyl and Bigg, 2013).

We, therefore, introduce the following paradox: on the one side, commoning is perceived as a claim to certain civic rights and expression of a collective identity. On the other side, multiple studies have revealed the need for an overarching authority, for formalisation or support. This paradox is embodied by the duality of the social contract as described by Jean-Jacques Rousseau (1762). In his view, people form a community to overcome certain obstacles. To do so, they make a "social pact" consisting in alienating one's natural rights in favour of the sovereign society and an associative pact to form a cohesive society. Every member of this society is then both a citizen, as a participant to the sovereign authority, and a subject to its laws. In Western societies, commoning can hardly function without the coordination of a governmental authority, because state and market are strongly present in the functioning of Western cities (Jerram, 2015).

Cities' values of production and capitalisation often oppose commoning logic. A third of our corpus explicitly positions neo-liberal agendas as a "productive threat" to the commons: urban dwellers engage in commoning as a result of services, spaces and in general means of social reproduction which are not provided by the state, because of their pursuit of private interests.

### 3.5.2 Limits in our approach

We used the broad new commons map of Hess, 2008 to select papers for our literature review. Yet, corpus boundary remained an issue: until what point can we talk about an urban commons? Are municipality-initiated active citizenship projects part of them? Does peri-urban farming count?

We have outlined the importance of the commons for such communities, which gives relevant insight to the commoning practice (Bruun, 2015). Co-production is an alternative framework of study for the urban infrastructure provision (Becker, Naumann and Moss, 2017). However, we have not looked at the urban commons from a circular economy or co-production perspective in this study. Interesting results may come from such analysis with a different focus: given the variety of fields talking about the commons (Figure 3.2), there are potentially strong and diverse contribution opportunities.

### 3.5.3 Directions for future research

We have uncovered several blind spots within the urban commons field. In line with Huron, 2015, we emphasise here the lack of theorising on the urban commons, particularly the urban part of it.

In the urban context, we still lack knowledge on the level of democracy of institutional linkages between the different commoning actors and the stakeholders, along with their underlying motivations and interests. Legal barriers also need more investigation. We lack overview on the role of equity-oriented decision-making processes, such as sociocracy, in commoning. The Théorie des Cités (Boltanski and Thévenot, 1991) and its regimes of justification, or shared visions of the world, could bring certain answers regarding institutions and interactions within co-construction processes. This theory has been connected to the concept of communities of practice (Wenger, 1998; Bussels et al., 2016), but lacks at the moment empirical applications.

Given the urban complexity and its multiple overlapping realms of values, we doubt that empirical studies alone provide sufficient knowledge in order to formulate applicable guidelines and recommendations. The field of computational social sciences is growing and may significantly contribute to this. Agent-based modelling is a type of computational model which allows the exploration of complex systems such as governance schemes or behavioural dynamics, with unlimited varying conditions and parameters (Ghorbani and Bravo, 2016; Janssen and Ostrom, 2006). We have for example applied agent-based modelling to study behavioural and institutional mechanisms in urban community gardens and cooperatives (Feinberg et al., 2021; Feinberg, Ghorbani and Herder, 2020).

Finally, after having introduced the main property regimes in subsection 3.2.3, it turns out, through many examples, that the conditions of use and access are more relevant than the question of ownership. Analysing these conditions with respect to the urban commons, in a context of unclear public space definition, seems to be a priority.

## 3.6 Conclusion

We aimed to build foundations on which future research and future planning guidelines and policy recommendations could be formulated regarding the urban commons. Through our straightforward analytical structure of benefits/challenges/supports, we made our analysis as practical as possible: usable both for researchers and practitioners.

The urban commons spans widely from tangible to less tangible resources, well-described by Hess' map of the new commons. The diversity also extends to its associated bundles of rights: from open-access to private property-rights regimes.

The urban commons is not a new phenomenon after all. It is a transposition of an old tradition of commoning, usually on agricultural and natural land, to urban systems: this can be a necessity for displaced populations due to urbanisation, a way to socialise in neighbourhoods, generate urban goods and services or finally, make a political claim. This transposition is however not straightforward, and justifies the distinction between traditional commons and new commons.

Several factors initially thought of as threats to the urban commons become opportunities or reasons to reinforce or reproduce the urban commons. Privatisations, resource enclosures, urbanisation, authoritarian regimes, weak welfare state: all these drive people to engage into commoning and claim the rights and freedom which otherwise would be destroyed. By providing major ecosystem services, the urban commons represents indeed a major contributor for livelihood in developing countries: it provides goods and services necessary for the urban poor to survive in growing cities, it helps shape a collective identity and values beyond multicultural issues, it generates local value through products, jobs or geographical added-value, and it helps maintain important ecological services. Last but not least, through the collective identity and values, adaptive capacity and capacity building within most initiatives, the urban commons has the potential to trigger social resilience to better face societal and environmental crises. The diversity of views and interests may also, under certain conditions, drive social resilience. A precondition to that is knowledge about the urban commons, itself becoming a commons, which increases potential participation in these initiatives.

However, the urban commons still struggles with land access, exclusion of specific users, a lack of formal recognition, autonomy and rigid institutions. This hinders an urban commons initiative's potential to trigger social resilience and to survive over time. A failing urban commons initiative is like a living organism's cell dying; its death does not affect the overall tissue or organism. Cells are renewed constantly to ensure a functioning tissue. The renewal of urban commons initiatives is the key to their survival.

Our urban commons analytical framework, as proposed in Table 3.1, is a summary of the existing results about the urban commons from an ecosystem, socio-economic and institutional perspective. Further research could use this structure to evaluate the potential of the urban commons for adaptive cities and communities. In addition, the benefits/challenges/supports scheme offers practical applications for potential research and field use. The institutional axis remains to be further investigated, for example through social simulations of the context-dependence and behavioural mechanisms in the commons.

Further research in the field of the commons could benefit from the assemblage approach, originally proposed by Deleuze and Guattari in 1980. For example, to gather knowledge, or as a foundation to study behavioural, political or economic dynamics, happening within commons examples, each of which can be seen as a component of the commons assemblage.

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## Appendix 1: Initial corpus on the urban commons

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## Appendix 2: Urban commons types according to Hess (2008) in our bibliography

DOI: https://doi.org/10.5334/ijc.1033.s2

## Appendix 3: Detailed benefits, challenges and supports for each initial corpus item

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# 4

# Sustaining collective action in urban community gardens

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Abstract– This paper presents an agent-based model that explores the conditions for ongoing participation in community gardening projects. We tested the effects of Ostrom's well-known Design Principles for collective action and used an extensive database collected in 123 cases in Germany and two case studies in the Netherlands to validate it. The model used the Institutional Analysis and Development (IAD) framework and integrated decision mechanisms derived from the Theory of Reasoned Action (TRA). This allowed us to analyse volunteer participation in urban community gardens over time, based on the garden's institutions (Design Principles) and the volunteer's intention to join gardening. This intention was influenced by the volunteer's expectations and past experiences in the garden (TRA). We found that not all Design Principles lead to higher levels of participation but rather, participation depends on specific combinations of the Design Principles. We highlight the need to update the assumption about sanctioning in such systems: sanctioning is not always beneficial, and may be counter-productive in certain contexts.

## 4.1 Introduction

Urban resilience has been defined as "the ability of an urban system and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity" (Meerow, Newell and Stults, 2016). Because cities are complex systems, achieving urban resilience is not simple. In the urban physical environment, the use of space must deal with a context of diversity, anonymity and change (Huron, 2017). Among the challenges to be faced, we highlight the increasing social stratification and unequal allocation of resources (Sassen, 2011; Chelleri et al., 2015). Short circuit economies provide forms of sociality and co-production, necessary to survive under global financial fluxes, which can lead to community social resilience (Petrescu, Petcou and Baibarac, 2016; Derkzen et al., 2017).

Community initiatives are a good example of such local economies. By community, we mean an organised group of people willing to contribute on an equal-to-equal basis to voluntary collective action in order to gain tangible or intangible benefits (Foster, 2011; Schauppenlehner-Kloyber and Penker, 2016). Such initiatives, in cities, are examples of political processes involving society at large, in a more or less self-organised way, which can lead to urban resilience (Anderies, 2014; Kim and Lim, 2016). Urban citizens are engaging more and more in collectively managed shared spaces and resources: the urban commons (Foster, 2011). The commons are the result of the old practice of community management of natural resources. They have greatly diversified to embrace both tangible and intangible resources (Hess, 2008; Feinberg, Ghorbani and Herder, 2021). Community gardens are a well-established example of urban commons: they are spaces mainly dedicated to growing crops, and which are managed and operated by members of the local community. As other urban commons, the focus is on the open space being managed collectively by members crafting their own rules, rather than on specific ownership rights (Colding and Barthel, 2013). While subsistence-driven collective action holds in certain countries, these spaces are more and more recognised for proposing alternative ecosystems to urban consumerism (Bowers, 2009; Feinberg, Ghorbani and Herder, 2021), enhancing well-being (Robson, Sinclair and Diduck, 2015) and connecting to nature (Łapniewska, 2017).

Recent research has shown the social benefits of urban community gardens: health, well-being, education, knowledge, food security, environmental justice, social cohesion and social capital (Łapniewska, 2017; Safransky, 2017; Rogge, Theesfeld and Strassner, 2018). This gives way to multiple motivations to participate. Like other urban commons, urban community gardens can be managed top-down by the local government, with the active participation of the citizens, or in a bottom-up way (Schauppenlehner-Kloyber and Penker, 2016). In most cases, and traditionally, such gardens rely on self-organisation and collective action, independently from government management and without the strict requirement of private ownership (Foster and Iaione, 2015). Such self-organisation relies on rules which are agreed upon by the garden users. These rules influence interactions between the garden users and the success of the initiative: keeping the community active (often volunteers) and

maintaining the resource (garden). Urban community gardens can thus be seen as complex systems. In the self-organisation scenario, urban gardening is relatively independent from periodic municipal changes and that makes it a relevant case study for urban resilience (Colding and Barthel, 2013).

However, urban community gardens face other difficulties. A summary of studies on community gardens mentions volunteer drop off as a challenge that community gardens face, for example because of land access issues, soil contamination, lack of water, safety issues, funding, cultural differences issues, neighbourhood complaints and waiting lists (Guitart, Pickering and Byrne, 2012). Some volunteers may take more yield than others, thus creating tensions (Charles, 2012). These issues can diminish the willingness of the whole group to contribute, which harms the functioning of collective management (Butler, 2013). While some communities have successfully surmounted them, in many cases low participation remains a weakness. In that sense, they present features that are also found in Common-Pool Resources (CPR): it is difficult or undesirable to exclude people from the resource, and the consumption of one user diminishes the possibilities for other users (Ostrom, Gardner and Walker, 1994; Ostrom, 2005). One of the issues commonly found in CPRs is free-riding, or "taking without giving". The study of institutions could bring understanding to such issues. By institutions, we mean an ensemble of rules, prescriptive or constraining, set by a group of individuals in order to organise repetitive and structured interactions (Ostrom, 1990).

Major contributions within this field were made by the Nobel laureate Elinor Ostrom. Thanks to numerous case studies of collective resources management across the world, such as fisheries, forestries and irrigation systems, Ostrom has proposed 8 Design Principles which act as guidelines for robust collective resources management (Agrawal, 2002; Ostrom, 2005; Ostrom, 2009b; Cox, Arnold and Tomás, 2010). Assuming a similar collective management of urban community gardens, it is still unclear how Ostrom's Design Principles could affect community involvement. To the best of our knowledge, apart from a recent Master thesis, which hinted that the Design Principles could be used to study urban community gardens (Butler, 2013), there is no published work which discusses such link. Secondly, urban gardening is also cited for its strong social value, for example through a sense of conviviality, recreation, education and well-being. Particularly in higher income regions, community gardens' social functions are more often prevailing (Rogge, Theesfeld and Strassner, 2018). We suppose that such motivations affect the community involvement.

In this paper, we investigate whether applying the Design Principles actually helps to sustain urban community gardens. By sustaining, we mean maintaining volunteer participation over time. We use Agent-Based Modelling (ABM) to study the effect of Ostrom's Design Principles on the evolution of the garden's volunteer participation. ABM allows more exploration of the institutional and human arrangements which can influence gardening participation. We calibrate the model using empirical data and literature. In the next section, we introduce the useful theories along with our empirical data. Subsequently, we explain the dynamics of our model, before presenting and discussing its results.

## 4.2 Theoretical background

An urban community garden represents a socio-ecological system with the following components: the resource system (the garden), the resource units (garden yield and added social value), the users (volunteers coming to garden) and the governance system (institutions for the community management of the garden) (Ostrom, 2009a). Participation in urban community gardens is a matter of collective and individual decision-making in a social-ecological system, where potential participants need to:

1. be motivated enough to join in the gardening activity ; we assume the participants' motivations to be multiple and to evolve over time;

2. be satisfied with their experience in the garden ; we assume that this experience depends on

    - the state of the garden (availability of resources)
    - the garden community's institutions (rules to which participants should abide to)
    - the other participants (number of participants and their behaviour)

We leave aside the dynamics of the physical resource, to focus exclusively on the participants' behaviour and decisions. We study the evolution of a system where, at a given instant, users decide whether or not to participate and assess the outcomes of that participation. We describe in the following subsections which theories we choose in order to deal with the motivation issue, the garden institutions and the effect of other participants.

### The Institutional Analysis and Development (IAD) Framework

The IAD framework is a descriptive framework originally designed to study systems of self-governance. It helps to understand the way in which institutions operate and change over time within such systems. It is in particular relevant in the field of CPR management (Anderies, Janssen and Schlager, 2016). We apply the IAD at the operational level of governance, which focuses on the practical decisions of the individuals who take certain actions as a consequence of collective choice processes.

The IAD is centred around the action arena, where decision-making takes place: actors (potential participants) choose from several actions (Ostrom, Gardner and Walker, 1994) (Figure 4.1). The composition of the action arena depends on explicit external variables, which define the physical system, on the characteristics of the community of potential participants and on the rules-in-use (or institutions). An action arena consists of several action situations. In each action situation, diverse actions and participants can be specified for the chosen level of governance (here operational). Action situations capture decision-making processes and assign actions to participants. The IAD has later been simplified by Ostrom, 2011 to only keep an action situation box. However, this simplification still enables describing its

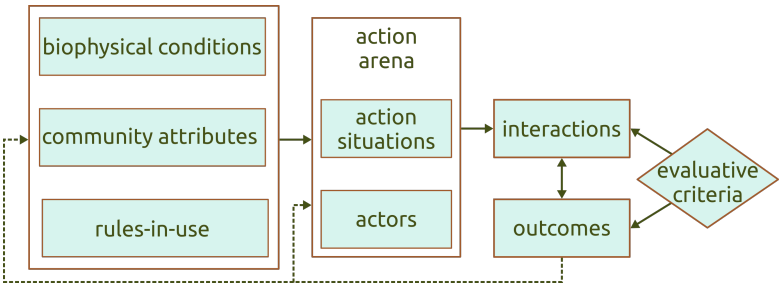


Figure 4.1 – The IAD framework (adapted from Ostrom, Gardner and Walker, 1994

components in detail. From here on, we use the concept of action situations instead of action arena for the sake of modelling.

The action situations lead to certain patterns of interaction which can be evaluated by the participants, for example in terms of effectiveness, cost or sustainability. This evaluation potentially modifies not only the initial properties, but also the possible action situations and participants in the future.

The IAD framework is very relevant for this study as it provides a strong basis for the conceptualisation of an agent-based model (Ghorbani et al., 2013). In particular, the external variables can be used to describe the state of the garden, the community of potential participants and the institutions in place (or rules in use). Furthermore, it allows us to keep track of the link between various variables, especially the institutions and the motivations to join gardening.

### Ostrom's Design Principles

These principles help design institutions for robust collective resource management (Cox, Arnold and Tomás, 2010). We use them to frame our garden institutions: they correspond to the Rules-In-Use that influence the action situations. These principles can be applied in various degrees to design institutions for urban community gardens which we explain in Table 4.1.

| **Design Principles** (name) | **definition and use in existing literature** |
|---|---|
| spatial boundaries | They delineate the realm of application of internal rules (Poteete, Janssen and Ostrom, 2010; Wilson, Ostrom and Cox, 2013), affecting accessibility. They may also create an illusion of closed space which blocks out the community for which the garden is intended (Milburn and Vail, 2010). Community gardens may be fenced or unfenced, while still mostly remaining open in access(Nettle, 2014; Müller, 2007; Spilková, 2017) |
| group boundaries | They generally facilitate rule enforcement (Poteete, Janssen and Ostrom, 2010): roles create new obligations and rights, such as the possibility to take yield from the garden (Milburn and Vail, 2010; Butler, 2013). |
| proportional equivalence benefits-costs | This considers local conditions and inputs to better match contribution and rewarded (Anderies, 2014; Schauppenlehner-Kloyber and Penker, 2016). Perceived inequity can lead to evaluate the rules as unfair, which may increase the proportion of rule violation, as with lower garden yield available for regular members Butler, 2013 |
| collective-choice arrangements | These allow the group members to create new rules or adapt existing ones, which increases the likelihood that rules fit local circumstances, change over time to reflect local environmental and social dynamics, and are considered fair by participants. (Ostrom, 2005; Poteete, Janssen and Ostrom, 2010; Wilson, Ostrom and Cox, 2013). |
| monitoring | This allows keeping track of actions and possible violations of rules in the group. When violators are likely to be sanctioned, the effect of monitoring is an increased confidence among users that they can cooperate without the fear that others are taking advantage of them (Wilson, Ostrom and Cox, 2013). In community gardens, this consists of accounting for participation and rule conformity, which can be done by peers, a coordinator or through a log book (Butler, 2013). |
| graduated sanctions | The sanction is proportional to the violation (Wilson, Ostrom and Cox, 2013). Sanctions bring confidence to the other users, that offenders will not continue harming the group's interests (Ostrom, 2005). Butler, 2013 noted four options for community gardens: no sanction at all, the offender can be told off, the offender is not allowed on the garden anymore. The last option is a graduation of the three previous options: telling off, suspension and cancellation of entry rights. |
| conflict-resolution mechanisms | Accessible and low-cost means to solve conflicts, which are a key issue in shared urban spaces (Foster and Iaione, 2015). Internal conflicts can happen for example through the self-appropriation of collective goods (Petrescu, Petcou and Baibarac, 2016), or because of different agendas (Pearson and Firth, 2012; Foster and Iaione, 2015). Mechanisms follow different approaches: solving cases individually, referring to a committee or encouraging people to talk informally about conflicts before bringing it to the next meetings to look for mediation (Butler, 2013). Such mechanisms are designed to prevent conflicts which could harm trust and overall participation (Ostrom, 2005; Poteete, Janssen and Ostrom, 2010) |
| recognition of rights to organise | Smaller units of decision makers have authority over certain matters (Wilson, Ostrom and Cox, 2013). This recognition comes from the local municipality allowing or not the gardening project (Butler, 2013), therefore impacting the lifetime of the collective action. |
| nestled enterprises | For more complex resources, part of larger systems, the activities related to the previous design principles may be organised in multiple layers of nested enterprises (Anderies, 2014; Foster and Iaione, 2019). |

Table 4.1 – Application of Ostrom's Design Principles in urban community gardens, according to the literature

### Theory of Reasoned Action

The motivational issue is handled in the action situation component of the IAD framework. However, the mechanisms by which actors become participants according to the perceived outcomes, and what actions they perform, still need to be formally described for urban community gardens. In this work, we needed a theory which enables the incorporation of a broad range of individual motivations as well as

the social influence of trust. According to Darnton, 2008, three theories matches this purpose : the Theory of Reasoned Action (TRA), the Theory of Planned Behaviour (TPB) and the Risk-as-feelings (RAF) model. TRA is the most fit to our empirical cases, as we noted no perceived behavioural control (TPB), and no complexification with emotions (RAF). We therefore use the Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 2011) to explain the decision making of individual agents in a group through their attitude (individual motivations) and subjective norm (group drivers).

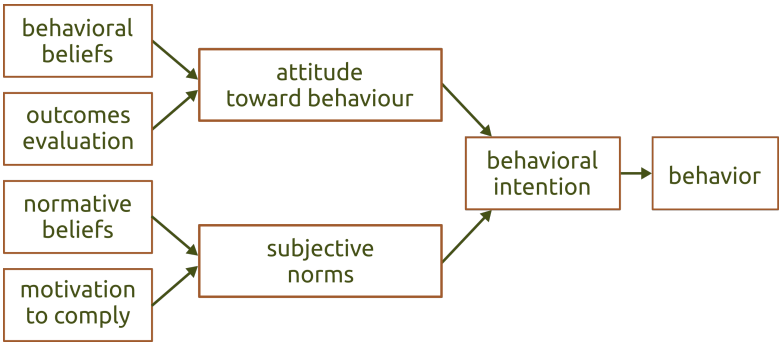


Figure 4.2 – The Theory of Reasoned Action (Fishbein and Ajzen, 2011)

In our model, we extend the TRA with inputs from Mui, 2002. In the TRA, a resulting behaviour depends both on attitudes (which correspond to individual motivations) and subjective norms (Figure 4.2). Such norms represent a perceived social pressure to perform, or not, a given behaviour (Fishbein and Ajzen, 2011). This induces action reciprocity, which is proportional to the normative belief's strength (Mui, 2002). In the belief that others perform a certain behaviour, we can recognise trust as defined by Mui: "a subjective expectation an agent has about another agent's future behaviour based on the history of their encounters". This trust is fuelled by reputation, which is the "perception that an agent has of another agent's intentions and norms" (Mui, 2002). So, by perceiving a reputation, an individual forms an image of the norms active in a group and trusts others to comply to this norm, and therefore, feels a pressure to comply to this norm as well.

Urban gardeners expect each other to perform well enough to maintain a good state of the garden. The social pressure results from the shared desire to have a functional social-ecological system. At the same time, each gardener has individual motivations. The TRA precisely takes both the individual and collective component into consideration. Therefore, the TRA appears as a powerful explanation for the decision making of individuals in an urban community garden.

In community gardens, we can recognise various behavioural beliefs: gardeners can for instance expect to enjoy the gardening or to receive yield. Normative beliefs translate the expectation resulting from trust and reciprocity: gardeners are more willing to contribute when they know that the other participants will do the same (Chalise, 2015). As mentioned above, our case-study has varied activities (such as gardening, education, meditation), for which participants probably have diverse

normative and behavioural beliefs. This makes TRA relevant in our study. We describe these beliefs later in this paper and in the Appendix (Table A.5).

## 4.3 Methodology

In order to study the behavioural mechanisms at stake in urban community gardens, we build an agent-based model which follows the IAD framework structure. We therefore need to collect data to inform some of the IAD's components: the biophysical conditions, the community attributes, the rules-in-use and the possible action situations. We propose to describe the rules-in-use based on Ostrom's Design principles. A detailed model description can be found in a dedicated appendix structured as an ODD.

### 4.3.1 Empirical data for the model

In addition to the available literature on community gardens, we use a database of 123 urban community gardens in Germany, collected through a survey on social sustainability (Rogge, Theesfeld and Strassner, 2018) and two case studies in the Netherlands to qualitatively and quantitatively build our model, which we will further elaborate in this section. In Table A.7 in the Appendix, we present the variables of interest and the origin of their feeding data.

We used the database of 123 community gardens to calibrate our model: categorisation of the institutional variables, motivations of people to join gardening, and most of the ranges for the parameters explored with our model (see model description). We draw some insights from the literature and this empirical data to build a model that studies the longevity of participation in urban community gardens. The model is then validated with the data from two case studies in the Netherlands by customising the parameter setup of the model to represent these cases (e.g. in terms of garden size).

We conducted two sets of interviews in two community gardens in Rotterdam (the Netherlands). Our questions are presented in Appendix, Table A.6. We have selected these two gardens because their internal rules closely match Ostrom's Design Principles. These two gardens have been active for a sufficiently long period to be relevant to our study. The first garden is called Gandhi Tuin and was active from 2011 to 2018, date at which it stopped. The second one is called Vredestuin and was launched around 2013. Our data was collected in 2018, a few months before the end of Gandhi Tuin activity. This gives us at least 5 years of information regarding the on-site collective action. Both gardens were managed by the Vredestuin association and maintained by volunteers from the neighbourhood, which participated in gardening twice a week. In both gardens, anyone could be a volunteer. This resulted in a diverse group of gardeners, including (temporally) unemployed people, people incapable to work, and participants with varying experience in gardening and permaculture. In addition to gardening and decision-making, participants cooked and ate together when harvest was available. The community also hosted educational activities such as lectures, workshops, discussions, documentary nights, yoga

and meditation classes in a classroom on the site. Participants, friends and families donated many materials to the garden and several social organisations supported the garden financially.

The institutions (such as membership, access rules, decision rules, monitoring) are framed using the terminology of the Design Principles, as commonly observed in literature and in our database of urban gardens in Germany (Table 4.1). After translating these principles into practical institutional variables (see ODD, Table A.2), the values applied to these variables are inspired from the Rotterdam cases. We further populate our model, based on the Rotterdam examples, with values for the community attributes (size, motivations of individuals) and for the occurrence of conflicts. We describe in appendix our data sources A.7.

The beliefs, or "motivations", to join urban community gardening are very diverse, and listed in Appendix (Table A.5): many social benefits draw people in, beyond food production. Another important attribute of a community is the extent to which its members share the same core values and goals; this common understanding (McGinnis, 2011) contributes to building up social capital. In the urban gardening context, common understanding is justified by the larger role played by informal rules than by formal rules and sanctions in the appropriation process (Butler, 2013).

### 4.3.2 Comparison between data and model outcomes

From our model, we expect to identify certain collective outcomes (e.g. gardening duration, interpersonal trust, sense of cohesion) from the implemented institutional arrangements (design principles). The results are given in the shape of correlation tables and conditional inference decision trees.

Decision trees are popular statistical models for regression analysis. They consist of a prediction rule based on recursive partitioning. The sequence of the binary partitions (or splits) forms a tree. Conditional inference trees (Ctrees) are more broadly used for the simpler construction, with respect to the popular Classification and Regression tree (CART). Ctrees also seem to handle categorical variables better (Hothorn, Hornik and Zeileis, 2006; Venkatasubramaniam et al., 2017). We therefore use Ctrees for an advanced analysis of the institutional pathways leading to higher or lower participation. They also represent a handy graphical support to our field discussions. We use the *ctree* function of the R *party* package. Because the trees tend to get very large, only splitting rules with a p-value $< 0.01$ are taken into account. Furthermore, we subdivide continuous institutional variables in three parts categorised as 'low', 'medium' and 'high' for more meaningful and interpretable analyses.

We test the validity of our model in two ways. Firstly, we compare our main model outcomes with the insights on social sustainability extracted from the German dataset. The comparison is made in subsection 4.6.3. Secondly, we receive feedback on our intermediate and final model outcomes, via the decision trees described above, from a Rotterdam garden expert. Frequent contact with the gardeners in Rotterdam helped us evaluating our model and its practical use. Gandhi Tuin and Vredestuin had a slightly different institutional structure, which diversifies the feedback given by our case studies on our model outcomes. The fact that Gandhi Tuin stopped

functioning several months after our data collection does not affect the validation process, as we were still able to exchange with their garden leaders. In addition, this gave us the opportunity to confront our model with a real case of failed collective action (subsection 4.6.4).

We consider an urban community garden as a complex system with outcomes that influence the physical, social and cultural context of the community. The complexity arises mainly from their institutional diversity in supporting collective use and social interaction (Rogge and Theesfeld, 2018). Here we list five outcomes:

1. Yield: it is the locally-grown product of gardening activities.

2. Trust: community gardening involves the commitment to certain tasks and an attention to others. Fulfilling these requirements increases the social interactions and the overall level of trust among the gardening community. This results in a positive feedback loop based on reciprocity (Chalise, 2015). As noted by McGinnis, 2011, trust appears among the attributes of the community through the social and cultural context.

3. Social cohesion: McGinnis, 2011 defines social capital as (1) resources that an individual can draw upon in terms of relying on others to provide support or assistance in times of need, and (2) a group's aggregate supply of such potential assistance, as generated by stable networks of important interactions among members of that community. Social cohesion corresponds to this second definition: the extent to which community garden participants form relationships with each other and offer each other mutual help (Kam and Needham, 2003; Veen et al., 2016). We measure social cohesion by the number of mutual dyadic ties within the group (Friedkin, 2004).

4. Gardening duration: this is an important outcome in our study, because it reflects the duration of the participation in an urban community garden. Cox, Arnold and Tomás, 2010 have used a similar measure of success, although we make it a continuous variable rather than a binary one, except to facilitate the comparison of our model outcomes with the Rotterdam cases (subsection 4.6.4).

5. Too-much-work : gardeners leave if maintaining the garden requires more effort than they expected. Chalise, 2015 determines the amount of work by the amount of activities leading to a desired quality.

The model is implemented in Netlogo version 6.0.4 and the model outcomes are analysed in R version 3.6.2. We run experiments with various institutional conditions, which are explained later.

## 4.4 An agent-based model of community gardening

We present the agent-based model of the participation behaviour within urban gardening communities, inspired from data collected in Germany and the Netherlands.

### 4.4.1 Core concepts of the model

Our model is an abstract representation of an urban community garden, with the following concepts:

- Agents: *gardeners* and *potential gardeners* of the community garden
- Individual strategies: the agents decide to participate based on behavioural beliefs (individual level) and normative beliefs (social pressure) (see Figure 4.2).
- Institutions: the gardeners are bound to follow institutions, which in our case are based on Ostrom's Design Principles.
- Outcome: yield, social cohesion, trust and gardening duration

### 4.4.2 Structure of the model following the IAD framework

We build our model based on the overall structure of the Institutional Analysis and Development (IAD) framework (Ostrom, 2005). We aim to gain insight into the influence of the design principles, without considering external regulations.

The external variables in the IAD framework (*Biophysical conditions*, *Attributes of Community* and *Rules-in-Use*) determine the *Action situations* taken by the members of a system; the resulting *Interactions* and their *Outcomes* are evaluated to update the external variables and the actions taken. In our case, the *Biophysical Conditions* and *Attributes of the community* components are defined using structured interviews in our case-study and the German database (Rogge and Theesfeld, 2018). The *Rules-in-Use* component reflects which of the Ostrom's Design Principles are manifesting in the system and how. For each agent, taking an action is defined using the Theory of Reasoned Action (Darnton, 2008; Fishbein and Ajzen, 2011): a resulting behaviour depends both on attitudes (deriving from evaluative beliefs) and subjective norms (deriving from normative beliefs and motivation to comply with these). In our system the agent's behaviour (*Action Situations* components) is affected by the rules (i.e., Design Principles), subjective norms and attitudes. We detail below each of the IAD's components, from our modelling perspective.

#### Rules-in-use: institutions

In our model, we derive several institutional variables from Ostrom's Design Principles. In Table 4.1, we have listed and detailed the relevant Design Principles which influence participation in urban gardens. The implementations in the model are explained below following the situation in the German dataset.

- Spatial boundaries – we assume two choices for this principle: a closed fence/hedge or no fence/hedge around the garden. Therefore this principle is implemented as a boolean: garden boundaries are either active (true) or inactive (false). Having a garden boundary:
    1. decreases the risk of yield being stolen;

2. makes rule enforcement easier (Poteete, Janssen and Ostrom, 2010);
3. worsens the evaluation of the belief of land availability, when deciding to join gardening (Milburn and Vail, 2010).

- Monitoring – this implies a higher probability of sanctioning (Wilson, Ostrom and Cox, 2013). We vary monitoring intensity across a range of values to clarify its impact (see ODD, Table A.2).

- Group boundaries – Possibilities range from an open-to-all flat organisation, to a hierarchy of roles such as key-holders, members, employees, trustees, and/or committee members. When this principle is inactive, everyone is allowed to join and take yield. In some cases, a membership fee is asked to become a member. The fee may be an obstacle and therefore reduces the intention to participate. We test the effect of the fee by varying its value in the formula below:

$$MemberIntention = Intention - fee$$

with:

| | |
|---|---|
| $Intention$ | the behavioural intention to go gardening, based on the evaluations and importance of each behavioural belief and normative belief |
| $fee$ | a range between 0 and 0.9 ; 0 meaning 'no fee for yield' and 0.9 meaning 'a fee for yield which is only worth paying for people that regard yield very important' |

- Collective-choice arrangements – The garden management rights are usually held by a core group, which sets up mostly roughly-defined rules. If active, this principle means that all gardeners have the opportunity to alter the existing rules. We assume in this case that the gardeners are less inclined to violate the rules which they co-designed. The global probability of violating a rule, implemented as a range, is decreased accordingly before the first simulation step (see ODD, Table A.2).

- Proportional equivalence benefits/costs – There are neither formal nor structured appropriation rules: the yield share is taken by the people present in the garden with no specified limit. We therefore implement this principle as follows: contributors receive an ideally fair amount of yield. They choose their own amount; they violate a rule and can be told off or sanctioned if this amount is higher than a set value.

- Graduated sanctions – When this principle is active, the agent violating a rule is told off a first set amount of times. In case of recurrent violation, the agent is suspended for a set amount of time, before risking indefinite access denial.

- Conflict-resolution mechanisms – This principle is implemented as a range determining the harm caused by a conflict (see ODD, Table A.2).

- Recognition of rights to organise – From some informal discussions in the field in Germany and the Netherlands, it seems that the absence of recognition may trigger a feeling of togetherness within the community. Because this principle relies on external actors and has not reached consensus regarding its effects, we leave it out of our research.

- Nestled enterprises – The urban gardening cases at hand being relatively simple systems, this principle is not relevant and left out of the model.

We define a probability of yield being stolen as a garden characteristic. The way in which rule enforcement gets easier with garden boundaries is unclear, just as the probability of a rule violation being sanctioned is also unclear. Therefore, we vary the probability of sanctioning in our model across a range and test this separately from the garden boundaries boolean.

There is no straightforward transcription of each principle into the model. Therefore, we have, in certain cases, grouped the effects of several design principles into one institutional variable of our model. We clarify our conceptualisation and labelling of these principles in the ODD at Table A.2.

### Material conditions

We consider here the yield and the uncomfortable conditions (defined above). Regarding the yield taking action situation, we assume the following. The yield is divided in equal shares; one share for each *gardener*. The minimum amount a *gardener* can take is 0, the maximum amount a *gardener* might take is defined by $DPMaxTakingMoreThanShare$, which we set for an experiment. The fair amount is 1. The *gardeners* randomly choose to wish for an amount of yield higher than 0 and lower than the maximum amount. When *gardeners* take their randomly chosen share, the amount of yield decreases. When the amount of yield decreases too much and *gardeners* cannot take their chosen share anymore, they evaluate the yield taking of that session negatively. This results in a decrease of $e_{yield}$.

### Community

A new community first consists of initiators, who visit the garden regardless of their beliefs for a set amount of gardening sessions. In our model, we assume that the number of *potential gardeners* is a function of the number of *gardeners*. This is formalised following Chalise, 2015: each *gardener* speaks to a set amount of individuals about the garden, of which a set percentage decides to give gardening a try. After this first try, the individual becomes a *potential gardener*. The repeated engagement of *potential gardeners* depends on their beliefs strengths and beliefs evaluation. The belief strengths for the attitudes (cohesion, social time, education, sustainability...) are an average of the values found in the German database (Rogge and Theesfeld, 2018) and those found in the Dutch cases Gandhi Tuin and Vredestuin. The amount of *potential gardeners* and *gardeners* decreases yearly by a fixed percentage ; this accounts for volunteers leaving due to reasons other than events happening in the community garden. The network in which agents interact is a random network.

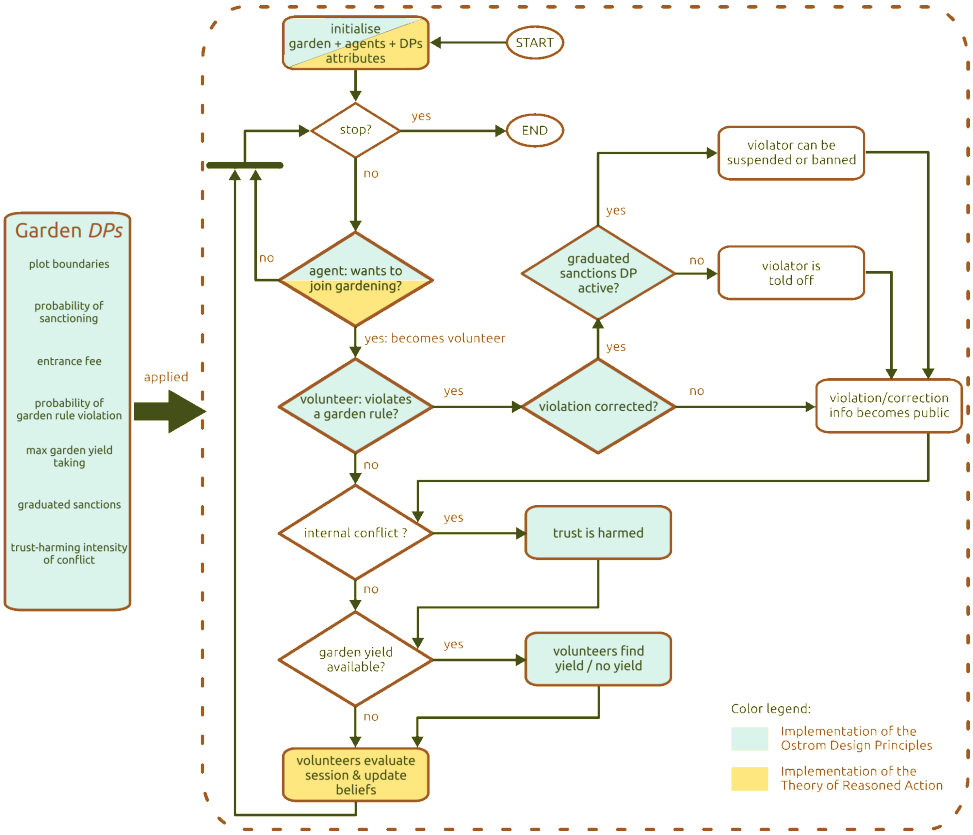


Figure 4.3 – Narrative model of the urban gardening case with applied Design Principles (translated into Institutional variables from Table A.2)

Conflicts occur with a set return period in our simulations, based on the observations in Gandhi Tuin.

The flowchart in Figure A.1 provides an overview of the model.

### Action situations

In this study of urban community gardens, we define three action situations:

1. Contributing to the garden:
   At this stage, all agents have the position of *potential gardener*. If the agent decides to contribute, it is given the position *gardener*. The decision depends both on the agent's behavioural intention (Figure 4.2) and on the Design Principles for garden boundaries and graduated sanctions. For some of the potential outcomes, the gardener has full control over his or her decision (e.g., enjoying nature or enhancing spiritual practice). Some outcomes are uncertain, such as access to fresh food. Some are certain but not under control of the gardeners (e.g., bad gardening conditions).

We describe the decision making of agents with the Theory of Reasoned Action: agents have evaluative beliefs and strengths for that belief (Darnton, 2008). A belief is defined as the subjective probability that an object has a certain attribute, which is determined by the information accessible in memory (Fishbein and Ajzen, 2011). The strength value for each belief is based on our database. When the agent visits the community garden, it combines the strength it gives to each belief and the evaluation of this belief according to its past experiences, if existing. For the first visit, the beliefs' evaluations are set to a neutral value. Parameter set-up is detailed in the next section. Beliefs are then re-evaluated at each simulation step.

2. Choosing an amount of yield to take:
   In the action situation of yield taking, only gardeners participate. Who can take the position to take yield, depends on the Design Principles for garden boundaries and appropriation between benefits and costs. These principles can be translated by the following questions, respectively: has the volunteer paid the access fee allowing it to participate and take yield? Has the volunteer worked enough to deserve taking yield? If these principles are not active, volunteers are free to choose their desired amount of yield. The potential outcomes of taking yield can be having a fair amount, having more than a fair amount or having less than a fair amount. The notion of fairness here depends on the rules in the garden. To simplify, we consider as fair an amount of yield taken that is below a fixed limit (parameter in the model). Any amount taken above would be flagged as a rule violation.

3. Violating rules while present on the garden:
   Gardeners can either contribute fairly or violate a rule. A rule can be violated by mistake, or deliberately (Ostrom, 2005). However, such violations are not considered equally across our garden cases, since rules may differ from one garden to another. We therefore, implement the decision to violate a rule as a probability to violate a rule (see ODD in Appendix).

The three action situations above are regulated by Ostrom's Design Principles. This is described in detail in the ODD.

From literature and our Rotterdam cases, we find that gardeners have multiple beliefs for joining gardening (Chalise, 2015; Drake and Lawson, 2015; Guitart, Pickering and Byrne, 2012). However, some of the beliefs overlap regarding the related practical needs. For example, the concrete action of taking yield may originate from the belief to save money or the belief to consume fresh self-grown food. This is why we merge these beliefs following their related practical need, as shown in the ODD (Table A.1). In the appendix, we also specify our data sources.

In addition to the attitudes, gardeners' decisions are also affected by subjective norms. In our case, the only effective norm is the pressure felt by volunteers to maintain the garden: it is labelled as *needcontribution*. Whether a person reciprocates the norm of contributing to the garden, depends on the individual's norm of reciprocity (Mui, 2002). We therefore, assume reciprocity determines the strength for this normative belief.

The steps characterising decision-making, through the weighing of the different beliefs, is explained in the Behavioural Intention formula visible in our ODD (appendix).

**Evaluation criteria**

Interactions between agents occur during gardening. As mentioned previously, agents who join gardening are affected by their participation experience, e.g. successful yield taking, binding with other gardeners or experiencing conflicts. The outcomes resulting from these interactions influence the beliefs of the agents. We have detailed this in the ODD section of the appendix.

## 4.5 Simulation setup and sensitivity analysis

### 4.5.1 Experiment setup

Our goal is to build experiments which represent combinations of institutional variables. Each variable is thus explored within a predefined range (ODD, Table A.2). We do the same with certain parameters (see Table 4.2). Because we can't anticipate their effects on our model results, it is important to represent as efficiently as possible these ranges. We use R's Latin Hypercube Sampling (LHS) package to generate pseudo-random vectors of 100 values for each range (Dam, Nikolic and Lukszo, 2012).

Our model runs for the same period as the Gandhi Tuin project, thus 6 years. Gandhi Tuin had 2 gardening sessions a week. Excluding a 2-week Christmas break, this results in 100 gardening sessions a year and thus 600 in six years. Therefore, unless they collapse earlier, our experiments run for 600 ticks. Our German dataset indicates that conflicts happen "very rarely". Our case study data is also in line with this, as large conflicts appear on average every 2 years, i.e. 200 ticks. Lacking more information on this, we this consider this value as conflict interval in our model.

The success of the experiments is measured by the output variable $CollectiveActionFailedTime$: the timestamp at which less than two gardeners are present in the garden, causing the simulation to stop. All simulations which could have run longer than 600 ticks (i.e. the number of gardeners at tick 600 is higher than 2) receive the value 600 for this output variable.

In the Netlogo software, experiments are run using the built-in tool *behaviorspace* (Wilensky and Shargel, 2002). We run 100 repetitions of each experiment.

### 4.5.2 Sensitivity analysis

We use the one-factor-at-a-time (OFAT) methodology to gain insight on the sensitivity of the model to uncertain parameters and define the parameter space in which the experiments will be conducted (Broeke, Voorn and Ligtenberg, 2016). OFAT is executed by setting a baseline of parameter values for all parameters: these are presented in the column "base value" of Table 4.3. We vary each uncertain parameter individually across a range of values, bounded by a maximum

| variable | dependence | value origin |
|---|---|---|
| CollectiveActionFailedTime | dependent | first moment there is 1 or no volunteer on the garden |
| Trust | dependent | sum of *gardeners*' trust after every tick / total visits. Trust is defined as good encounters / total encounters. |
| Cohesion | dependent | sum of *gardeners*' cohesion belief after every tick / total visits. Cohesion is defined by the rate of *gardeners* in the group with whom a *gardener* has a tie. |
| Yield | dependent | sum of *gardeners*' yield belief after every tick / total visits. Yield is evaluated positively if the wished amount of yield is received. |
| Too much work | dependent | sum of *gardeners*' belief for too much work after every tick / total visits. It is evaluated positively if the amount of volunteers is higher than a given threshold. |
| DPfee | independent | LHS: $\in [0, 0.9]$ |
| DPMaxTakingMoreThanShare | independent | LHS: $\in [1, 5]$ |
| DPglobalprobabilityruleviolation | independent | LHS: $\in [0.1, 0.9]$ |
| DPconflictharm | independent | LHS: $\in [0, 100]$ |
| DPprobabilitysanctioning | independent | LHS: $\in [0, 0.9]$ |
| DPgraduatedsanctions | independent | LHS: $true/false$ |
| DPplotboundaries | independent | LHS: $true/false$ |
| NoAccessSessions | independent | LHS: $\in [5, 20]$ |
| MaxAmountTellingOffAfterSuspension | independent | LHS: $\in [2, 8]$ |
| Membershipduration | independent | LHS: $\in [26, 104]$ |
| MinAmountOfTellingOff | independent | LHS: $\in [2, 10]$ |
| MaxAmountOfTellingOff | independent | LHS: $\in [10, 40]$ |
| BalanceAttitudeSocialNorm | independent | LHS: $\in [0.5, 4]$ |
| ContributingThreshold | independent | LHS: $\in [3.5, 4]$ |

Table 4.2 – Overview of the variables analysed ; for the independent variables, the range of values for the LHS setup is indicated

value; this range may be a single value (e.g., *Initiators*) or series/ranges of values (e.g.,*ContributingThreshold*). For each parameter, a series of values consisting of the base value, the range value(s) and the maximum value were tested for 100 repetitions, both with active institutional variables or without (Table 4.3).

The institutional settings corresponding to active or inactive design principles are presented in Table 4.4.

| **parameter name** | **base value** | **range** | **max.** | **CAfailed$^+$ sensitive (No DPs)** | **CAfailed$^+$ sensitive (DPs)** |
|---|---|---|---|---|---|
| ContributingThreshold | 2 | 2.5, 3.5, 4, 4.5, 5, 5.5 | 6 | - 0.45*** | - 0.32*** |
| NoAccessSessions | 10 | 5 | 20 | 0.00 | 0.00 |
| MaxAmountTellingOffAfterSuspension | 5 | 2, 8 | 10 | 0.00 | 0.12 |
| Membershipduration | 52 | 26 | 104 | 0.00 | 0.00 |
| MinAmountOfTellingOff | 5 | 2 | 10 | 0.00 | 0.00 |
| MaxAmountOfTellingOff | 20 | 10 | 40 | 0.00 | 0.00 |
| BalanceAttitudeSocialNorm | 1 | 2, 3 | 4 | 0.15*** | 0.28*** |
| *ChanceYieldAvailability* | 1 | 0.8 | 0.8 | -0.03 | 0.03** |
| *ChanceYieldStolenWhenBoundaries* | 0 | 0.20 | 0.5 | -0.01 | -0.02** |
| *VolunteersToFullySee* | 3 | 1 | 6 | 0.09** | 0.06 |
| *AmountOfTasks* | 10 | 5 | 20 | -0.05** | -0.03 |
| *Initiators* | 10 | 5 | 20 | 0.14*** | 0.12* |
| *InitiatorCommittedTime* | 52 | 26 | 104 | 0.20*** | 0.33*** |

Table 4.3 – Input parameters ranges and sensitivity of the collective action lifetime to each of the parameters, both with or without active institutional variables.

*in italic*: garden characteristics CAfailed$^+$ means *CollectiveActionFailedTime*

| Name | Not active | Active |
|---|---|---|
| DPplotboundaries | Off | On |
| DPfee | 0 | 5 |
| DPMaxTakingMoreThanShare | 2 | 1 |
| DPglobalprobabilityruleviolation | 0.61 | 0.31 |
| DPconflictharm | 70 | 30 |
| DPprobabilitysanctioning | 0.31 | 0.61 |
| DPgraduatedsanctions | Off | On |

Table 4.4 – Initial behaviour space for the institutional variables

### Sensitivity analysis outcomes

In order to define ranges for the input parameters, we explore simulation scenarios with and without the institutional variables (Table 4.4). Parameters are evaluated against the output variable *CollectiveActionFailedTime* using Spearman correlations and Kruskal-Wallis p-values. This variable indicates the simulation tick when less than two *gardeners* remain, which is also a measure of the gardening duration. Table 4.3 shows the sensitivity of *CollectiveActionFailedTime* to the model parameters. The garden characteristics (in italic in Table 4.3) are set to match the case-study during the simulations and are unchanged during the simulations. The analysis shows that only the values for the *ContributingThreshold* and *BalanceAttitudeSocialNorm* show significant impact on the gardening duration (Table 4.3). These two parameters result from our theoretical choices, and therefore we have no data for them. We assign them a range of values from which we look for the highest variation of *CollectiveActionFailedTime*.

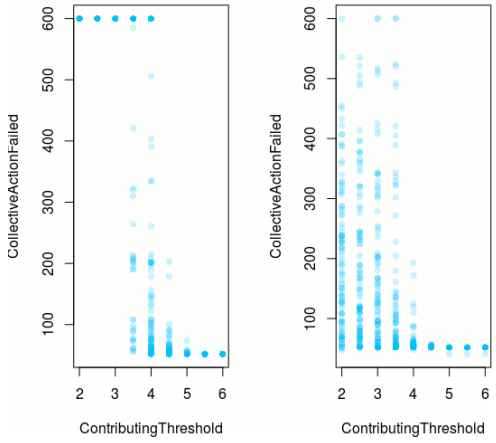


Figure 4.4 – Gardening duration for different values of *ContributingThreshold*, without (left) or with active institutional variables

*ContributingThreshold* is key to determine whether or not a *potential gardener* becomes *gardener*. When testing its effect on *CollectiveActionFailedTime*, we ob-

serve a sharp drop of the gardening duration around the value 4 (Figure 4.4). Our simulations will, therefore, consider values of *ContributingThreshold* close to 4 (Table 4.3). *BalanceAttitudeSocialNorm* indicates the values of the weight $W_2$ of the social norm, with respect to the weight $W_1$ of the attitudes, as defined in the ODD (see appendix). The related scatterplot (Figure 4.5) shows that the output variable's values are not significantly impacted by a specific subinterval of *BalanceAttitudeSocialNorm* values. The other non-garden related parameters show similar plots. Therefore, we have to take into account the whole range of values in our experiments for these parameters, as indicated in Table 4.3. The independent variables in Table 4.2 show the ranges of parameters as they are in our exploratory experiments.

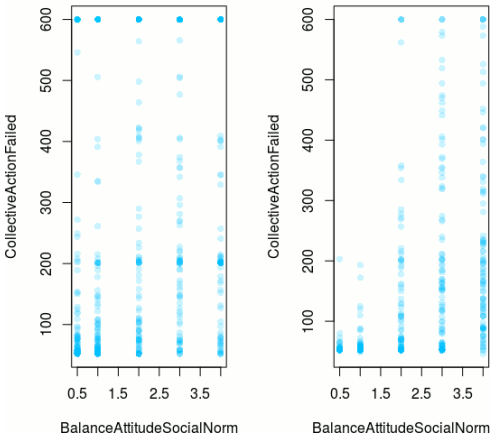


Figure 4.5 – Gardening duration for different values of *BalanceAttitudeSocialNorm*, without (left) or with active institutional variables

## 4.6 Results

In this section, we first present our model experiments results, obtained through Netlogo's Behaviorspace tool. Subsequently, we compare our modelling outcomes with the German urban gardens datasets. Finally, we perform a historic replay by using the values of Gandhi Tuin, and comparing the model results with our field observations.

### 4.6.1 Collective action outcomes

We measure the gardening duration, the overall trust among *gardeners*, their beliefs for social cohesion, for yield taking and for too-much-work. The simulation outputs are analysed with correlation tables and decision trees from R package *party*.

The output variable *CollectiveActionFailedTime* is our indicator of success, and represents the experiment lifetime.

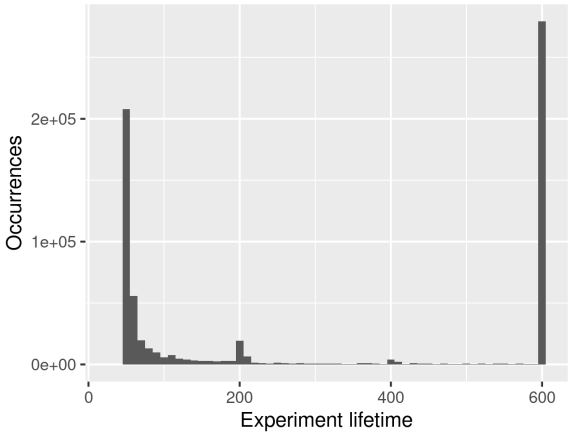


Figure 4.6 – Gardening duration across our simulations

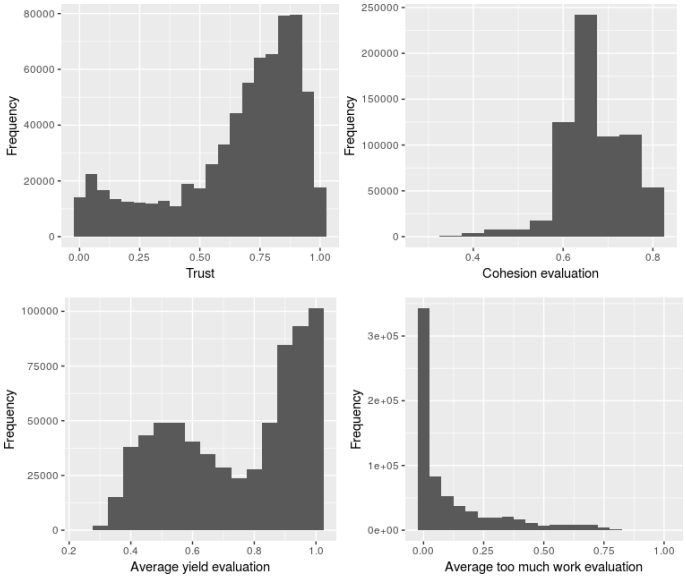


Figure 4.7 – Values distribution for all experiments: Trust, Cohesion, Yield, TooMuchWork

Figure 4.6 shows four peaks in the variable's distribution. The first peak emerges because the initiators can leave the garden, resulting in a drop in *gardeners* which can cause the collective action to collapse. The next two peaks at 200 and 400 ticks appear because of our implemented periodical conflict appearance. The final peak at 600 ticks is the amount of cases that did not collapse in the first 6 years.

Figure 4.7 shows the values distribution of the other four outcome variables, which we discuss below.

### Collective action outcomes and its dependencies

Among the dependent variables, we observe that the beliefs for trust and cohesion are both strongly and positively correlated with high values of $CollectiveActionFailedTime$ : trust and cohesion lead to longer collective action. The belief for yield is also positively correlated to $CollectiveActionFailedTime$, but to a lesser extent. This means that *gardeners* participate longer when they do so for cohesion and trust rather than for physical yield (Table 4.5).

| dependent variable | trust | belief for cohesion | belief for yield | belief for too-much-work |
|---|---|---|---|---|
| **CAFailedTime** | 0.51*** | 0.53*** | 0.4*** | -0.18*** |
| **Trust** | | 0.21*** | 0.2*** | -0.06*** |
| **Belief for cohesion** | | | 0.1*** | 0.19*** |
| **Belief for yield** | | | | -0.23*** |

*** $p < .001$ ** $p < .01$ * $p < .05$

Table 4.5 – Correlations and significance among output variables ; CAFailedTime stands for CollectiveActionFailedTime

### Collective action and the effect of independent institutional and social variables

Table 4.6 shows the correlations between the five outcomes variables (experiment lifetime, trust, cohesion, yield, Too-much-work) and the independent institutional variables and the social system parameters in our experiments. In the subsequent subsections, we analyse each of the outcomes variables.

| **independent variable** | $\rho_{CAfailed^+}$ | $\rho_{trust}$ | $\rho_{cohesion}$ | $\rho_{yield}$ | $\rho_{TooMuchWork}$ |
|---|---|---|---|---|---|
| DPfee | -0.09 *** | 0.06 *** | -0.09 *** | 0.21 *** | -0.03 *** |
| DPMaxTakingMoreThanShare | -0.02 *** | 0.08 *** | -0.02 *** | -0.75 *** | 0.08 *** |
| DPglobalprobabilityruleviolation | -0.25 *** | -0.38 *** | -0.04 *** | -0.14 *** | 0.11 *** |
| DPconflictharm | 0.00 *** | -0.05 *** | -0.02 *** | -0.04 *** | -0.02 *** |
| DPprobabilitysanctioning | 0.58 *** | 0.74 *** | 0.25 *** | 0.25 *** | -0.10 *** |
| DPgraduatedsanctions | -0.02 *** | 0.00 ** | -0.08 *** | -0.01 *** | 0.08 *** |
| DPplotboundaries | 0.01 *** | -0.01 *** | 0.00 | 0.22 *** | -0.01 *** |
| NoAccessSessions | 0.02 *** | -0.02 *** | 0.01 *** | -0.01 *** | -0.03 *** |
| MaxAmountTellingOffAfterSuspension | 0.00 *** | 0.00 *** | 0.01 *** | -0.01 *** | 0.01 *** |
| Membershipduration | -0.02 *** | 0.01 *** | 0.00 *** | 0.00 *** | 0.06 *** |
| MinAmountOfTellingOff | 0.05 *** | 0.02 *** | 0.10 *** | 0.01 *** | -0.03 *** |
| MaxAmountOfTellingOff | 0.06 *** | 0.00 *** | 0.12 *** | -0.01 *** | -0.05 *** |
| BalanceAttitudeSocialNorm | 0.38 *** | -0.14 *** | 0.09 *** | 0.22 *** | -0.27 *** |
| ContributingThreshold | -0.12 *** | 0.05 *** | -0.01 *** | -0.06 *** | 0.05 *** |

*** $p < .001$ ** $p < .01$ * $p < .05$

Table 4.6 – Correlations and significance for the independent variables with respect to $^+CollectiveActionFailedTime$ , $Trust$, $Cohesion$, $Yield$ and $Too-much-work$

### Experiment lifetime

Regarding the influences of the institutional variables, the lifetime of the experiments is strongly positively correlated with $DPprobabilitysanctioning$ ($\rho = 0.58$), followed by $BalanceAttitudeSocialNorm$ (Table 4.6). It is negatively correlated with $DPglobalprobabilityruleviolation$. This means that participation survives better in the presence of monitoring (probability that a person would be sanctioned), but also when *gardeners* consider normative beliefs (or social pressure) as important. On the opposite, rules that minimise probability of rule violation are associated with weaker collective action.

### Trust

As mentioned earlier, indirect reciprocity is the belief strength for trust, which therefore depends on the occurrence of collaborative encounters within the total encounters. This is also called group reputation.

Trust values vary between 0 and 1, and are most often in the top range (Figure 4.7). The correlations indicate a high sensitivity of trust to strong sanctioning ($\rho = 0.74$). Accordingly, violating rules negatively affects trust ($\rho = -0.38$). However, looking at the decision tree for trust reveals that values of trust just as high, can emerge when $DPprobabilitysanctioning$ is medium or low. This implies that monitoring rules that increase the probability of a person being sanctioned do not necessarily increase the level of trust among gardeners.

Our implementation of $DPconflictharm$ decreases trust among *gardeners* whenever a conflict arises (every 200 ticks), with the formula below.

$$TotalConflicts = TotalConflicts + DPconflictharm$$

$$Trust = \frac{AmountOfGoodEncounters}{TotalEncounters + TotalConflicts}$$

In the trust formula, the higher the amount of good encounters (encounters with no rule violation), the lesser the impact of the number of conflicts. We assume that a gardener who has witnessed many good encounters would be only marginally affected by the emergence of a conflict. We illustrate the results of this assumption in Figure 4.8, and make it more visible by setting conflict points exceptionally every 100 ticks, instead of 200. The effect of the conflict points (black arrows in the graphics) on the average trust is dampened over the simulation time, while the amount of good encounters increases regularly.

### Cohesion

Cohesion is the extent to which community garden participants form relationships with each other. We measure it by the amount of dyadic ties within the group.

Cohesion values do not cover the full range, as they depend on the ties each *gardener* can make, which depends on the number of *gardeners* present and on a set probability *Relationrate* for an individual to form a relation with another *gardener* (Chalise, 2015). Among all institutional variables, $DPprobabilitysanctioning$ has

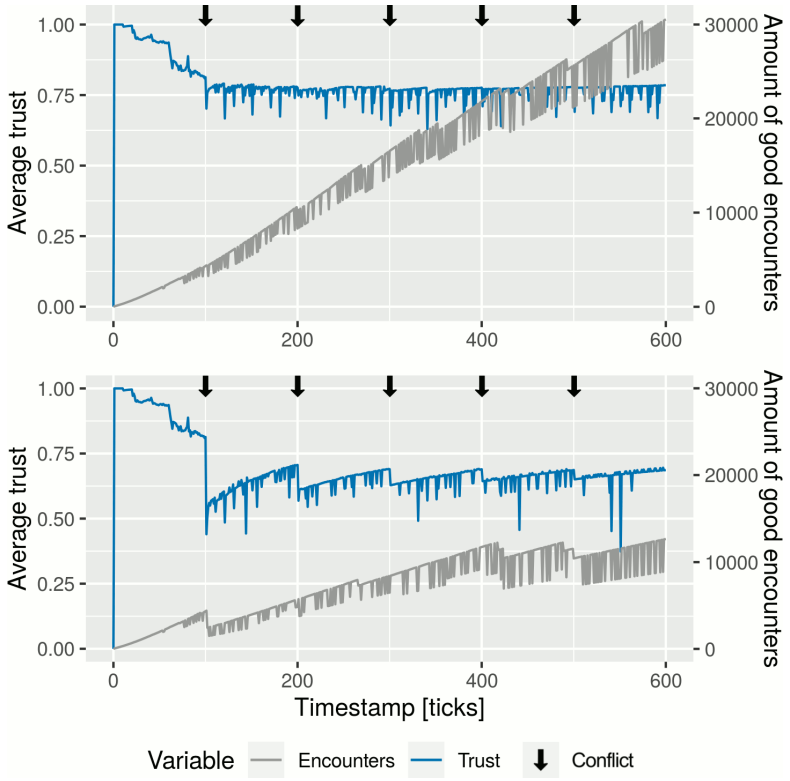


Figure 4.8 – Effect of conflicts on trust, with $DPconflictharm = 6$ (top) or $DPconflictharm = 93$ (bottom). Black arrows indicate conflict points (set every 100 ticks in this example)

the highest correlation with cohesion, however it is weak ($\rho = 0.25$). Active graduated sanctions tend to lower cohesion. This result is coherent with the empirical data, which indicates that graduated sanctions could lead to the suspension or the exclusion of group members. When such a measure is taken, social bonds break.

### Yield

Yield has a strong negative correlation with $DPMaxTakingMoreThanShare$, which is coherent with the assumption that taking more than one's share reduces the other's expectations for yield. $DPfee$ and $DPplotboundaries$ seem to additionally secure the belief for yield. $BalanceAttitudeSocialNorm$ also has a positive effect ($\rho = 0.22$).

### Too-much-work

The belief for Too-much-work is in most experiments low. Consequently, in our model, people are unlikely to quit gardening because of too much work. $BalanceAttitudeSocialNorm$ is linked with lower beliefs for Too-much-work ($\rho =$

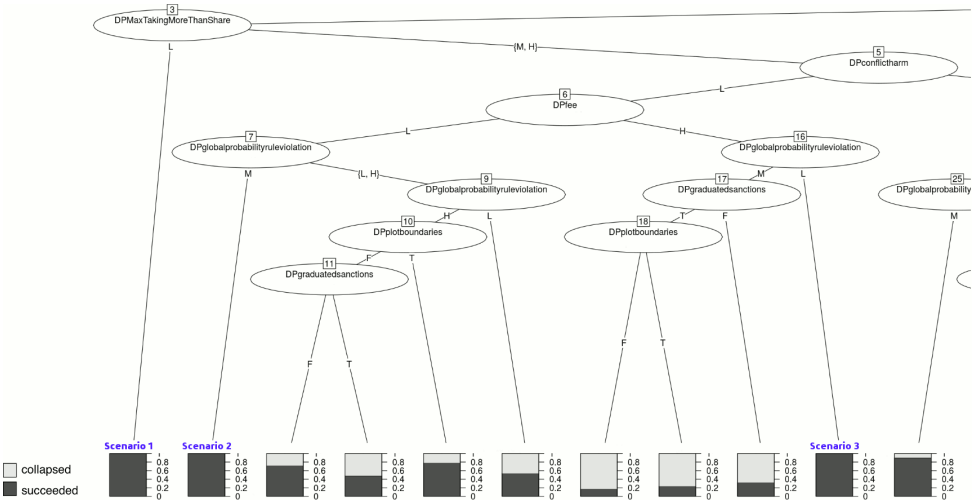


Figure 4.9 – Sample of the *CollectiveActionFailedTime* decision tree, in which scenarios 1, 2 and 3 (Table 4.7) are shown

−0.27): the higher the weight for social norm, the lower the belief for Too-much-work.

### 4.6.2 Decision tree analysis of the collective action

We use decision trees to further analyse our findings of Table 4.6 with respect to the experiment lifetime variable. This is another way to analyse the experiments as defined earlier in the the simulation setup section. We provide an example in Figure 4.9. We have categorised the independent variables (institutions and social parameters) into low, medium and high, for a simpler interpretation. In addition, we have also divided *CollectiveActionFailedTime* in two categories: the successful cases, sustained for 6 years or more, and the collapsed (failure) cases, which stopped before that time. The Ctree algorithm splits our output dataset in a way to form pathways, which we call "scenarios". These scenarios emerge from the analysis, and are not set by us in the model. Each scenario is linked to a certain ratio of collapsed/successful cases.

Figure 4.9 is a subset of the decision tree generated for the variable *CollectiveActionFailedTime*, with 10 nodes visible out of the 283 total nodes. We can recognise three of the successful scenarios from Table 4.7. The top of the tree is not visible: nodes 1 and 2 which are missing, and should be on top of the tree, correspond to high *DPprobabilitysanctioning* and high/low $DPfee$. Overall, the decision tree shows a clear path dependence for the chance of success. For scenario 3, less conflict-resolution mechanisms at node 16 (increase of *DPglobalprobabilityruleviolation* from low to medium) would severely reduce the chance of success.

We have identified in Table 4.7 14 scenarios, leading either to successful or to failed collective action. According to our decision tree analysis, it is not the in-

| Institutional variables / Scenario | DPprobabilitysanctioning | Dpfee | DPMaxTakingMoreThanShare | DPconf ictharm | DPglobalprobabilityruleviolation | DPplotboundaries | DPgraduatedsanctions |
|---|---|---|---|---|---|---|---|
| 1 | H | H/L | L | - | - | - | - |
| 2 | H | L | M/H | L | M | - | - |
| 3 | H | H | M/H | L | L | - | - |
| 4 | H | L | M | M/H | - | - | - |
| 5 | M | L/M | L/M | L | M/H | - | F |
| 6 | M | L/M | L/M | L | M/H | T | T |
| 7 | M | - | L | - | L | T | - |
| 8 | H | H | M/H | M/H | M | F | F |
| 9 | H | M | L | - | - | - | - |
| 10 | H | M | M/H | M | H | - | T |
| 11 | L | H | L | L/H | L | - | T |
| 12 | L | L/H | M/H | - | M | - | - |
| 13 | M | L | H | L | M/H | - | - |
| 14 | M | M | L/M | M/H | H | T | - |

L LOW
M MEDIUM
H HIGH
T TRUE
F FALSE

Table 4.7 – Combinations of institutional variables more likely leading to success (sc. 1 to 7) or failure (sc. 8 to 14) of the collective action, according to the set value of the institutional variable: low, medium or high range ; true or false. Ex. "M/H" means that, given the combination context, values from the medium and higher range both lead to similar outcomes

stitutional variables themselves, but rather their combination that influences the success or failure of the gardening experiment. In other words, certain combinations of Design Principles lead to the success of all experiments, while other combinations lead to early collapse. Most of the combinations generate mixed results in which only a certain percentage of all experiments were successful. Active sanctioning combined with taking low amounts of yield leads to certain success (scenario 1). As a corollary, we observe a free-riding case (scenario 12): a low level of sanctioning, combined with the possibility of taking higher amounts of yield and a medium risk of rule violation, leads to certain collapse, no matter the entrance fee. Sanctioning is however not always key to success. Less active sanctioning leads to similar success only if further principles are applied (scenario 7): collective-choice arrangements (which reduce the probability of rule violation) and garden boundaries. Active sanctioning combined with other principles can also lead to early collapse of the collective action (e.g. scenarios 8, 9 and 10). We will elaborate on that in the Discussion section.

The decision tree has allowed us to pinpoint a path dependency based on combinations of institutional variables. This type of insight did not appear in the correlations (Table 4.6). Another example is the effect of conflict-resolution mechanisms ($DPconflictharm$): their insufficient implementation was the cause of the collective action failure in the Gandhi Tuin case. This result does not appear in the correlation table, but is more visible in the decision trees. In most scenarios (Table 4.7), well implemented conflict-resolution mechanisms (low $DPconflictharm$) are linked with successful experiments.

### 4.6.3 Comparing model insights to the German cases

The experiment lifetime was not measured in the German dataset, therefore we compare the other four outcomes variables.

#### Trust

The empirical data from the German cases (Rogge and Theesfeld, 2018) does not support the strong positive effect of sanctioning on trust. We found $\rho_{model} = 0.74(***)$ while the German dataset displays $\rho_{data} = -0.19(*)$. Another contradiction occurs with $DPglobalprobabilityruleviolation$, which is in the dataset measured by the frequency of complaints regarding either resource use or community interaction. We find $\rho_{model} = -0.38(***)$ while the dataset shows no correlation. The weak effects of the other institutional variables on trust are similar in the German dataset.

#### Cohesion

Weak correlations were found between social cohesion and the institutional variables, which is confirmed by the data from the German gardens. However, the German examples did not show such a high correlation $\rho_{sanctioning} = 0.25(***)$ between the chance of sanctioning ($DPprobabilitysanctioning$) and social cohesion. Instead, the initial probability of violating a rule ($DPglobalprobabilityruleviolation$) played in those cases a stronger role.

#### Yield

Our results from Table 4.6 are similar to insights from the German dataset, except for the strong negative correlation for $DPMaxTakingMoreThanShare$, since, in the field, *gardeners* hardly set expectations for yield, as it is not a main belief for them. The weak effects of the other institutional variables on yield are, however, comparable in the dataset.

#### Too-much-work

From the German gardens, (Rogge, Theesfeld and Strassner, 2018) found a weak negative effect of community size on social sustainability, an outcome which is simplified in our model as long-lasting participation. This is however, not comparable to our model results (see discussion). Yet, Ostrom, 2002 states that community size has no effect on successful management of shared resources. If we assume that gardeners strongly value the collective purpose, then our result is in line with the work of Ostrom, 2002.

### 4.6.4 Comparing model insights to the Dutch cases

We perform a historic replay of the Rotterdam case-studies. This time, we have a unique scenario which is set by the modeller, in such a way to replicate the institutional arrangement of Gandhi Tuin. After running the model with this scenario, we

plot five different decision trees, one for each outcome variable. Since the characteristics of Vredestuin are very similar, we use the same scenario for the second case study comparison as well. Decision trees were used to show our model results to the gardeners of both Gandhi Tuin and Vredestuin, in order to receive feedback.

| **Institutional variable** | **Gandhi Tuin** | **Vredestuin** |
|---|---|---|
| $DPprobablilitysanctioning$ | L | H |
| $DPfee$ | L | L |
| $DPMaxTakingMoreThanShare$ | H | M |
| $DPconflictharm$ | H | L |
| $DPglobalprobabilityruleviolation$ | L | L |
| $DPplotboundaries$ | T | T |
| $DPgraduatedsanctions$ | T | T |
| **Collapsed cases** | 59 % | 2 % |
| **Trust** | 0.78 | 0.92 |
| **Cohesion** | 0.72 | 0.58 |
| **Yield** | 0.52 | 0.93 |
| **TooMuchWork** | 0.08 | 0.00 |

Table 4.8 – Validation: our model results for the two case studies, taken from the decision trees

The institutional variables based on the cases of Gandhi tuin and Vredestuin can be found in Table 4.8. Gandhi Tuin collapsed after 5-6 years. Its garden leaders explained that conflict-resolution mechanisms were insufficiently implemented: a conflict appeared and could not be dealt with efficiently, leading the volunteers to quit. Vredestuin has learned from Gandhi Tuin that people's behaviour can harm trust when monitoring and sanctioning are poorly applied. $DPprobabilitysanctioning$ becomes high and $DPconflictharm$ is low for Vredestuin. In the decision trees obtained for each dependent variable, we looked for the paths which correspond to the two case studies. We have noted the predicted values of our dependent variables in the lower part of Table 4.8.

The garden expert from Vredestuin felt very confident about the people gardening under this new set of principles. This confirms the rise in trust measured by our model (0.92 against 0.78). In addition, our model predicts a significantly lower proportion of collapsed experiments for the Vredestuin scenario (2 % against 59 % for Gandhi Tuin). This is in line with the fact Gandhi Tuin actually collapsed within 6 years.

Our assumption on the belief for Too-much-work leads to a positive feedback loop. Too-much-work is a barrier to participation (Chalise, 2015), which has the effect of reducing the number of gardeners (community size), thereby reinforcing the belief of Too-much-work. Our model indicates very weak effects of most institutional variables on this belief. It is only when *gardeners* join for a collective purpose (high $BalanceAttitudeSocialNorm$), that they are less affected by the amount of work to be done ($\rho = -0.27$, Table 4.6). In the Rotterdam cases, only 20 % of the gardeners mentioned being affected by too much work. Our model gives less than 10 % (Table

4.8), which is a bit underestimated. This supports the idea that community size may not affect the overall gardening duration, since only a minority of gardeners are affected by low attendance and therefore higher workload (see also Figure 4.7). Overall, our model was able to explain the observations and impressions given to us by the Rotterdam garden leaders.

## 4.7 Discussion

In this paper we explored the role of Ostrom's design principles for collective action on urban community gardens, a classical example of urban commons. We used the IAD framework and the theory of reasoned action to frame our agent-based model, and then translated Ostrom's Design Principles into institutional variables. We discuss below the outcomes of our research.

### 4.7.1 Reflections on the method (added February 2022)

The ABM on urban gardens is calibrated using data from the German cases; section 4.6.3 gives a rather satisfactory confirmation that the model works and represents well the German cases from which it was originally inspired. The model is then populated with data from the Dutch cases to make the model relevant for validation (tuned range for population size, adapted names of beliefs to join gardening and frequency of conflicts).

This represents a weakness in the validation process since we inject a small fraction of the first Dutch case data into the model. While this does not alter the results of this chapter, i.e. about the idea of combination of Design Principles and the correlations between certain Design Principles and our dependent variables (trust, cohesion, lifetime...), our findings should now be taken lightly in the absence of a stronger validation.

### 4.7.2 Institutions for successful urban gardening

Ostrom's Design Principles are perceived as indicators of robust collective action. Our research leads to two main findings: (1) the longevity of urban gardening participation depends on the combination of the Design Principles ; (2) the assumptions behind sanctioning and taking yield should be further investigated.

Although we measured success of urban gardening initiative in a similar manner as Cox, Arnold and Tomás, 2010, we did not find that all design principles contribute equally to the success of the gardening experiments. Yet, it is worth mentioning here that, as we translated these principles into practical institutional variables, certain principles could not be tested individually (e.g. monitoring). We have identified certain combinations of institutional variables, and by extension, of design principles, which can either lead to the success of the gardening experiments or their failure. This finding is also supported by a study on 60 cases of Common-Pool Resources (CPR) which points out that context-specific combinations of design principles lead to greater success (Baggio et al., 2016). They consider mainly fishery, irrigation and forestry activities. Their measurement of success embraces resource

sustainability, an element which we did not consider, and trust, which we measured. For example, they noted the prevalence of both active boundaries and equivalence benefits/costs together in successful CPR cases. Our agent-based model confirms the idea of combinations of Design Principles, without necessarily pointing to the same combinations as those identified in (Baggio et al., 2016). This can be linked to a divergence of assumptions (e.g. indicator of success), modelling translations (e.g. redefined design principles in the ODD at Table A.2), and types of resources analysed, which leads us to our second point below.

Urban community gardening is more than a CPR, in the sense that gardeners join not only to create physical value (yield) but also for intangible resources such as cohesion, leisure and education. The absence of physical yield does not necessarily reduce the quality of the resource (urban garden) nor the level of participation. This may be why our results diverge from those of Cox, Arnold and Tomás, 2010, who dealt specifically with natural resources (e.g. forest, fishery, irrigation, pasture). Our case shows that trust and cohesion are both the main drivers of durable participation (Table 4.5). This is in line with Baggio et al., 2016, who explain the prevalence of the equivalence benefits/costs Design Principle by the idea of perceived equity, which can be related to trust. At the same time, trust can be seen as one of the main outcomes of urban gardening, rather than yield: it emerges through the collective action processes undergone by the gardeners (Rogge, Theesfeld and Strassner, 2018). This may be why, unlike in the work of Baggio et al., 2016, the equivalence benefits/costs is weakly correlated to trust, our common indicator of success. In other words, because yield extraction plays a lower role in gardening communities, than it does for fishery, irrigation and forestry, a more just equivalence benefits/costs (i.e. proportionality investment/extraction) does not necessarily ensures more success.

Trust appears both as a condition for and a result of successful collective action. Through long-term repeated interactions among the same members of a community, trust as outcome may outweigh trust as a condition and induce adaptability. This may explain why, in Figure 4.8, gardeners are less affected by conflicts over time, as the number of positive encounters increases.

We also wish to highlight the current emphasis on the role of sanctioning for collective action. The ongoing assumption, in the Ostrom and Common-Pool-Resource literature, is that sanctioning reduces the risk of rule violation through increased compliance. We wish to moderate this claim in the case of urban community gardens, an example of urban commons, with the following two arguments. Rogge, Theesfeld and Strassner, 2018 highlighted the higher explanatory effect of trust, rather than sanctioning, in collective (social) actions situations, such as community gardening. In most of the cases from the German community gardens dataset, detailed rules were not of high importance. Conjointly, Rogge and Theesfeld, 2018 found that monitoring and sanctioning had the lowest impact on social sustainability, among the following factors: community size and heterogeneity, size of the area, perceived trust, size of the management group and rule design. We suspect that monitoring and sanctioning in case of vaguely-defined rules becomes less relevant, which can explain the low impact of this factor on social sustainability. We can rephrase this argument by saying that sanctioning mechanisms are rather an indicator for low social sustainability and compliance problems. Furthermore, regardless of

how strictly defined rules are, sanctioning has unclear effects on gardening participation (Table 4.7). Baggio et al., 2016 have also found an indeterminate link between sanctioning and success, unless when sanctioning goes together with proportional equivalence benefits/costs.

While our results show that rule violation indeed weakens trust, sanctioning does not always imply long-term collective action. Although we took the ongoing assumption of sanctioning, in the sense of Ostrom, into account, we have observed multiple scenarios where active sanctioning leads to early collapse of the collective action (scenarios 8, 9 and 10 in Table 4.7). Regarding trust, although we measured a high sensitivity of trust to both active sanctioning ($\rho = 0.74$) and rule violation ($\rho = -0.38$), we have also observed that high values of trust can emerge when sanctioning is weakly implemented. In addition, although cohesion is the most correlated factor with sanctioning ($\rho = 0.25$), it is still a relatively weak one. At the same time, active sanctioning impacts cohesion negatively, which we explain by the possibility of loosing social ties when sanctions such as suspension or exclusion are implemented.

To support our claim regarding the ambiguous role of sanctioning in collective action, we also point to recent research on archival records of European commons across the past centuries, which has also highlighted a negative correlation between rules corresponding to sanctioning and the longevity of the commons (Moor et al., 2016; Boyd et al., 2018). Their research shows that sanctioning may have been used occasionally on long-lasting commons, but most of the time and effort was dedicated to organising regular meetings. This involvement, implying rules adjustments, information exchange, mutual monitoring and the internalisation of norms, is positively correlated with long-lasting commons, unlike plain sanctioning. Therefore, commons with more effort put on participatory, rather than punishing institutions, tend to last longer. Conscious that our work describes cases of new commons (Hess, 2008) with important social motivations, our conclusions are in line with these historical commons. In addition, we found similar conclusions regarding the effective combinations of design principles as Baggio et al., 2016, who studied traditional Common-Pool Resources. We conclude that the existing assertions on the efficacy of sanctioning in cases of voluntary collective action should be moderated and investigated further.

### 4.7.3 Further developments

In our model we have used the current assumption of sanctioning, which says that sanctions prevent free-riding and therefore extend the lifetime of the urban commons, such as community gardens (Ostrom, 1990; Foster, 2011). However, our results, the study on social sustainability (Rogge, Theesfeld and Strassner, 2018) and recent research indicate that the urban commons do not necessarily revolve around free-riding problems (Moor et al., 2016; Borch and Kornberger, 2015; Boyd et al., 2018; Rogge, Theesfeld and Strassner, 2018). In Europe, as well as in East-African pastoral groups, coercive institutions are less likely to solve collective action problems than "informal, culturally evolved moral norms" are. (Boyd et al., 2018, p. 1236). European community gardens proposing various activities, social or not,

they are less likely affected by free-riders. The value of the urban commons tends to increase with higher participation, rather than observing resource depletion (Borch and Kornberger, 2015). The study of such value emerging from the diversity of members and activities should be looked into, notably in different cultural contexts.

Secondly, we strongly suggest to update the ongoing sanctioning assumption, at least in the circumstances where sanctioning has unclear effects. We imagine two ways:

- Adding the indirect burden created by the existence of plain sanctioning rules: empirical data (Rogge and Theesfeld, 2018), our model results and recent findings (Moor et al., 2016; Boyd et al., 2018) are critical towards the effectiveness of sanctioning measures. A hypothesis is that sanctioning may be perceived negatively by potential gardeners, who solely wish to join for leisure, and therefore are discouraged by the presence of punitive mechanisms.

- Including the possibility for people to become *gardener* solely with benevolent intentions, as commonly observed by Rogge and Theesfeld, 2018 in the German cases. We have presently assumed that all *gardeners* make mistakes or violate rules with a given probability which evolves over the simulations in a way to mimic the others' behaviour. In that case, taking too much yield would not have such a negative effect on yield as the one we measured, although yield was already not a strong belief for gardening in our case study (Table 4.6).

In addition, we may need to include an indirect form of sanctioning, which happens by gossiping in such communities, as a result of informal monitoring. Both our empirical data and Moor et al., 2016 point to this. It thus becomes difficult to argue for the absence of sanctioning, as it happens informally even in the absence of plain sanctioning rules.

Regarding urban community resilience, we have voluntarily, in our modelling exercise, restricted the expected outcome to a maintained level of volunteer participation. However, it is perhaps not the most stable state. A resilient urban system should not necessarily return back to one of its previous stable states (Meerow, Newell and Stults, 2016). The abandonment of a community garden is not per se a failure, and may signal the local transition to another state, for example to match new needs or political environments. At this stage of knowledge, both ways to resilience are described in literature: persistence or transition through transformations or changes. Secondly, we have not touched the notion of adaptability of the system, for example with the capacity to change the community rules upon collective decision-making. Such dynamics are possible to study with agent-based modelling (Ghorbani and Bravo, 2016).

Regarding our modelling assumption there are several points that may need further development. First, in order to model the design principles, we only considered their effect on the gardening action situations, rather than actually modeling the institutions that are designed based on these principles. This led us to few simplifications of the Design Principles, as explained in Table A.2 (ODD). For example, the proportional equivalence benefits/costs was translated into $DPMaxTakingMoreThanShare$, which indicates how much more than one's

share, a gardener can take, regardless of how much the *gardener* actually contributed (which is not measured).

Second, in our model, collective action collapses when only one *gardener* remains. This is a condition, which in real life does not necessarily cause collapse: a *gardener* could be physically in the garden alone a couple of times, without it causing the end of the collective action. The mechanisms evaluating whether or not collapse occurs thereby were beyond the frame of this research.

Third, in our model, we have not tested the effect of the presence of a core group of members which would take the decisions in the garden. Although recent research suggests that higher social sustainability, which we measure in our work through long-lasting participation, may be attained when decisions are taken by the entire group, rather than by a core group (Rogge, Theesfeld and Strassner, 2018), this may still be a point to consider for further extension of the model.

## 4.8 Conclusion

In this research, we have analysed the effects of Ostrom's Design Principles over time, by studying their dynamic effects on long-term volunteer participation in urban community gardens. Decision trees also proved to be an efficient communication tool in the field.

We have built our model using Ostrom's Design Principles as the institutional structure which guides and limits the decisions of volunteers to join gardening, a decision itself motivated by individual and collective beliefs, as framed by the Theory of Reasoned Action. We borrowed assumptions from the literature, that the Design Principles lead to a more robust collective resource management and that sanctioning has the notable effect of reducing free-riding, and therefore, enhancing cooperation.

Our model results offer several points of discussion to the Ostrom discourse above. A higher weight placed on social norm facilitates long-lasting participation and increases the trust perceived among gardeners. In addition, the higher the probability for a rule to be violated, the lower the trust. The system performed longer when gardeners joined for social cohesion rather than for taking yield from the garden. This is also confirmed by the fact that higher cohesion values are found when sanctioning is in place. Taking more than its share of yield badly impacts the overall belief for yield taking, while the presence of garden boundaries around the garden increases this belief. Repeated interaction in urban community gardens lowers the negative impact of conflicts. This phenomenon could be linked to trust being generated through such interactions, and suggests a form of adaptability of such communities.

Although we initially found that higher probabilities of sanctioning were correlated with more successful collective action (in terms of lifetime), a closer analysis of the institutional arrangements showed many combinations in which either low sanctioning led to success, or high sanctioning led to failure. Sanctioning has therefore an unclear effect on collective action. More generally, Design Principles do not act in isolation, rather, their specific combination determines the outcomes of the collective action. This was put in evidence thanks to the conditional inference trees.

Our study is among the first to confirm this outcome through social simulations, an outcome which was highlighted by recent research.

We wish to stress the importance to re-evaluate the assumption behind sanctioning, especially for future social simulation work, which is more subject to biased results due to the formulation of assumptions. Although implementing sanctioning in the sense of Ostrom in our model, careful analysis did not always associate successful collective action to higher level of sanctioning. Our empirical database of urban community gardens also indicates a negative correlation between perceived trust among gardeners and active sanctioning. Gardeners do not contribute only for subtractable resources (garden yield), but may contribute for non-subtractable resources as well, which links to the diversity of possible beliefs or motivations (e.g. socialising, education, sustainability purpose). Free-riding, by operating on subtractable resources, is therefore perceived less negatively and the existence of formal sanctioning rules could dissuade gardeners to join, rather than trigger cooperation. Recent research has been contesting the prevalence of sanctions in the management of the commons, suggesting that effort should be put on participatory mechanisms rather than coercive institutions.

# Model Documentation

The model description, formatted as an ODD protocol, along with additional information on the data sources, our assumptions, the field study questions and further details on the gardening motivations, can be found in Appendix A.

Our model's Netlogo script along with the LHS parameters used as input in the model can be found in the following online repository:
https://www.comses.net/codebases/6ad1edde-d9f3-49f6-ba36-d251ff1886b5/releases/1.1.0/. This folder also contains a pseudocode to help understand the structure of the Netlogo script, and a brief description on how to run the Netlogo script.

# 5

# Commoning toward urban resilience: The role of trust, social cohesion, and involvement in a simulated urban commons setting

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Abstract– In this chapter, we investigate the potential of urban commons for building community resilience. We focus on the issue of adaptability to socio-ecological issues, which depends on the social capital built by the local community of practice. We measure this capital through the variables of volunteer involvement, perceived trust, and social cohesion in an agent-based model, which simulates the dynamics of participation in collective activities. We anchor our model with the case of KasKantine in Amsterdam, a cooperative and restaurant run by volunteers. Our model shows that both trust and social cohesion emerge from the interactions in the cooperative, especially when group sizes are kept small. This contributes to the adaptability of such social-ecological systems, helping their communities build social resilience.

## 5.1 Introduction

In the aftermath of an environmental, socio-economical, or sanitary crisis, we question our adaptability as individuals within a community. We thus thrive for community resilience as a means to mitigate future crises. With the population concentration happening in cities, such concerns are particularly legitimate for urban communities. "A city without resilient communities will be extremely vulnerable to disasters. Human communities are the social and institutional components of the city, directing its activities, responding to its needs, and learning from its experience" (Kim and Lim, 2016, p. 6).

Recent research has placed emphasis on processes of co-production and collective governance as drivers of urban resilience (Elmqvist et al., 2019; Kim and Lim, 2016; Meerow, Newell and Stults, 2016; Shah and Garg, 2017). Among such processes, the wide-spread urban practice of commoning (Bollier and Helfrich, 2015; Bresnihan and Byrne, 2015) "involves a collaborative process of bringing together a wide spectrum of actors that work together to codesign and co-produce shared, common goods and services at different scales" (Foster and Iaione, 2019, p. 4). In the city context, the urban commons are generated through commoning processes, either as resources, which can be material, immaterial or digital, or as more complex "forms of social infrastructure" (Foster and Iaione, 2019, p. 16). In the latter case, the commons comprise dynamics of mobility, encounter and the re-imagination of the social and spatial environment (Susser and Tonnelat, 2013). What matters is not only preserving the urban commons, but the struggle over the conditions of producing them (Hardt and Negri, 2009). These conditions revolve around an ecosystem of local practices, guaranteed by a citizen-based democratic governance at a community scale (Petrescu, Petcou and Baibarac, 2016). Multiple studies have highlighted the urban commons as a potential for higher urban resilience (Camps-Calvet et al., 2015; Colding and Barthel, 2013; Mundoli, Unnikrishnan and Nagendra, 2017; Petrescu, Petcou and Baibarac, 2016; Radywyl and Bigg, 2013; Schauppenlehner-Kloyber and Penker, 2016). R-Urban in Paris is a good example of a network of commons which is part of a participatory strategy of civic resilience. It connects local inhabitants, researchers, and public authority mostly around an urban community garden, which is a gate to other pedagogic activities: recycling facility, co-working space, repair café, communal kitchen, and compost. All activities have a social, economical, and ecological dimension, with a strong collective decision-making part (Petrescu, Petcou and Baibarac, 2016).

Although community resilience through the urban commons has been emphasised in numerous research articles, none have formally demonstrated the role of the urban commons in sustaining community resilience, nor the conditions that lead to this resilience.

In this research, we explore the role of urban commons for building community resilience and investigate conditions under which such communities can reach higher resilience. In addition to grounding our research in a real-world example, we use agent-based modelling and simulation to conduct our research. In the next section, we provide theoretical evidence of the role which urban commons can play in community resilience building. Then, we introduce our experimental methodology, by

formulating clear hypotheses to be tested in this research, and laying the theoretical basis of the agent-based model used for that purpose. In the following section, we present the empirical data which we calibrate and populate the model with, and we develop the structure of our agent-based model: overview, conceptualisation, and measured outcomes. In the results section, we present the outcomes of interest of our model in terms of social capital building, we test our research hypotheses, and we give details on the conditions favourable to community resilience. Finally, we discuss our findings on social capital building in the urban commons in the light of recent research. This allows us to indicate paths for further research in the field of urban community resilience.

## 5.2 Urban commons and community resilience

In this section, we provide theoretical background on urban resilience and hypothesise how urban commons can potentially lead to higher urban resilience. Meerow, Newell and Stults, 2016, p. 39 defined urban resilience as "the ability of an urban system – and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales – to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity." The most recent paradigm of resilience thinking is about social-ecological resilience, with adaptability rather than robustness as its key characteristics (Quigley, Blair and Davison, 2018). Adaptability comes out as a key requirement in the social-ecological resilience paradigm (Meerow, Newell and Stults, 2016), and has been recognised as a way to deal with increasing deep uncertainties, for example, regarding climate and global changes (Pahl-Wostl, 2009). Adaptability allows making alterations in the processes of a system: simple direct changes or more structural changes through iterations to enable the mitigation of expected perturbations in the societal or natural environment.

In the next paragraphs, we provide arguments suggesting that the urban commons can trigger more community resilience and adaptive capacity (Camps-Calvet et al., 2015; Colding and Barthel, 2013; Petrescu, Petcou and Baibarac, 2016; Scharf et al., 2019; Schauppenlehner-Kloyber and Penker, 2016). In the urban commons, "commoners" work together to manage and allocate a shared resource (Foster and Iaione, 2015), which can be tangible or not (Moss, 2014). Ostrom has shown the potential of such communities to self-organise (Ostrom, 1990). The social processes happening within the urban commons initiatives can be described from an evolutionary perspective, in which not only predictable processes are taken into account, but also complex, unpredictable ones (Kim and Lim, 2016). We mean here the implicit evolutionary approach which Ostrom describes in her work on collective action, and not the strict evolutionary definition, for example, used in generalised Darwinism (Kim and Lim, 2016; Ostrom, 2000). In this implicit perspective, individuals have predispositions to act in accordance or not with existing social norms, depending on how they individually value reciprocity, fairness, or trustworthiness. This individual behaviour can trigger adaptability in the urban commons, through processes of collective decision-making, cooperative behaviour and planning, collective

learning, and governance as a political process involving society at large (Resilience Alliance, 2010).

The urban commons potentially support this type of adaptability via informal networks of actors interacting in a bottom-up manner (Colding and Barthel, 2013; Foster, 2011; Nagendra and Ostrom, 2014), their experimental and sometimes disruptive character (Arora, 2014; Borch and Kornberger, 2015; Chatterton, 2016; Corsín Jiménez and Estalella, 2013; Radywyl and Bigg, 2013) and their openness to newcomers (Arora, 2014; Bruun, 2015; Foster and Iaione, 2019; McShane, 2010). This results in the formation of a network as community of practice with shared practices, shared knowledge, identity building, and tangible products. Each element of this network – space, infrastructure, actor – can undergo continuous cycles of change (Anderies, 2014).

The urban commons therefore become a fertile ground for the adaptability of their communities, a driver of their resilience. Their ongoing potential to change can help respond to a sudden shock (Schauppenlehner-Kloyber and Penker, 2016). From our earlier comprehensive review of the urban commons, we mean adaptability with respect to institutional, socio-economical, and ecosystem factors (Feinberg, Ghorbani and Herder, 2021; Plummer and Armitage, 2007).

The institutional dimension of the commons has been covered by scholars such as Ostrom, 1990, who identified principles, rules and power relations, which can support the commons. This is exemplified by the Design Principles for robust collective action (Ostrom, 1990), which have been adapted to the urban context (Foster and Iaione, 2019). We propose to look at the urban commons' potential for adaptability through the socio-economical and ecosystem factors (Plummer and Armitage, 2007) because of the equally important lens of subjectivity production in the commons (Singh, 2017).

The urban commons ensure the maintenance of collective subjectivities (Hardt and Negri, 2009), a phenomenon which has been earlier described by Simondon, 1989 in his theory of transindividuality (Singh, 2017): individuals never stop constituting themselves and this process is reinforced through collective experiences. This offers potentials for adaptability: the interdependence of the commoners generates spaces of care (Corsín Jiménez and Estalella, 2013) where individuals evolve through collective practices, and are concerned with the more-than-human world. This enables reinventing nature–society relations which contribute to solving the ecological crisis (Singh, 2017).

In this article, we study the conditions for urban community resilience within the urban commons with a lens on adaptability. Adaptive co-management was shown to depend on social capital and social networks (Folke et al., 2005). Similarly, urban resilience relies both on social capital and social relations (Kim and Lim, 2016). Inspired by Jacobs, 1961, social capital is defined by "the networks of residents who build and strengthen working relationships over time through trust and voluntary cooperation" (Foster and Iaione, 2019, p. 1). As this definition already encompasses the idea of networks, which together with social capital, can trigger more resilience, we focus in this article mostly on the notion of social capital to evaluate the resilience building of urban commons communities.

A community's social capital relies on involvement, mutual assistance, trust and

social cohesion (Adger et al., 2004; Folke et al., 2005; Quigley, Blair and Davison, 2018; Rusch, 2010). Past research has also shown that smaller groups are more successful in the management of the commons, thanks to more frequent interactions and higher levels of trust (Nagendra and Ostrom, 2014; Poteete and Ostrom, 2004; Rogge, Theesfeld and Strassner, 2018). Involvement in the urban commons may be voluntary in the case of informal arrangements; otherwise it may be guided by institutions in state-owned or privately-owned systems. Voluntary involvement better contributes to sustainability and equity (Shah and Garg, 2017). Mutual assistance and, to a larger extent, risk sharing, facilitate acting collectively in an atmosphere of trust (Adger et al., 2004). Adaptability through trust-building may not be straightforward, as it relies on a form of collective identity, an "urban citizenship," which is often described as threatened by neoliberal or capitalist environments such as cities (Harvey, 2014; Huron, 2015). Relating to this last point, trust more likely emerges from smaller groups (Poteete and Ostrom, 2004). Members of smaller groups are indeed more prone to set their own rules, and comply with those (Marshall, 2008). In addition, concrete and intermediate outcomes, "small wins," are more visible in smaller groups, which feeds successful collaboration (Ansell and Gash, 2008). Mui defines trust as the "subjective expectation an agent has about another's future behavior based on the history of their encounters" (Mui, 2002, p. 75). This definition is in line with the one given by Lumineau and Malhotra, 2011, who highlight a vulnerability to the actions of others, given positive expectations on why and how they could perform. Finally, the sense of cohesion is a measure of the group ability to bond and potentially engage in meaningful collaboration (Quigley, Blair and Davison, 2018).

We have framed the theoretical dependencies above in Figure 5.1.

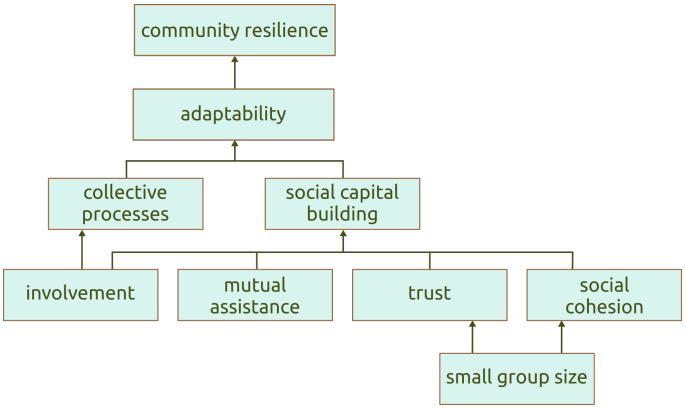


Figure 5.1 – Factors of urban community resilience; mutual assistance is not evaluated in our model

We conclude this section by specifying a definition of urban community resilience on which we build this study of the urban commons. It is the ability of a more or less formal group of individuals, forming a self-organised community, to mitigate the effects of future environmental, socio-economical, and sanitary crises through

experimental or disruptive social processes, the unpredictability of which supports collective learning and continuous cycles of change with respect to space, infrastructure, and actors. This adaptability strongly relies on the community's social capital, which builds up through voluntary involvement, trust, social cohesion and mutual assistance.

## 5.3 Methods

In this section, we translate the theoretical framing (Figure 5.1) developed above into research hypotheses that can be tested with our agent-based simulation model. We also present the case study and the data used to test these hypotheses. The use of this data is detailed in the next section, together with the model.

### 5.3.1 Research hypotheses

In order to characterise the adaptability of communities engaged in cases of urban commons, thus building urban community resilience, we formulate the following hypotheses based on the theoretical background that was discussed in detail in the previous section:

- (H1) interactions within the urban commons contribute to building trust;
- (H2) interactions within the urban commons provoke a higher sense of cohesion;
- (H3) more trust emerges from smaller self-organized groups.

We test these hypotheses through the development of an agent-based model, representative of an urban commons community. With this model, we focus on the internal dynamics of participation and social interaction, and we aim to clarify the contribution of such urban commons practices to urban community resilience, via the emergence of social capital. We explain in the subsections below how we measure social capital within an example of urban commons community.

External factors related to public institutions and local governments are left out of this research to only focus on the intrinsic conditions for urban community resilience within the urban commons. Regarding these external factors, we give a few indications for future research in conclusion. Our goal, in this research paper, is to clarify the contribution of urban commons practices to urban community resilience, with the help of a model which looks at the internal dynamics of participation and social interaction.

### 5.3.2 Agent-based model

Agent-based modelling is a simulation technique, which is well-suited to study complexity (Ghorbani and Bravo, 2016; Macal and North, 2009): it allows the simulation of the interactions of individual social entities within a specified environment and allows individual choice-making, often leading to the emergence of behavioural

patterns. It takes into account adaptive mechanisms of agent interaction and heterogeneous systems (Balbi and Giupponi, 2011). In this sense, it matches well the bottom-up dynamics of most urban commons. Finally, agent-based modelling enables more experimentation on the system variables than real-life experiments would allow.

We use the initial structure of a model originally developed by the authors to study the interaction patterns within urban community gardens (Feinberg et al., 2021), considering individual and group beliefs, and under different sets of organisational rules (i.e. local institutions). We adapt this model to match the context of an urban commons case in Amsterdam which we will explain next and re-design in such a way to enable the testing of our hypotheses. The model is coded in Netlogo software version 6.0.4 (Tisue and Wilensky, 2004).

To test the hypotheses stated above with our agent-based model, we proceed to field observations in an urban commons initiative and build a model, which recreates the dynamics of volunteer participation and interaction in the initiative. The model features events, which could affect the rate of emergent participation, evaluates trust and cohesion within the modelled volunteer community.

### 5.3.3 Empirical data

Our empirical urban commons site is the "KasKantine" (Dutch for "GreenhouseEatery"), a cooperative located in the south-west of Amsterdam. It pioneers ways of living sustainably and in autonomy. They have developed several Do-It-Yourself (DIY) infrastructures, the blueprints of which are available on their website: an efficient wood-fuelled pizza oven, a self-sufficient aquaponics wallgarden, or a gray water filter. KasKantine was initiated in 2012. Thanks to temporary agreements with the municipality of Amsterdam, it has been able to lease vacant lots and experiment with living off-the-grid, meaning disconnected from electricity, water, and sanitation amenities. Its modular architecture mostly consists of recycled materials, including a greenhouse and several cargo shipping containers. These containers are refurbished either for collective, or individual purposes. They offer spaces for small-scale rooftop agriculture, storage, office space, culinary and artistic activities, which would be too expensive in the conventional estate market. For such individual use, a financial contribution to the container purchase is usually asked. More than a restaurant, it is run by volunteers, who are involved in many tasks such as cooking, serving, but also gardening, building, fixing and supporting bottom-up activities, such as bike-fixing workshops, yoga classes, and a social change discussion group. Volunteers contribute in the form of shifts, which are 4-hour straight time slots of activity. KasKantine is meant as a free space for the local community with a focus on food waste reduction, up-cycling materials and circular economy. We have collected the data first through semi-structured interviews of two of the three initiators. The initiators are self-employed Amsterdam residents who teamed up of own free will to build the KasKantine project. Their answers informed us on the institutional context of the cooperative, the existing tasks, the issues encountered, and the annual participation. A guided tour of the cooperative also informed us on the available amenities. In addition, we asked the volunteers about their motivations (or beliefs)

to participate. We thus asked the initiators to forward an online questionnaire to their regularly active volunteers: those contributing at least one shift per week (4 hours). Out of 25 regular volunteers, 8 responded. The online questionnaire contained one multiple-answer question, the possible answers to which were specified and defined to prevent any ambiguity. The possible answers consist of the most common beliefs to participate in commoning, according to an auxiliary literature review (see next section and Appendix for the interview answers). We recap these beliefs in the next section. The data collected through the interviews and the questionnaires allow us to calibrate our model to match the reality of KasKantine. In order to build a model sufficiently representative of people participating in such urban commons initiatives, we also refine our calibration using a dataset on urban community gardens (another type of urban commons) in Germany and the Netherlands which we will explain in the next section (Feinberg et al., 2021; Rogge and Theesfeld, 2018).

## 5.4 An agent-based model of urban commons

### 5.4.1 Theoretical basis for the model

Our agent-based model should describe a system in which agents choose to volunteer and interact with other agents, based on existing motivations and rules, and in which they evaluate that interaction to re-assess their intention to volunteer again.

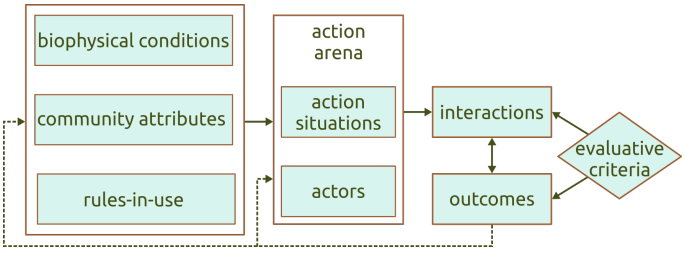


Figure 5.2 – Overview of Ostrom's IAD framework (adapted from McGinnis and Ostrom, 2014)

The model follows the structure of the Institutional Analysis and Design (IAD) framework (Ostrom, Gardner and Walker, 1994): external variables (Biophysical conditions, Attributes of Community and Rules-in-Use) determine the Action situations taken by the members of the system; the resulting Interactions and their Outcomes are evaluated to update the external variables and the actions taken. Our main external variables are the institutions (Rules-in-Use) and the beliefs toward commoning in KasKantine (Attributes of Community). Institutions are sets of rules defined by individuals to organize repetitive activities, and we formalize them through Ostrom's Design Principles for robust collective action (Ostrom, 1990). These can be summarized as follows (Wilson, Ostrom and Cox, 2013):

1. Clearly defined boundaries: both for the resource system and the community;

2. Proportional equivalence between benefits and costs: a higher contribution is better rewarded;
3. Collective-choice arrangements: possibility for the group members to create new rules or adapt existing rules;
4. Monitoring: keeping track of actions and possible violations of rules in the group;
5. Graduated sanctions: the sanction is proportional to the violation;
6. Conflict-resolution mechanisms: inexpensive mechanisms to solve conflicts;
7. Minimal recognition of rights to organise: smaller units of decision makers have authority over certain matters;
8. Nestled enterprises: for better coordination across groups, sometimes working at different scales.

We use these principles to conceptualise the institutions which affect the dynamics in our model. We express the agent's motivation, or beliefs, toward commoning as in the Theory of Reasoned Action (TRA, Figure 5.3 (Fishbein and Ajzen, 2011)). Motivation is a broad term which encompasses two dimensions in the TRA: an individual drive (attitudes) and a collective drive (social norm), which rely, respectively, on behavioural and normative beliefs (see Figure 5.3). Agents, therefore, have beliefs or expectations of outcomes with respect to certain actions. For each belief, agents have a belief strength, which relates to how much they care for the related outcome, and a belief evaluation, which depends on the agent's experience regarding that outcome. The conjunction of a high belief strength and a positive belief evaluation motivates a related behaviour intention.

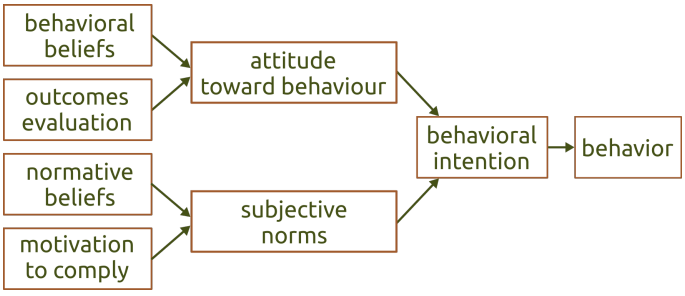


Figure 5.3 – Overview of the theory of reasoned action (adapted from Fishbein and Ajzen, 2011)

The most common beliefs to join this type of urban commons, as found in earlier work (Feinberg et al., 2021) are given below. Only the last two beliefs are considered as negative, in the sense that they limit the chances of participation.

- Social development: commoning fosters a social environment that enhances the activity itself by providing participants with a social network that becomes

important particularly when they are feeling isolated (Duchemin, Wegmuller and Legault, 2009);

- Social cohesion: participants form relationships with one another and offer mutual help, which does not occur for example, in individual gardening lots (Kam and Needham, 2003; Veen et al., 2016);
- Consuming fresh food: relevant for KasKantine, which has a food garden; its access depends on biophysical variables but also on the active institutions and the participants' behaviour (Duchemin, Wegmuller and Legault, 2009); it is a possible source of conflict when it comes to (fair) yield taking (Butler, 2013; Charles, 2012) or even stolen yield from non-participants (Ruggeri, Mazzocchi and Corsi, 2016);
- economic benefits: eating or selling own garden production is a current practice (Guitart, Pickering and Byrne, 2012; Patel, 1991); KasKantine also collects non-sold products and contributes to reducing food waste in Amsterdam;
- improving health: through improving a diet, increased exercise and involvement in nature (Guitart, Pickering and Byrne, 2012);
- outdoor activities: give a sense of well-being (Rogge and Theesfeld, 2018);
- education: specific, such as gardening (Drake and Lawson, 2015) or more general: science, nutrition, and environmental education (Guitart, Pickering and Byrne, 2012); indirect social education can also be gained by simply participating (Duchemin, Wegmuller and Legault, 2009);
- enhancing cultural practices: cultural practices are broadly defined as the knowledge of 'what to do, when and where', and how to interact within a particular culture; in the urban gardening context, this can be translated to integration, particularly for foreign immigrants; in our work, this belief is satisfied by the simple presence of others in the garden (Rogge, Theesfeld and Strassner, 2018);
- increasing land availability: this belief reflects the well-described claim to urban space, the accessibility to which is reduced by land developments and privatisations (Huron, 2015; Sassen, 2015; Williams, 2018); urban community gardens also increase the share of green spaces in the city (Schmelzkopf, 2002); this belief is influenced by access rules (e.g., fences, membership) (Milburn and Vail, 2010);
- environmental sustainability: green spaces highly contribute to microclimate regulation, water run-off, pollution mitigation, water filtering, or biodiversity (Colding and Barthel, 2013; Wolch, Byrne and Newell, 2014); participants may be driven by such goals;
- enhancing spiritual practice: the connection to nature achieved through activities like gardening can be meditative, or help release tensions and develop spirituality (Kingsley, Townsend and Henderson-Wilson, 2009); more caring connections with other participants may result (Okvat and Zautra, 2011);

| Data category | Output variables | Input parameters | Source of data |
|---|---|---|---|
| Biophysical conditions | product availability | Chance of uncomfortable conditions<br>Chance of available product | Case-study |
| Community attributes | | Beliefs types, number of initiators, pool of potential volunteers, beliefs strength (all agents), chance of bonding with others age of initiative (maximum), interaction rate | Community gardens (Germany, Netherlands) (Feinberg et al., 2021; Rogge, 2020), literature, case-study |
| Institutions | | Design Principles, adapted from Ostrom, 1990 | Case-study, community gardens literature |
| Action situations | | Tasks | Case-study |
| Outcomes | Beliefs evaluation (cohesion, trust, social time, product availability, ...) social ties good encounters lifetime (of initiative) | Conflict rate | Case-study |

Table 5.1 – Type and source of data fed in our model

- social norm: trust in contributing to the cooperative is higher when the other participants are reciprocating (Chalise, 2015; Mui, 2002), which becomes the cooperative's social norm; the group's overall reputation is an important factor when deciding whether or not to participate;

- amount of work: the engagement required toward a shared goal motivates participants, unless these efforts exceed expectations (Chalise, 2015), which can happen when there are not enough participants;

- uncomfortable conditions: we mean physical conditions, such as bad weather or bugs, often mentioned to rebut participants (Drake and Lawson, 2015; Vercauteren et al., 2013).

### 5.4.2 Data usage

We populate our model with data that is collected from the KasKantine and community gardens. Our modelled system represents the KasKantine cooperative, from which we extract most of the characteristics (Table 5.1).

The IAD framework requires data on the system's biophysical conditions, rules-in-use (institutions), community attributes and action situations. In addition, since

the TRA describes the pathway from certain motivations, or beliefs, to actual behaviour, data addressing the beliefs of the agents is also required. Data for the community attributes, action situations, institutions and beliefs were collected from KasKantine. Table 1 summarises the data that is used in the model and the sources. Based on our interviews in Amsterdam, an earlier literature review (Feinberg, Ghorbani and Herder, 2021), and the fact that we are looking at urban commons in general, we assume the beliefs in KasKantine to be similar to those found in urban community gardens (Rogge, 2020, p. 89). These beliefs are generally positive, in the sense that they motivate the agents to become a volunteer in the cooperative (see end of previous subsection). Most of them are defined for individual volunteers. From the group standpoint, the perceived need for contribution to the cooperative constitutes the group normative belief, or social norm. The motivation to comply with it, which depends on trust, generates the subjective norm. We will explain this in the Outcome variables subsection. Other beliefs may discourage the agents: uncomfortable conditions (mostly bad weather) or the excessive amount of work required. According to our interviews in KasKantine, uncomfortable conditions do not influence participation.

### 5.4.3 Model overview

Our model represents a situation in which the agents are periodically invited to volunteer in the KasKantine cooperative, with no entrance fee. Their intention to volunteer depends on their beliefs and experiences in the cooperative. Agents indeed reevaluate their beliefs before renewing their participation on the next session, which is in line with the argument of adaptive capacity (Pahl-Wostl, 2009). We implement regular disruptions in the form of large conflicts in order to reflect real- life crises and test our model further. Other disruptions, not imposed by the modeller, occur in the form of rule violations. The model functions as presented in Figure 5.4. The agents volunteer in the cooperative if they are motivated enough, according to their individual beliefs and the perceived social norm. Once volunteer (called commoner), the agent interacts with the physical system, by performing tasks or taking product which originates from the cooperative. The agents also interact with the other commoners of the cooperative. They may violate or see someone else violate a rule of the cooperative. This violation is made public and its treatment (i.e. sanctioning) affects the "history of encounters" (Mui, 2002) and the positive expectation toward future sessions (Lumineau and Malhotra, 2011). The commoners who witnessed it therefore perceive lower trust toward the group. A conflict may also occur and cause an additional decrease of trust. To mitigate this point, we consider in our model a temporary increase of motivation to volunteer after a large conflict (see details later in this section). This is a corollary of the evolutionary theory, in which modern humans are capable of learning social norms, not by reasoning about what is true or false, but by reasoning through deontic relationships inspired by the cultural context: in our case, by looking for violators (Ostrom, 2000). Each volunteering session may be seen as a learning opportunity. At the end of each session, commoners evaluate their experience in terms of the beliefs mentioned earlier. This evaluation impacts their willingness to volunteer again at the next session. The sense of social cohesion

depends on the presence of other commoners. Details of these processes are explained in the conceptualisation section.

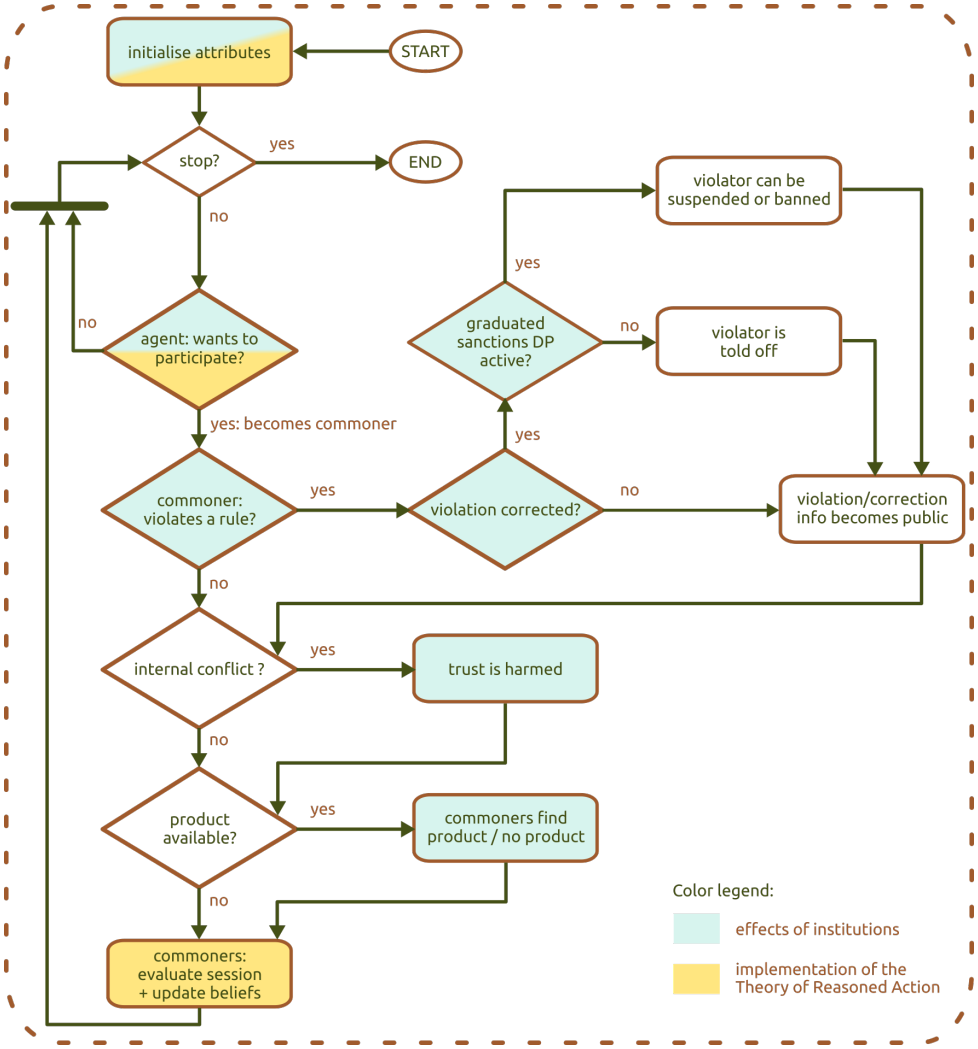


Figure 5.4 – Narrative of the model

### 5.4.4 Model conceptualization

Rule violations may be sanctioned with a certain probability. The institutions also define whether a rule violator may be excluded from the cooperative. The outcome of such events affects the number of good encounters, of which each agent keeps note for the belief evaluation for trust.

Agents are assigned a fixed value of belief strength for each of their beliefs, within a range defined by our data, and a value of belief evaluation which evolves across

| Parameter | Definition | range swept |
|---|---|---|
| *Contributing-Threshold* | Arbitrary value above which an agent becomes volunteer; defined through sensitivity analysis | $\in [1, 6]$ |
| *DPconflictHarm* | Intensity of harm caused by each conflict | $\in [10, 50]$ |
| *InteractionRate* | Amount of other commoners a commoner can connect with | $\in [1, 4]$ |
| *RelationRate* | Probability to form a connection with a commoner interacted with | $\in [0.1, 0.9]$ |
| *BalanceAttitude-SocialNorm* | Weight of the social norm | $\in [0.5, 4]$ |
| *conflictlearn* | Degree of learning following a conflict | $\in [0, 1]$ |
| *TotalPool* | Maximum number of agents | $\in [10, 40]$ |

Table 5.2 – Parameters and their experimental range of values

the sessions (Fishbein and Ajzen, 2011). The agents have one main action situation, volunteering, which entails two other possible actions: taking a product from the cooperative and violating a rule. At the beginning of the simulations, all agents are potential commoners. Potential commoners become commoners when they decide to volunteer. At each simulation step, the model tests the degree of motivation of all agents to volunteer. We derive the attitudes for volunteering as follows: social time, cohesion, getting product, education, pleasant tasks, sustainability, land availability. The latter attitude relates to the possibility to equip ship containers or bring new ones on the KasKantine parcel. The weight of the subjective norm versus the attitude is a parameter which we call *BalanceAttitudeSocialNorm* (Table 5.2). The weight for attitudes is thus expressed as a function of *BalanceAttitudeSocialNorm*. In a given model run, the probability for volunteering depends on the weighted sum of the attitude and subjective norm tested against a contributing threshold (Table 5.2). The weights come from a study which evaluates the participation to team sports (Eves, Hoppé and McLaren, 2003). If the agent's weighted sum of beliefs is higher than *ContributingThreshold*, meaning that it is motivated enough, it becomes a commoner. The commoner may then violate a rule (e.g., not showing up at one's work shift) or decide to take a cooperative product. Both decisions are regulated by a set probability. The institutions controlling these actions are coded based on Ostrom's Design Principles (see Feinberg et al., 2021 for more detail). At the end of a session, the agents evaluate two things: the realisation of their expectations and the result of the past social interactions. Through this evaluation, which builds on both the IAD framework (Figure 5.2) and the TRA (Figure 5.3), the agents' beliefs are updated. This influences their willingness to participate in the next session, partly reflected in the variables of social cohesion and trust, which are our outcome variables of interest.

### 5.4.5 Outcome variables

We have three outcome variables, which we derive from the beliefs evaluations and the duration of the collective involvement. Each agent reevaluates its beliefs at the

end of each session, while the total involvement time is assessed for the entire group at the last simulation. Among the beliefs, we exclusively focus on trust and social cohesion.

### Trust

Following the previously mentioned definitions of trust, we consider it in our model intimately related to reciprocity: in the presence of a group norm, or social norm, an agent who trusts that its peers are complying to this norm, will itself feel pressure to comply as well. An agent may value the idea of reciprocity, without necessarily experiencing it because of recent unfavourable encounters. In our model, reciprocity becomes the belief strength for trust. Mui, 2002 estimated reciprocity by the proportion of cooperative actions over all encounters. From this expression, we propose a simplified expression for trust, which includes the expected negative effect of conflicts on trust:

$$Trust = \frac{AmountOfGoodEncounters}{TotalEncounters + TotalConflicts}$$

The variable *TotalConflicts* multiplies the actual number of conflicts experiences by an aggravation factor, which we call *DPconflictHarm*. This factor reflects the implementation of conflict-resolution mechanisms (6th Ostrom Design Principle). It is inversely proportional to the effectiveness of the conflict-resolution mechanisms.

We assume that conflicts also involve new coordination measures rather than new control measures. Such coordination measures trigger competence- and goodwill-based trust development (Lumineau and Malhotra, 2011), which enhances the present relations rather than the desire to switch partners. These measures may create channels of communication through which conflicts are discussed and which can help mitigation in the case of future conflicts. Therefore, we introduce in this model the parameter *conflictLearn*, which temporarily increases the willingness to volunteer after a conflict.

### Cohesion

We define social cohesion as the extent to which the cooperative's volunteers bond and offer mutual help to each other. It is close to the concept of cohesiveness, which encompasses both the group's attractivity to its members and the attraction to mutual goals attained via the group (Gross and Martin, 1952). In the model, we measure social cohesion by the number of mutual dyadic ties within the group (Friedkin, 2004). In our model, the capacity to form bonds is influenced by two parameters: *InteractionRate*, the amount of other volunteers an agent can connect with, and *RelationRate*, the probability for an agent to form a relation with a volunteer it interacts with. In the results section, we use the terms cohesion and social cohesion interchangeably.

### Involvement

The amount of commoners along the simulation gives an indication of participation in our model example. We measure involvement as the duration of the participation,

as long as the number of participants stays above a threshold which we define below in the experimental design section.

### 5.4.6 Experimental design

We here present how we test our hypotheses on urban community resilience using the model. Below is the layout for each experiment:

- Agents interact within a random network and make individual choices;
- Disruption occurs in the form of conflicts and rule violations;
- Absence of an entrance fee;
- New agents are regularly invited to participate.

We design our experiments to estimate the emergence of social capital which reflects adaptability and in turn community resilience in our model (Figure 5.1). In other words, we are testing the adaptability of the KasKantine cooperative, in a simplified reality scenario. We, therefore, need to measure trust and social cohesion during and after the agents' interactions in the model to answer our first two hypotheses (H1 and H2). We also register the duration of the experiments, labelled lifetime. The different experiments test which variables affect our outcome variables, and to what extent. We explain below how we designed our experiments.

#### Procedure

The KasKantine initiative being 6 years old at the moment of this study, we set our experiments to run for a period corresponding to 10 years. It reflects reality sufficiently, without an excessive processing time on the computer simulations: only 0.035% of all our runs last more than 10 years. We have two main sessions per week (Friday and Saturday), during which KasKantine welcomes customers. This makes about 100 sessions per year. Each volunteering session corresponds to one simulation tick. Each experiment, therefore, runs until a maximum of 1,000 ticks. According to our interviews, the cooperative requires a minimum of 10 participants to run, 7 volunteers and 3 initiators, who should be present to maintain the cooperative activity. The attendance by customers of the KasKantine restaurant is high, which requires a sufficient volunteer participation in the cooperative. We, therefore, assume that the cooperative activity would stop when the number of volunteers is below 7 for 16 consecutive sessions, or about 2 months. This would cause an experiment to stop. An experiment is said to have collapsed at the tick where the experiment stops.

Rule violations can occur anytime with a probability specified as parameter in the model. Volunteers who violate a rule can get a reprimand for example, when not showing up at their shift. We have translated such events as two probabilities in our model: one for the rule violation, one for the correction. Other minor violations usually go unnoticed, according to our field interviews. The overall sense of conviviality in the cooperative being opposed to strict sanctioning, we, therefore, set the chance of sanctioning to 50%.

Conflicts occur with a predefined periodicity. In our previous study on urban community gardens in Germany and the Netherlands, we observed conflicts on average every two years (Feinberg et al., 2021). From our field discussions in KasKantine, where no such count is made, we assume that this figure also applies. We arbitrarily define an experiment to be potentially resilient when it survives at least two conflicts. These cases are further analysed to determine the system conditions more likely triggering resilience in the community. At the rate of one conflict every two years, it would take at least 4 years to qualify as potentially resilient. This represents only 5% of our total experiments. To get more material for discussing the conditions toward resilience, we increase the conflict rate to one per year. 18% of experiments now qualify for further analysis. We, therefore, isolate two types of output simulations: the collapsed cases, with a Lifetime below 200 ticks, and the potentially resilient cases, with a Lifetime above 201 ticks.

The cooperative institutions do not vary between each experiment: the combination of Design Principles is fixed to match reality. Exception is made for *DPconflictharm*, the degree of intensity of harm caused by any conflict, on which we lack data, and which we, therefore, sweep across a range of values as explained, among others, in Table 5.2.

We test the learning effect induced by conflicts through an artificial increase of the motivation to volunteer during the 50 sessions following a conflict. The corresponding parameter is called *conflictLearn*. A more straightforward approach would be to manually increase the belief for cohesion or decrease the value of Total Conflicts in Equation (1). However, this is not possible because it would create modelling bias as it would directly influence cohesion and trust, which are our main output variables of interest.

Earlier empirical research (Feinberg et al., 2021; Rogge, Theesfeld and Strassner, 2018) suggested that smaller group sizes were more likely to sustain trust and social cohesion. This is in line with the argument of Poteete and Ostrom, 2004, which led to the formulation of our third hypothesis (H3) on group size effect. We measure it with the variable *TotalPool*, which is the maximum number of agents in an experiment.

Our experiments consist of testing the effects of the parameters which we assume can impact trust and social cohesion (Table 2). We first perform a sensitivity analysis to pinpoint the most relevant value interval for each variable above, except for *InteractionRate* and *TotalPool*, the values of which are based on field interviews. Then, we use the Latin Hypercube Sampling (Dam, Nikolic and Lukszo, 2012) method to derive 100 different values for each of the above variables in their respective value interval. We then use the *BehaviorSpace* tool of the Netlogo software, which allows the variable sweeps defined in Table 5.2.

The combination of the value ranges specified above, along with 10 repetitions and the use of 100 random seeds, led to a total of 200,000 experiments. For each of these, we measure the averaged value of perceived trust and social cohesion for all participants over the total duration of the simulation run, which is the number of ticks until collapse occurs. When no collapse occurs in the first 1,000 ticks, the Lifetime variable is set to 1,000. The outcomes of the simulations are analysed with the statistical tool R (version 3.6.1 from 2019 to 07-05) in the visualisation software RStudio (version 1.1.383).

## 5.5 Results

Performance indicators of community resilience Our goal in this study is to assess the capacity for community resilience within a case of urban commons. We focus in particular on the notion of adaptability of the volunteer community in the KasKantine cooperative, an example of urban commons. We need to demonstrate the building of social capital within the cooperative's volunteer community by means of the agent-based model results. We measure social capital through the emergence of trust, cohesion, and long-lasting volunteer involvement. Trust, in our model, reflects the reciprocity in the community's social interactions: positive encounters versus total encounters, including those aggravated by conflicts. Cohesion is measured by the number of dyadic ties that an agent has with others. Through simple dynamics of joining or leaving, under the influence of motivations fluctuating based on individual and collective performance assessment, we quantify the overall levels of trust and cohesion. In addition, we have measured the duration, in our model, of the volunteer involvement. All the analysis which follows is based on the experiments which lasted 2 years or more, so that they experienced at least two conflicts. This represents 18% of all experiments.

### 5.5.1 Testing the hypotheses

Our model allows us to test the previously-formulated hypotheses below:

- (H1) interactions within the urban commons contribute to building trust;
- (H2) interactions within the urban commons provoke a higher sense of cohesion;
- (H3) more trust emerges from smaller self-organized groups.

Our results first indicate that both trust and cohesion emerge from group interaction in the Amsterdam-based cooperative (hypotheses H1 and H2). We illustrate this with one of the experiments which lasted 436 ticks, long-enough to show the effects of four consecutive conflict crises (Figure 5.5). The maximal number of volunteers (*TotalPool*) is here set at 30, arbitrarily. Other experiments may show a different behaviour of the variables represented, but the curves for trust, cohesion and the volunteer count remain very similar. Cohesion grows rather regularly as long as the number of volunteers present remains high enough. Trust follows a similar pattern, with sharp drops occurring at the time of occasional conflicts, which are set by the modeller every 100 ticks. Such events lower trust temporarily. If the initiative survives such an event, by maintaining a sufficient number of volunteers, the perceived trust among its volunteers grows back. A quick drop of the level of trust is visible at each conflict time, for example, at ticks 100 and 200 in Figure 5.5. It is accompanied by a decrease in the number of volunteers and in the amount of good encounters. The effects of conflicts dampen over time, as the total number of good encounters grows and thus mitigates the negative perception of conflicts in the evaluation of trust. Both trust and cohesion briefly drop as rule violations occur.

In the rest of this analysis, we measure the cohesion and trust related to any experiment with their cumulative value over all ticks, taken at the last tick. This

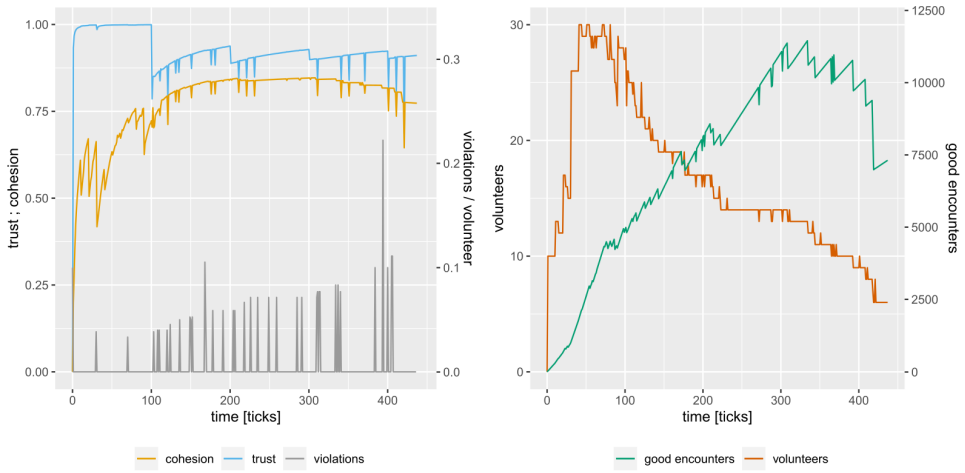


Figure 5.5 – Typical evolution of trust, cumulative cohesion, violations, amount of volunteers and positive encounters over time, for example, of experiment.

allows comparison between experiments. The correlation between trust, cohesion and lifetime is presented in Table 3. Trust and Lifetime are negatively correlated. Nonetheless, during shorter periods of time without conflicts, trust grows saturatedly as we've observed above. Cohesion and Lifetime are positively correlated, a result which relates to the cumulative cohesion measurement. We present below the parameters which mostly affected these results, including the role of group size (H3).

| | trust | cumulative cohesion |
|---|---|---|
| Lifetime | -0.11*** | 0.16*** |
| Trust | | -0.02 *** |

*** p < .001 ** p < .01 * p < .05

Table 5.3 – Correlation table for the outcome variables, in the resilient cases.

### 5.5.2 Analysis of the experiments

In the following sections, the terms cohesion and trust correspond to their respective cumulative value, for any given experiment. We visualise the degree of contribution of each tested parameter (Table 2) on a two-dimensional diagram obtained via Principal Component Analysis (PCA). We use R packages *FactoMineR* and *factoextra* for that. We project each variable as a vector on an orthogonal Cartesian coordinate system. The two axes in Figure 5.6 represent the two main axes of variance (eigenvectors) of our output data in the experiments. These axes are called principal components (PCs). The length and direction of each vector reflect the respective

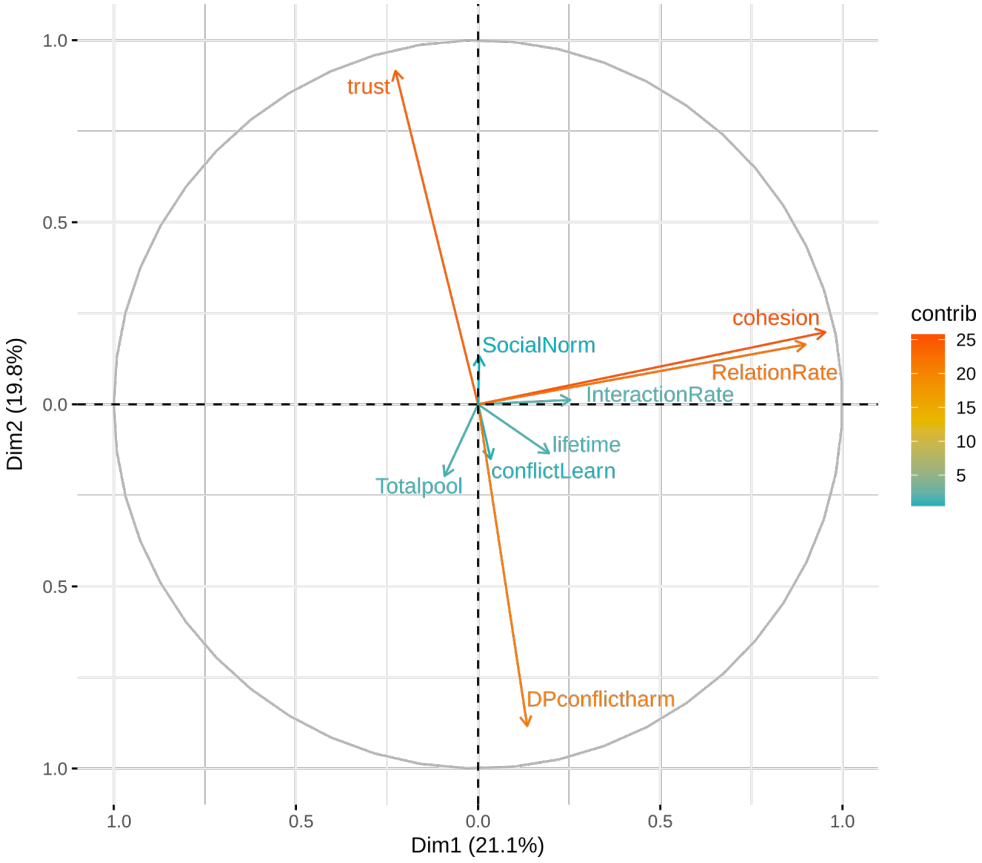


Figure 5.6 – Principal component analysis diagram for the resilient cases

effect of its variable or parameter on the model's PCs. The color scale in Figure 5.6 indicates the degree of contribution of each variable to the PCs, in % of the total explained variance. Our output variables, cohesion, trust and lifetime, highly contribute to the two PCs, which means that the ranges of input parameters selected in our experimental design do affect the variability of our output variables. This was the purpose of the sensitivity analysis. We can now find the specific conditions leading to high cohesion, trust or lifetime.

The cohesion vector aligns with those of *RelationRate* and *InteractionRate*, indicating a positive correlation. This result is not surprising, as these two variables directly affect the belief for cohesion in the estimation of the number of dyadic ties per agent. *RelationRate* is the chance to form a bond with another commoner, and *InteractionRate* is the number of other agents a volunteer can connect with. *RelationRate* better explains the cohesion variability: in other words, the number of commoners I can connect with (3 or 4), matters less than the mutual affinity I may have with each of them. *TotalPool* is negatively correlated both with cohesion and trust: a higher maximum group size decreases the overall sense of cohesion and trust (Table 4). The diagram further indicates that trust is negatively correlated to *DPconflictharm*, which is the sensitivity to conflicts. This result is a consequence of our model, as explained earlier by the mathematical formula of trust given earlier. The vector for *conflictLearn*, the capacity to learn from conflicts, opposes the one for trust, while aligning close to the one for lifetime: higher *conflictLearn* is associated to higher lifetime, but slightly lower trust.

| Parameter | $\rho_{Lifetime}$ | $\rho_{trust}$ | $\rho_{social-cohesion}$ |
|---|---|---|---|
| DPconflictharm | -0.06*** | -0.77 *** | -0.04*** |
| InteractionRate | 0.02** | -0.03*** | 0.24*** |
| RelationRate | 0.00*** | -0.04 *** | 0.86*** |
| SocialNorm | -0.02*** | 0.05 *** | 0.03*** |
| Conflictlearn | 0.12*** | -0.07 *** | -0.03*** |
| TotalPool (max. group size) | 0.16*** | -0.11 *** | -0.18*** |
| | *** p $<$ .001 | ** p $<$ .01 | * p $<$ .05 |

Table 5.4 – Correlation of the outcome variables with the input parameters in the resilient cases. In light gray font, we have represented the values deriving only from the model operationalization, and therefore not emergent from the model

All the results hinted through the PC analysis are confirmed in the correlation tables (Tables 5.3 and 5.4). Cohesion and lifetime are positively correlated ($\rho_{Cohes-Lifetime}$ = 0.16). Even though trust and lifetime are negatively correlated ($\rho_{Trust-Lifetime}$ = -0.11), we have seen in Figure 5 that, at another scale of analysis, trust grows with time in between two consecutive conflicts. *SocialNorm*, the weight put by agents on the collective drive to become a volunteer rather than on individual drives, is positively correlated to higher trust. Cohesion, in its cumulative definition, is somewhat negatively correlated to conflict sensitivity ($\rho_{Cohes-DPconflictharm}$ = -0.04). Higher trust was observed in cases of higher collective drive ($\rho_{Trust-SocialNorm}$

= 0.05) and lower conflict-induced learning ($\rho_{Trust-conflictLearn}$ = -0.07). We can also confirm the third hypothesis; we measured a negative correlation of large maximal group sizes with both trust and cohesion ($\rho_{Trust-TotalPool}$ = -0.11 and $\rho_{Cohes-TotalPool}$ = -0.18). However, a larger group size also correlates with long-lasting collective action ($\rho$ = 0.16). This reflects the dynamics of participating as volunteer or leaving, as simplified by our model, and may not be an argument in favour of larger group sizes.

## 5.6 Discussion

Our model showed that trust and social cohesion closely follow the cooperative's social interactions and degree of participation. Cohesion is intimately related to the number of volunteers present. Trust appears as an indicator for a stronger motivation for the cooperative's collective purpose (social norm). The community's perception of trust decreases during conflicts, but the group slowly regains trust during the sessions following a conflict. Trust tends to be higher in smaller groups, where conflicts and rule violations can cause less harm. Although certain parameters positively affect trust and not cohesion (and vice-versa), we have validated our three hypotheses.

We have outlined a significant link between lower group size and higher trust among the commoners, in line with recent research which has been drawing attention on the higher success potential of smaller-sized common initiatives (Nagendra and Ostrom, 2014; Poteete and Ostrom, 2004; Rogge, Theesfeld and Strassner, 2018). Poteete and Ostrom, 2004 identified ambivalent effects of group size on successful collective action: trust-generating interactions occur at lower group sizes, however such a lower workforce means lower resources (time, financial) for effective mobilisation. We find this ambivalence in our results with higher group sizes being positively correlated with the lifetime of the initiatives, but negatively correlated with the group perception of trust and cohesion. Regarding transaction costs, larger groups seem to suffer more from the efforts required to bring users together and agree on institutional changes (Ostrom, 2009a). A recent study isolated the most successful cases of collective urban lake management as those being relatively small with a moderate number of actors (Nagendra and Ostrom, 2014). They showed that trust and leadership contributed to the success of the resource's collective management. Regarding urban community gardens, a non-statistically significant negative correlation was also found between group size and perceived trust (Rogge, Theesfeld and Strassner, 2018). The difficulty to derive a clear guideline on the effect of community size comes from the diversity of institutional arrangements employed to overcome collective-action problems (Poteete and Ostrom, 2004). Local knowledge should be harnessed to optimise the community's institutions, which thus would appear more legitimate and fair. This is in line with the third design principle of Ostrom, 1990.

Rogge, Theesfeld and Strassner, 2018 further identified trust as being more a product of social interactions than a precondition. This point is important when considering the conditions of urban environments and their high population diversity:

mutual interests in commoning may drive social interactions, through which trust can emerge. Social capital can then bridge people together even in atmospheres of preexisting distrust and divergent interests (Rusch, 2010). Such bridging may lead to resilience of local collaboratives (Clarke, 2017). As framed by Stern et al., 2002, the institutional performance of such systems depends on how the institutional arrangements in place deal with group heterogeneity and group size. In an earlier version of the present model, we had varied these arrangements and measured their effects on the collective action within urban community gardens. We indeed found specific combinations of institutions which led to higher or lower rates of success, in line with another recent research on the management of common-pool resources (Baggio et al., 2016).

Literature mentions such places of conviviality, a term used to describe processes of friendly and welcoming cohabitation and interaction which accommodate individuals' differences, which are likely to occur in the urban multiplicity (Chiu and Giamarino, 2019; Hinchliffe and Whatmore, 2006). Developing as experimental spaces, such places are both an object and practice of care where people look for each other as much as they look after each other. A classical example is the assembling of neighbours in open-space, such as the urban commons. This produces a space of care and understanding,, an "atmospheric installation" where people assemble and materialise their proximity (Corsín Jiménez and Estalella, 2013, p. 131). Such spaces are more likely produced with frequent interaction, or togetherness, of different individuals: in that sense, conviviality emerges more from semi-public spaces than public space (Wessendorf, 2014). This highlights the need of "zones of encounter" (Wood and Landry, 2008) or "micropublics" where human boundaries, such as ethnicity, religion or class can be bridged (Rusch, 2010). Our present case of urban commons represents such a zone of encounter. In the KasKantine cooperative, volunteers interact in a convivial space, physically materialised by shared premises with comfortable chairs and sofas. Such a space is a breeding ground for trustful interactions and social cohesion. It is perhaps not surprising to note the success of open events such as the social change discussion group, which proposed several events in spring 2019 at KasKantine. Such events are an opportunity to exchange and learn, either about the world, the other humans or oneself.

As shown in our model, smaller group sizes contribute to some extent to higher trust emergence, probably via the creation of such zones of encounter. Although stereotypes may still be privately kept, under a veil of apparent courtesy (Valentine, 2008), there is in conviviality this evidence of civility toward diversity, as a strategy to mediate positive relations and possible tensions (Wessendorf, 2014). This strategy aligns with the notion of symbiotic mutualism (Rose, 2012), which extends diversity to the non-humans (Metzger, 2015).

Urban commons communities can also be associated to the notion of Communities of Practice (CoP) (Euler, 2018; Radywyl and Bigg, 2013), originally defined by Wenger, 1998; Wenger, 2010a. As reformulated from Wenger's work, CoP consists of "(1) a 'joint enterprise' of vigor in learning about a particular enterprise (e.g., gardening), (2) 'mutual engagement' through which people bond and build social capital, and (3) a 'shared repertoire' of rules, jargon, and metaphors that enable a community to reflect upon and understand its own state of development and to

move forward" (Bendt, Barthel and Colding, 2013, p. 19). Repeated interaction within CoP generates a so-called history of learning, which iteratively defines the community of practice. This shared knowledge base is similar, in a more comprehensive way, to the idea of history of encounters in our model which generates certain expectations, and influences trust.

In the same line of thought, we can question in such communities the evaluation of trust solely with reciprocity (based on the history of past encounters): "I follow the social norm because I trust my peers will do so too." In certain situations, interpersonal commitment, through predefined coordinating procedures, can outperform relations of reciprocity, by preventing defection through a mirroring effect (Bravo, Squazzoni and Boero, 2012; Lumineau and Malhotra, 2011). We have not considered the emergence of trust through such contract mechanisms, formal or not. CoPs however encapsulate such institutions, or "shared repertoires of rules," as expressed through the third point of the definition given above (Bendt, Barthel and Colding, 2013, p. 19).

As defined by Wenger, CoP are by definition built around social capital and the collective processes associated to a shared enterprise. According to our theoretical framework (Figure 1), CoP may a priori qualify as adaptive systems. CoP have been further described to build resilience in the urban context, with the examples of urban forestry (Campbell, Svendsen and Roman, 2016) and urban community gardens (Chan, DuBois and Tidball, 2015). The latter example is a typical example of urban commons.

According to Colding and Barthel, 2013, solving ecosystem-related issues requires cognitive resilience building, which is also the result of repeated interactions of a group of individuals with a local ecosystem. They connect this notion with the earlier one of cultural capital (Berkes and Folke, 1992; Folke et al., 2005) which provides means of adaptation to the natural environment, but by adding to it social learning and the retention of knowledge, as we incorporated to some extent in our model. This latter element somehow relates to the history of learning which defines CoP. The conviviality of the urban commons brings individuals together in zones of encounter (Wood and Landry, 2008) where human boundaries, such as ethnicity, religion, or class can be bridged. It is at this boundary that the learning of these communities can occur. The term social capital seems to embrace the notions of cultural capital and social learning, which help communities adapt to their natural environment. In our understanding, social capital adds certain important conditions to successful urban adaptive co-management, namely trust and social cohesion, the two main outcomes of our model.

The earlier validation, via computer simulations, of hypotheses H1, H2, and H3 in the Amsterdam cooperative context means that social capital (which relies on social cohesion and trust, itself related to reciprocity) builds up over time, especially in smaller groups of volunteers. Both social cohesion and trust seem to grow, at least in between consecutive conflicts in the latter case, until a saturation point (Figure 5). From the literature above, we can link our case of urban commons to CoP, which are defined by a social history of learning, which repeated interactions around a shared goal produce. The social learning processes associated with such interactions have been identified as a strong component of resilience building at

the community scale, although they still lack assessment from trans-disciplinary approaches (Schauppenlehner-Kloyber and Penker, 2016). Resilience is a term, which is difficult to embrace, especially for the younger inhabitants. It can be promoted precisely by activating it at community scale through mutual learning, community of practice and active land management (Colding and Barthel, 2013; Petrescu, Petcou and Baibarac, 2016). In addition, the different types of resilience observed in urban systems may contradict one another: ecological resilience, social/community resilience, and technological infrastructure resilience may have different normative goals (Elmqvist et al., 2019). Emerging from the urban communities of practice which we here studied are: social capital (trust, social cohesion) and a simple form of social memory. Both social memory and social capital contribute to "building social capacity for resilience in social-ecological systems" (Folke et al., 2005, p. 455).

### 5.6.1 Concluding words

Our study indicates that the KasKantine example of urban commons can improve the adaptability of local communities to institutional, social-economical and ecosystem issues, through repeated interactions generating social capital and social memory, thus increasing their social resilience. Such communities can be considered as Communities of Practice, which by definition produce social capital and can drive community resilience. The social interactions occurring within the KasKantine cooperative and urban community gardens, both forms of urban commons, support social capital building through trust and social cohesion. These traits are not preconditions, but rather emerge from the collective action occurring in such convivial spaces. This combination of openness, experimentation in the face of disruptions, and freely accessible knowledge can help local communities to better face possible socio-economic changes. Such capacity-building can trigger urban community resilience, notably through forms of cognitive resilience. The fact that trust and cohesion do not need to be preexistent for communities to engage in the urban commons should not surprise us. Late 19th-century German philosopher G. Simmel, through the intellectual analysis of boundaries Simmel, 1994, noted that only that which is previously separated can be connected; for example, the two banks of a river joined by a bridge. The paradoxical dependence of separateness and unity extends to human beings, which Simmel qualifies as "being- boundaries which have no boundary": an individual is itself a boundary, with for example, its values, cultural background and lifestyle, but with the capacity, at any time, to modify its situation through its interactions. It is at this boundary that the learning of communities can occur. In an often multicultural urban scenario, this particular trait of capacity-building "from scratch" is a priori a strong argument for social resilience. Assuming the existence of a convivial urban space where communities potentially bring individuals together, this can trigger constructive interactions thanks to trust and cohesion.

### 5.6.2 Further research

Our conclusions above are given for the Amsterdam cooperative of KasKantine, and more empirical work is needed to assess the building of social capital in other ex-

amples of urban commons. We have not investigated the interpersonal commitments, formal or not, which could influence trust and therefore social capital building in our example of urban commons. In contexts where such contracts are relevant, it may be useful to consider trust emergence through such institutions. We also wish to highlight the need to study the role of alliances between citizens and public entities, such as municipalities, in contributing urban commons resilience building. Empowering citizens may be perceived as a threat to local governments ((Petrescu, Petcou and Baibarac, 2016). Similarly, commoners may prefer to maintain a certain distance with local authorities. The initiators of KasKantine accept certain help from the municipality of Amsterdam, mostly as moral and logistic support, but prefer to stay independent of financial help, perhaps for the sake of their autonomy. Participatory approaches in collaboration with local authorities have also generated positive results (Clarke, 2017; Nagendra and Ostrom, 2014). Such polycentric arrangements, on activities which are beyond the scope of local communities, offer a powerful alternative to the usual process of privatisation and top-down ecosystem restoration. In line with this argument, adequate forms of governance and management may help the creation or promotion of urban places which trigger social integration and cognitive resilience building (Colding and Barthel, 2013). Exchanges public-civic are also proposed as further research by the authors of the study on R-Urban in Paris (Petrescu, Petcou and Baibarac, 2016).

Humanities can further contribute to the question of alliances of the public and civic sector in an attempt to reach urban resilience through the urban commons.

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# 6

# Knowledge, learning and adaptability in the urban commons

This chapter is to be submitted as Feinberg, Arthur and Sergei Zhilin, with the above title.

Abstract– We investigate the social learning mechanisms contributing to more resilience in the urban commons. Such mechanisms require physical artefacts, such as an urban place of conviviality and existing grassroots networks, but also digital artefacts, such as the digital commons. The mechanisms of knowledge co-production operate both within a community, where knowledge is extracted, and between communities, thereby making them more resilient to systemic changes.

## 6.1 Introduction

Bottom-up initiatives in the form of community projects are taking momentum to tackle socio-environmental issues through collective action. They can involve multiple actors, such as individuals, companies or local authorities (Aernouts and Ryckewaert, 2017; Batliboi et al., 2016; Nagendra and Ostrom, 2014; Ni'mah and Lenonb, 2017; Rocha et al., 2016), and support certain functions for communities, such as infrastructure (Middleton and Crow, 2008), ecosystem services (Colding and Barthel, 2013; Dennis and James, 2016) or political participation (Giannini and Pirone, 2019; Ruiz, 2018).

Cities are conceived as complex systems with interdependent relations of communities and their environment (Mehmood, 2016). The urban commons, defined as tangible or intangible shared urban resources and spaces (Foster and Iaione, 2015), is

a well-described example (Colding et al., 2013). The urban commons reflects urban communities' needs by providing essential benefits, which can lack under economic crises (Di Feliciantonio and Aru, 2018; Huron, 2015), housing crises (Aernouts and Ryckewaert, 2017; Bunce, 2016)or the welfare state drawback (Camps-Calvet et al., 2015; Petrescu, Petcou and Baibarac, 2016; Susser, 2017a). It can support subsistence or livelihood, well-being, recreation and a sense of collective identity (Feinberg, Ghorbani and Herder, 2021).

The urban commons is generated and cared for through mechanisms of commoning, defined as "voluntary and inclusively self-organised activities and mediation of peers who aim at satisfying needs" (Euler, 2018, p. 12). The management of the urban commons requires "creating spheres of relative autonomy" (Borch and Kornberger, 2015, p. 17)which need to communicate and interact, in order to better organise, gain benefits and avoid harm (Ostrom, 1990). Such repeated interactions help forming a foundation of shared norms and patterns of reciprocity, called social capital, on which institutional arrangements can be established (Ostrom, 1990). These contribute to social learning (Armitage et al., 2011). Based on the evolutionary resilience framework of Davoudi, Brooks and Mehmood, 2013and additional research from Mehmood, 2016, the learning capacity of communities triggers preparedness, one of the four pillars of the evolutionary resilience framework.

Communities involved in the care of the urban commons potentially play a significant role in urban system resilience (Chan, DuBois and Tidball, 2015; Petrescu, Petcou and Baibarac, 2016; Shaw et al., 2016). They have the capacity to learn through uncertainty and system changes, which is key to enable their adaptability (Armitage et al., 2011; Mehmood, 2016; Quigley, Blair and Davison, 2018). Such learning can emanate from knowledge co-production, a well-described driver of urban resilience (Camps-Calvet et al., 2015; Elmqvist et al., 2019; Folke, Colding and Berkes, 2003; Schauppenlehner-Kloyber and Penker, 2016).

Much research has been describing the urban commons, its traits and challenges (Feinberg, Ghorbani and Herder, 2021). Several studies have mentioned the importance of knowledge and communication in the daily activities of the involved communities (Aernouts and Ryckewaert, 2017; Chan, DuBois and Tidball, 2015): "Many informal forms of social interaction [...] allow the project to learn collectively and strong relations to flourish" (Chatterton, 2016, p. 8). However, the social learning mechanisms in the urban commons are yet unexplored.

In this paper, we first introduce the role of communication channels in the urban commons, from a resilience-building perspective. Based on a literature review of past empirical research on the urban commons, we present the main communication channels which can support urban commons social learning. Then, we bring these results in perspective with a rich database of 123 urban community gardens in Germany (Rogge, 2020).

## 6.2 Theoretical background

### 6.2.1 Communication, information and knowledge

Information is generally defined as "the characteristics of the output of a process, these being informative about the process and the input" (Losee, 1997). The hierarchy of information-generating processes constitutes communication. In the urban commons, these processes are the interactions of the community members with each other and with their environment, thus creating knowledge: the shared concept of two interacting elements is a space-time nexus where "information is interpreted to become knowledge" (Nonaka, Toyama and Konno, 2000, p. 14).

Urban commons researchers have regularly described knowledge as a substantial condition for community engagement (Chiu and Giamarino, 2019; Frantzeskaki, 2019; Radywyl and Bigg, 2013; Ruiz, 2018; Scharf et al., 2019)and solidarity (Montagna and Grazioli, 2019)to negotiate change. Knowledge may be brought from outside (experts or other urban commons initiatives) or generated through processes within the community (Brain, 2019). Action research can for example feed urban commons communities with relevant technical knowledge (Gilmore, 2017; Lang, 2014; Łapniewska, 2017; Petrescu, Petcou and Baibarac, 2016). Knowledge can also be produced through and for community engagement (Aernouts and Ryckewaert, 2017).

Despite the positive role of knowledge on communities engagement, one should remain aware of certain challenges, especially in the online communication domain. E-participation can for example suffer from too many users or too superficial interactions (Rao, 2013; Sobol, 2017), a lack of communication between the various actors (Durusoy and Cihanger, 2016)and the unequal access to IT resources (Batliboi et al., 2016). Communication quality also alters the image given by the urban commons to the public or the authorities, which can impact their support of the initiative (Bresnihan and Byrne, 2015; Chiu and Giamarino, 2019; Leitheiser and Follmann, 2019).

### 6.2.2 Drivers of urban community resilience

The most recent paradigm of resilience thinking shifted towards social-ecological resilience, with adaptability rather than robustness as its key characteristics (Meerow, Newell and Stults, 2016; Quigley, Blair and Davison, 2018). Given the specificity and complexity of urban problems, Meerow, Newell and Stults, 2016, p. 39define urban resilience as:

*The ability of an urban system - and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales - to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity.*

Urban scholars thus mean resilience as an adaptation mechanism of systems that involves change, innovation, and system transition from one stable state to another. Communities can trigger long-term adaptability from short-term processes, notably in the field of disasters risk reduction (Kim and Lim, 2016; Radywyl and

Bigg, 2013; Schauppenlehner-Kloyber and Penker, 2016; UNDRR, 2013). Several elements may trigger resilience in communities: people-place connections; values and beliefs; knowledge, skills and learning; social networks; engaged governance (involving collaborative institutions); a diverse and innovative economy; community infrastructure; leadership; and a positive vision towards change (Berkes and Ross, 2013).

To mitigate a crisis which requires exceeding its adaptive capacity, a community should transform a way of functioning. Béné et al., 2012, p. 22argue that a transformation needs the support of governmental institutions in order to be successful, otherwise communities may face "enormous barriers to transformation, rooted in culture and cognition and expressed through economic and social policies, land-use legislation, resource management practices, and other institutions and social practices". Although some scholars warn against top-down community resilience strategies, such as those driven by consensus and unable to deal with all claims (Bianchi, 2018), successful transformation may be guided by a so-called asset-based approach which discards the top-down/bottom-up dichotomy to let communities "use the power of association to mobilise assets in a manner that also optimises their capacity to take advantage of external connections and partnerships with institutional actors who bring resources, broader connections and access to expert knowledge" (Brain, 2019, p. 179).

### 6.2.3 Social learning and adaptability

Resilience theory particularly aligns with communities' desire for self-reliance and societal change through a requirement for "social learning and transformation" (Cretney and Bond, 2014, p. 29). Social learning occurs through the mutual shaping of social behavior and the environment around it, and plays a major role in enabling adaptability (Armitage et al., 2011; Quigley, Blair and Davison, 2018)and social-ecological resilience (Wilkinson, 2012).

Adaptability relies on preparedness to disruptions. Social learning within communities makes them less vulnerable to future disturbances (Cretney and Bond, 2014): "Preparedness refers to increasing the learning capacity of the communities through knowledge exchange and sharing mutual experiences" (Mehmood, 2016, p. 415). This is for example the purpose of the Transition Network, a charity created to "inspire, encourage, connect, support, nurture and train" networks of urban communities (Network, 2020). It relays knowledge across these communities.

Combining different types of knowledge for learning is one possible resilience-building strategy (Folke, Colding and Berkes, 2003): merging various knowledge sources or building knowledge through practice and habits (Camps-Calvet et al., 2015). Such repeated interactions around a given goal generate a shared history of learning which characterize Communities of Practice (CoPs) (Wenger, 2010a).

### 6.2.4 Communities of Practice towards resilience

A Community of Practice (CoP) (Wenger, 1998) can be seen as a social learning system where members co-produce practice through social learning. The boundaries

of CoPs are usually fluid. Boundaries are not tangible, but still can be felt when engaging, for example, with a group talking about their shared interests. Repeated engagement with such a group is required in order to fully understand their shared knowledge base: a shared history of learning is what defines a community of practice. Its members engage by both participating and creating artefacts which, over time, generates the social history of learning. Communities of Practice combine individuality and collectivity (Wenger, 2010a; Wenger, 2010b). As reformulated from Wenger's work, CoPs consist of :

(1) a 'joint enterprise' of vigor in learning about a particular enterprise (e.g. gardening), (2) 'mutual engagement' through which people bond and build social capital, and (3) a 'shared repertoire' of rules, jargon, and artefacts that enable a community to reflect upon and understand its own state of development and to move forward (Bendt, Barthel and Colding, 2013, p. 19).

This connects with the idea of commoning (Euler, 2018). CoPs have indeed been described to occur conjointly with the urban commons (Radywyl and Bigg, 2013). As the urban space of Times Square, New York, was iteratively being reappropriated temporarily through tactical urbanism in 2009, its users started to become aware of a forming group identity with self-organising practices, while at the same time operationally modifying the spatial arrangements. Identity is a fundamental concept of the theory of social learning, as it "reflects a complex relationship between the social and the personal" and makes production of practice unpredictable because through identity members are positioning themselves in a community (Wenger, 2010b, p. 182).

CoPs have been described to build resilience in the urban context, in the examples of urban community gardens (Chan, DuBois and Tidball, 2015)and urban forestry through research-practice networks (Campbell, Svendsen and Roman, 2016). In sections 6.4 and 6.5, we are describing the mechanisms of social learning in the urban commons.

## 6.3 Materials and methods

### 6.3.1 Urban commons literature study

In earlier work (Feinberg, Ghorbani and Herder, 2021), we have performed an up-to-date review of the urban commons by assembling knowledge from theories and examples gathered from all possible research fields of research which study the urban commons. We are reusing some of the outcomes of this research and expand its bibliography with snow-ball search to have a stronger focus on communication and knowledge. A search on Scopus using keywords communication or knowledge and necessarily with the expression "urban commons" gave 20 results [date: 02.11.2020], 10 of which were relevant to our research.

### 6.3.2 Dataset on urban community gardens

We use a dataset of 123 urban community gardens located in Germany, which are a recurrent example of urban commons. The data was collected through online ques-

tionnaires in 2017 to study social sustainability (Rogge, Theesfeld and Strassner, 2018). In each case, one frequent gardener or member of the managing group answered the questions. It gives us relevant information on the channels used by these communities, and their relative importance.

We extract relevant metrics from the dataset for the purpose of our study regarding information, communication and knowledge. We also consider how the communities perceive internal and external knowledge flows. Finally, we extract the respondents' success perceptions of their community, and connect this information to the communication channels used.

## 6.4 Results

### 6.4.1 Conditions for social learning in the urban commons

This subsection derives mostly from literature findings, with field data being punctually used for illustrative purposes.

#### Physical characteristics

**Places of conviviality** Conviviality was first meant by Ivan Illich as a fundamental force to re-capacitate human beings in a quickly industrializing society, in which machines were supposed to work for men (Illich, 1973, ch. II). He defines it as "autonomous and creative intercourse among persons, and the intercourse of persons with their environment". Conviviality also describes processes of cohabitation and interaction which accommodate individuals' differences, for example in urban multiplicity (Hinchliffe and Whatmore, 2006). Convivial places are both an object and practice of care where people look for each other as much as they look after each other. The care generated within an urban commons represents an atmospheric installation, a "mood-space" where people assemble and materialize their proximity (Corsín Jiménez and Estalella, 2013). Such "mood-spaces" are more likely to appear with frequent interaction, or togetherness, of different individuals: in that sense, conviviality emerges more from semi-public spaces than public space (Wessendorf, 2014). This highlights the need of "zones of encounter" (Wood and Landry, 2008)or "micropublics" where human boundaries, such as ethnicity, religion or class can be bridged. This boundary interaction is a frontier at which the learning of communities can occur ; a frontier called boundary of practice (Wenger, 2010a).

The physical boundary of a commons is different from the CoP boundary at which learning occurs. However, such places of conviviality offer the necessary conditions for learning inside the community: sustained time spent together, personal relationships and open communication ; enhanced by a convivial atmosphere. Thanks to conviviality, the urban commons offers opportunities for encounters with strangers, which can contribute to accommodating interactions towards difference (URBACT, 2014). Urban dwellers meet in the urban commons people with different norms, backgrounds and cultures, which can trigger tolerance and respect.

In addition, the urban commons often has shared premises which incite to spend time together, such as sofas, a kitchen but also digital communication platforms.

Such places nurture trustful interactions and social cohesion, both drivers of intra-community knowledge co-production. The Amsterdam initiative De KasKantine (Dutch for "GreenhouseEatery") illustrates this. It provides a free convivial space for the local community with a focus on food waste reduction, up-cycling materials and circular economy. It is run by volunteers involved in many tasks such as cooking, serving, but also gardening, building, fixing and supporting bottom-up activities, for example bike-fixing workshops, yoga classes and a social change discussion group. The community created and its digital platform aim at exchanging knowledge and experience about ways of living sustainably. The platform displays open source blueprints of several Do-It-Yourself (DIY) infrastructures present in the KasKantine: an efficient wood-fuelled pizza oven, a self-sufficient aquaponics system, or a gray water filter, to name a few.

In the case of urban community gardening, a well-documented example of urban commons (Colding and Barthel, 2013), the shared repertoire mentioned above in the definition of CoPs consists of stories and discourses, norms of conduct, association's by-laws and artefacts like a garden layout, tools, flowerbeds, compost and sometimes shared websites, such as in Bürgergarten Laskerwiese and Rosa Rose Garten (Bendt, Barthel and Colding, 2013). Such artefacts are a form of tacit and codified knowledge (Krishnaveni and Sujatha, 2012), which are collectively used and produced in the CoP's joint enterprise. The gardeners benefit from several learning streams: gardening skills and ecological awareness, politics of space, self-organisation and social entrepreneurship (Bendt, Barthel and Colding, 2013).

**Place-specific knowledge: joint events and grassroots organisations** Camps-Calvet et al., 2015 identified three learning pathways in urban community gardens. Firstly, they merge different knowledge sources - local, traditional and experimental - with a particular focus on knowledge from elders being transmitted to younger generations and on "trial and error" experimentation. Secondly, such places are medium for education and raising awareness on issues like urban agriculture, society or the environment: they regularly host joint events such as workshops and open public days. In the KasKantine cooperative, such events are organized via a Meetup group. Thirdly, the activities themselves allow recoupling urban inhabitants to ecological dynamics. We could name these three processes place-specific knowledge (Langemeyer et al., 2018).

Similar processes occur in other types of urban commons, but also at a different scale. In Berlin, the Neighborhood Academy, a self-organized open platform for urban and rural knowledge sharing, cultural practice and activism, allows inter-community exchange. It connects different actors and enables the sharing of knowledge, methods and experiences on shared use and resource management (Unteidig et al., 2017). Another example of urban commons benefiting from such networks is housing, through the current trend of Community Land Trusts (CLTs). CLTs are "nonprofit organizations that own land in a set geographic area, and are governed by a board of residents, other community members, and trusted professionals" (Caldwell, Krinsky and Brunila, 2019, p. 1209). CLTs therefore represent institutional arrangements which manage certain housing commons. Such arrangements may also be found in the UK (East London CLT), and Kenya (Tanzania Bondeni

CLT). New York City CLT has for example inspired the CLTs in Brussels, which benefited from government support (Aernouts and Ryckewaert, 2017). Caldwell, Krinsky and Brunila, 2019 elaborate on the 'expansive learning' concept to explain the formation of NYC's CLT. Another example is the network of citizen projects and grassroots organizations as part of the R-Urban strategy (Petrescu, Petcou and Baibarac, 2016).

These examples show that inter-community knowledge exchange is occurring via both grassroots activism and top-down support. It helps reproducing the commons and fuels social learning. As proposed by Elmqvist et al., 2019, p. 271, knowledge generation involving multiple urban actors is a "process to invite, facilitate and enable locally informed and globally related meanings of urban resilience and sustainability".

**Online characteristics: digital commons**

Communication also takes place online. We have mentioned earlier the use of dedicated websites in urban community gardens (Bendt, Barthel and Colding, 2013). Learning rquires tools for shaping "shared repertoires" of communities (Wenger, 2010b). Digital platforms can serve as artefacts for intra-community and inter-community knowledge exchange, i.e. learning at communities' boundaries. These forms of digital commons exist in a parallel to physical commons (Arora, 2015). Digital commons consists of "shared artifacts which can be taken over and self- governed by concerned people" (Teli et al., 2015, p. 17).

Digital commons can help citizens to build networks and engage in collaborative processes (Deng et al., 2015), such as the care of urban greenery (Rao, 2013). Actors from various origins, such as activists, civic organisations, experts, planners can collectively produce knowledge sitting at the same virtual table (Rotta et al., 2019; Spagnoletti, Resca and Lee, 2015). Connected devices can be used to generate and store user-generated content, related for example to tourism (Artopoulos, Charalambous and Wehmeier, 2019; Cantone, Motta and Marrelli, 2014), public transport (Teli et al., 2015)or political mobilisation (Arora, 2015). In some cases, a digital community may be created from user-installed devices which carry a wireless signal in public spaces such as in Montréal (Middleton and Crow, 2008). Through this infrastructure, users are sharing content, promoting local artists, news and events. Similar examples, but from a top-down perspective, are "tech parklets" (Batliboi et al., 2016): temporary street installations triggering social interaction, providing access to internet, electricity and allowing digital inclusion and citizen engagement.

Resilient communities can be built with the help of digital commons, which supports both inter- and intra-community production of resilience knowledge. Baibarac and Petrescu, 2017propose for this purpose the concept of *open-source resilience*, which is based on three principles: (1) a favourable implementation site with connections across scales and locations, (2) commons-based peer knowledge production (e.g., of knowledge, know-how, methods and practices) towards radical transformation for greater resilience, (3) the existence of collaborative technologies to connect local resilience initiatives and co-producing strategies.

We have showed above in 6.4.1 that urban commons communities thrive around places of conviviality, which become implementation sites where knowledge from

different origins can be shared. These communities sometimes use digital commons technologies to build networks and exchange knowledge more efficiently (Deng et al., 2015; Rao, 2013; Rotta et al., 2019; Spagnoletti, Resca and Lee, 2015). The urban commons therefore embraces respectively the principles (1) and (3) of open-source resilience, as defined by Baibarac and Petrescu, 2017.

The second principle of the same definition relies on a term coined by Benkler, 2003, p. 1254, commons-based peer production, applied to knowledge. It is "a process by which many individuals, whose actions are coordinated neither by managers nor by price signals in the market, contribute to a joint effort that effectively produces a unit of information or culture". Participants of such processes are equal peers that select tasks according to their skills and personal motivations. They cooperate freely and are not bonded by contract in order to produce value for themselves or their community (not for market exchange) (Benkler, 2017; Benkler and Nissenbaum, 2006; Kostakis and Papachristou, 2014). This type of organisation, in which usage and consumption are required in the process of commons production, is characteristic of the urban commons (Borch and Kornberger, 2015; Ruggiero and Graziano, 2018).

When applying this term to knowledge, we can link the principle (2) above to the notion of knowledge commons (Hess and Ostrom, 2005) where, "in open source software communities, [...] free-riders are wanted" (Borch and Kornberger, 2015, p. 8). The knowledge built-up through such processes forms a digital database (Corsín Jiménez, 2014), such as the taxonomy of urban solutions developed by Madrid's Zoohaus, which generates "bidirectional teaching-learning processes" (Rubio, 2018, p. 67). The building of digital libraries has been described to trigger learning (Hess, 2008; Krowne, 2003). As described by Helbing, 2015; Helbing, 2017, this kind of data commons objective requires a diversity of users and settings which enables collective intelligence, a driver of societal resilience to disruption. From a design point of view, the platform or devices used should promote recursive engagement (Parker and Schmidt, 2017; Teli et al., 2015), thanks to which the technology (and community using it) sustains by itself after some time. VCoPs (virtual Communities of Practice), with repeated interactions (Wenger, 1998; Wenger, 2010a) also induce more "resilience planning" (Amaratunga, 2014, p. 76). In that perspective, people are more likely to take initiative with "bounded", rather than pervasive technologies (Rogers, 2006; Teli et al., 2015). Such technologies should enhance users' capabilities by focusing on issues instead of being solution-oriented.

Examples of digital commoning used towards community resilience are the Park(ing) Day interventions. Through such interventions, a rented car parking lot becomes a place of citizen expression, often with trees and grass planted on it; such installation was named as 'parklet'. It started by the initiative of Rebar in San Francisco in 2005. Rebar group has since gathered experiences, tips, images and pins on Google map to create a blueprint of the intervention under the Creative Commons license, allowing anyone to use the concept and call the event Park(ing) Day. Therefore, through digital commoning, the global community of activists created plenty of variations of the original blueprint and conducted the event throughout the world. Furthermore, several US municipalities have adopted and institutionalised such practices. Incorporated in the official urban planing agenda, parklets have now become a tool of both activists and urban practitioners (Bradley, 2015).

| | OFFLINE | ONLINE |
|---|---|---|
| INTRA-community | Urban place co-creation, Conviviality, Joint events | Digital commons |
| INTER-community | Grassroots networks | Digital commons, Open-source resilience |

Table 6.1 – Mechanisms of knowledge co-production and exchange in the urban commons

**Urban commons social learning mechanisms**

Based on the analysis above, we present in table 6.1 the mechanisms of knowledge co-production and exchange which convey social learning in the urban commons. It embraces both scales inter- and intra-community, and spans across the physical/offline and the digital/online domains.

### 6.4.2 Knowledge co-production in the real world: urban community gardens

We illustrate the results from Table 6.1 with the answers of gardeners from 123 different urban community gardens throughout the Rhine-Ruhr area in Germany (Rogge and Theesfeld, 2018).

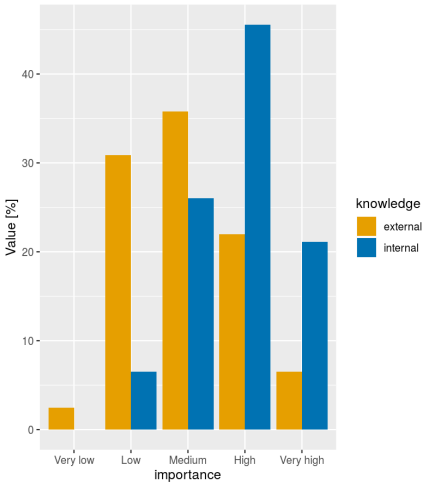


Figure 6.1 – Relative importance perception of external and internal knowledge

The first result we obtain from these communities is that they put more importance on internal knowledge (intra-community) than external knowledge (inter-community and experts), as shown in Figure 6.1.

When asked about their preferred communication support, verbal or written, respondents showed a large preference of verbal communication for knowledge sharing, whereas daily information and communication were more likely to occur written

(Figure 6.2).

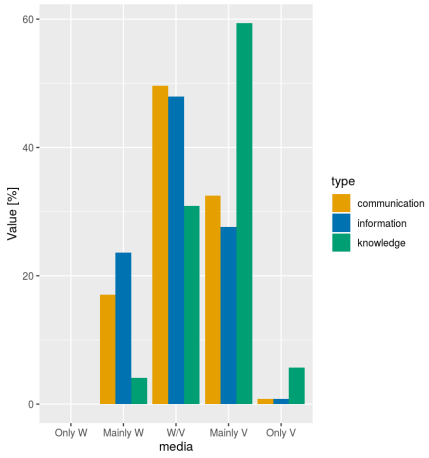


Figure 6.2 – Use of communication, information and knowledge, written (W) or verbal (V)

The mechanisms of communication are visible in Figure 6.3. Respondents indicated that their community more likely uses direct communication mechanisms, such as meetings, emails or phone calls and SMS. The knowledge sharing possibilities offered by web-pages or social networks, or phone messengering applications are seldom used. When connecting these results with those of Figure 1, we can emit the hypothesis that intra-community communication more likely occurs through meetings, emails and phone calls and SMS.

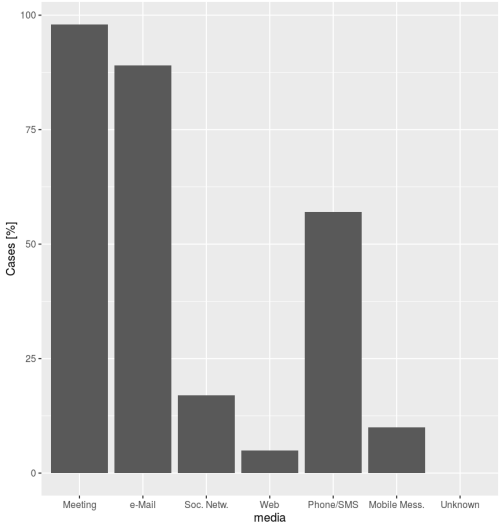


Figure 6.3 – Communication mechanisms in urban community gardens

The mechanisms of communication found in the dataset span across the scales

developed above in section 6.4 online vs. offline, intra- and inter-community. The interviewed urban gardening communities seemed to put more weight on internal knowledge, which may have limited their use of digital communication tools: websites, social networks and mobile messengering (e.g. Whatsapp). However, we cannot exclude that such tools may be used within a community: the KasKantine cooperative activities for example rely on several Whatsapp groups for daily coordination, and social network (Facebook, Instagram and Meetup) groups to advertise for joint events. The urban place is by default present as the physical garden where activities take place. The notion of conviviality was not directly mentioned in this dataset, although the authors of the dataset found a significant correlation between group heterogeneity and the social sustainability of the community. The latter notion can be assimilated with the community resilience investigated in background of this paper.

In this case of urban commons, all mechanisms of knowledge co-production and exchange (Table 1) are present to some extent, depending on the purposes (communication, information, knowledge). It is interesting to note that knowledge sharing occurs mostly in a verbal way, and therefore more likely at the intra-community scale. This is backed by the fact that external knowledge is perceived predominantly of medium or low importance. Online mechanisms seem not to prevail, except for emails and occasional social network or web-page. Again, this seems to indicate a focus on members of the community only. In terms of open-source resilience (Baibarac and Petrescu, 2017), the above examples of urban commons display the first two principles: (1) an implementation site, however with limited connections across scales and locations, and (2) mechanisms of commons-based peer knowledge production. The third principle applies to a weaker extent: collaborative technologies are used more internally and less to connect with other resilience initiatives.

## 6.5 Discussion

We have identified several knowledge co-production mechanisms in the urban commons and structured them across two scales, which embrace the physical and digital spaces, both within and between such communities of practice (Table 6.1). We have established the following: social learning triggers social resilience (sections 6.2.2 & 6.2.3), knowledge exchange is a driver of social learning (section 6.2.3), more diverse types of knowledge exchange implies more learning (end section 6.2.3), such knowledge exchange is particularly relevant for Communities of Practice (such as the urban commons).

According to our literature, diversifying the mechanisms of knowledge exchange facilitates social learning, and therefore supports more resilience (Table 6.1). There are still several challenges to knowledge sharing towards community resilience. We have identified them for three types of actors: (i) urban commons practitioners, (ii) policy makers, and (iii) researchers.

### 6.5.1 Challenges for urban commons practitioners

Building networks of urban commons initiatives is not a straightforward task. As mentioned by (Arora, 2015, p. 57), "the state continues to be a key player in mediating movements of people, and defining their rights and benefits online and offline". Urban commons initiatives are often seen as the "third way" of solving citizens' issues which diverge from both governmental and market mechanisms. Developing inter-community networks similar to those in other sectors facilitate knowledge co-production and, therefore, the resilience of the involved communities. This has been observed in the case of funding, the quest of which can cost a great amount of time and efforts to the participants (Scharf et al., 2019, p. 8).

Secondly, the daily interactions in CoPs require alignment (Wenger, 2010a)and should be based on consensus, non-violence, a commitment to process politics and learning. The Internet triggers such exchange of ideas (Rao, 2013). These are required conditions to create and maintain the urban commons (Chatterton, 2016). The efficiency of exchanging of short online messages in collaborative processes, and the difficulty to engage all potential actors, remain challenges (Deng et al., 2015; Rao, 2013). Urban gardening communities in Germany used mostly offline communication media. This point has also been highlighted by Rao, 2013, p. 169 who insists on a "cautious recognition of strengths and weaknesses of networked activism", which may be perceived as "elitist or exclusionary" (Arora, 2014). The shallow sense of engagement it provides brings the community to additionally meet offline. According to Rao, a network already connected by personal ties and trust has more chances to overcome the digital limitations described above. Rao, 2013, p. 170 further suggests that more physical engagement is required "to counter the Internet's limited reach". Finally, some digital technologies may be too solution-oriented, while they should address issues in such a way to let community members take initiative (DiSalvo et al., 2014; Rogers, 2006; Teli et al., 2015).

### 6.5.2 Challenges for policy-makers

Policy-makers face the challenge of fostering inter-community knowledge exchange. Indeed, knowledge production is not enough, and needs an institutional framework (Folke, Colding and Berkes, 2003; Camps-Calvet et al., 2015), such as in the CLT and R-Urban examples. Digital infrastructures play an increasingly important role in knowledge co-production. For urban commons communities, digital commoning (i.e. sharing of open knowledge with help of open source software and social networking tools) is a natural fit, because such communities already understand the logic of commoning. Nevertheless, they seldom codify and share collected knowledge online as they don't see direct benefits of such activities. Critical factors are digital literacy, information overload, insufficient incentives for knowledge creation and the absence of suitable software solutions. Policy-makers may help with finding material incentives for digital commoning (e.g. external funding) or with promoting cross-sector collaborations which facilitate knowledge co-production (Campbell, Svendsen and Roman, 2016).

"Bringing in new sources of knowledge to access options developed at regional,

national, and international levels may require bridging organisations, such as development non governmental organisations (NGOs), for resilience-based development policies that incorporate multiple levels of participation" (Robinson and Berkes, 2011, as quoted in Berkes and Ross, 2013, p. 9).

On the other side, information infrastructures carry certain properties of common-pool resources by requiring "storage and preservation, and over which one must define rights and rules of access, extraction, exclusion, and alienation" (Hess and Ostrom, 2005, p. 7, as quoted in Corsín Jiménez, 2014, p. 344).

### 6.5.3 Challenges for researchers

All the mechanisms by which digital communication technologies facilitate knowledge co-production by and for urban communities have not been clarified conclusively in the literature (Quigley, Blair and Davison, 2018).

We have partly answered two of the concerns raised by Elmqvist et al., 2019, by outlining the importance of knowledge, both offline and online, in urban community resilience. However, we did not analyse the vulnerabilities possibly caused by over-connectivity. Secondly, the connectivity of cities, through bottom-up initiatives talking to each other and exchanging knowledge, may well become a force on its own in urban governance. To what extent can such islands of community resilience impact urban resilience at a larger scale? The organisational and institutional processes leading to the building of learning capabilities are still a challenge (Folke, 2006; Quigley, Blair and Davison, 2018).

## 6.6 Conclusion

Communication in the urban commons serves direct organisational functions, it also nurtures a local generation of knowledge which can then be shared with other communities. Social learning therefore occurs both at the intra- and inter-community scales. The media used originate from the offline as well as from the online domain. Physical events, meetings and direct knowledge transmission may be combined with digital devices which generate, store and propagate knowledge: the digital commons. The social learning induced by the various processes of knowledge generation in the urban commons contribute to urban community resilience. The concept of open-source resilience embraces the idea of an implementation site where a community co-produces knowledge and makes use of collaborative technologies to connect with similar initiatives and develop strategies toward more resilience. Although much attention has been placed on the digital communication tools, our research indicates two points. First, certain successful communities barely use digital media. They have found their equilibrium but neglect the importance of shared experiences from different communities. Second, online engagement is still problematic because of digital divides, privacy issues, impersonal and superficial communications, potential over-connectivity and most importantly, unclear benefits for communities. These are sources of challenges for practitioners, researchers and policy-makers.

# Part III

# ASSEMBLING AND WRAPPING-UP

# 7

# Discussing the foundations of urban commons community resilience

This chapter is based on a journal article currently under review.

Abstract– This article assembles knowledge and arguments from the author's recent research in order to build a framework of urban commons community resilience (UCCR). It is inspired from Ostrom's Socio-Ecological systems (SES) framework with a focus on urban commons resources and with community resilience, rather than mere interactions/outcomes, as its core variable. We apply our UCCR framework to a case of urban cooperative in Amsterdam, the Netherlands.

## Introduction

Cities are caught in crossfire: world-scale environmental crisis, reinforcement of social inequalities and market-driven urbanisation. World leaders and scientists call for making cities more resilient ; but resilience for whom? what? and why? Urban resilience has been defined as "[...] the ability of an urban system - and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales - to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity" (Meerow, Newell and Stults, 2016, p. 39).

Following the tragic 2011 earthquake which hit Japan, the mayor of Sendai declared at a UN Office for Disaster Risk Reduction meeting that "disasters cannot be prevented solely by improving facilities and taking other 'hardware' approaches", further highlighting the urgent need of self-sufficiency and social bonds within com-

munities of local residents (UNDRR, 2013). Cities are directly concerned:

*"A city without resilient communities will be extremely vulnerable to disasters. Human communities are the social and institutional components of the city, directing its activities, responding to its needs, and learning from its experience"* (Kim and Lim, 2016, p. 6).

Focusing at the community scale aims to trigger long-term change from short-term processes (Radywyl and Bigg, 2013; Schauppenlehner-Kloyber and Penker, 2016).

The urban commons (UC) has become a significant practice in the urban environment over the past decades. More than 500 initiatives have been surveyed and mapped in the Co-Cities platform (Foster and Iaione, 2019; Co-Cities, n.d.), which centralises the experiences of urban commons governance laboratories worldwide. The UC consists of shared material, immaterial or digital goods in an urban setting, which are generated, exploited and cared for by a community. The new commons concept, mapped by Hess, 2008, has enlarged the variety of urban commons (see Chapter 3). Scholars describe the commons both as a community governance of shared resources, and as the resources itself (Foster and Iaione, 2019). In most cases, urban communities are self-organising to manage their commons, using several of the community resilience pathways identified above (see Chapter 5). Sustaining the UC therefore requires a governance system interwoven with the active participation of community members which drives more resilience in urban subsystems.

Urban community resilience is driven by institutions - formal, semi-formal or informal (Shaw et al., 2016). This highlights the need to investigate urban commons governance through the angles of power relations, agency, self-efficacy, values and behaviour (Berkes and Ross, 2013)within community-based activities to understand how they sustain over time.

To evaluate the extent to which the urban commons contribute to urban community resilience, we propose a framework on urban commons community resilience (UCCR). This framework, which concludes previous research, particularly investigates the role of institutions and communities within the urban commons. We first summarise relevant theories and frameworks, then detail the methods which led us to build the UCCR framework. Consequently, we describe the framework structure and propose a method to evaluate it, highlighting certain performance indicators.

## 7.1 Theoretical background

In this section, we justify the need for a framework on urban commons community resilience and explain how existing theories and empirical evidence can contribute to it.

We call in different streams of literature to build the foundations of the UCCR framework: Common-Pool Resources (CPR), socio-ecological systems and resilience theory, backed by a literature review of the urban commons (Feinberg, Ghorbani and Herder, 2021).

**Common pool resources** theory was notably developed by E. Ostrom. She explored the robustness of collective natural resources management systems and listed 8 Design Principles which can be used to assess and compare such systems (Ostrom, 1990). In a more process-oriented perspective, this led her and colleagues to develop the Institutional Analysis and Design (IAD) framework (Ostrom, Gardner and Walker, 1994). It is a descriptive framework well adapted to study systems of self-governance. It captures ways in which institutions operate and change over time within such systems, along with variables describing the community and its resource system.

**Socio-ecological systems** are "dynamic systems that are continuously changing" which "co-evolve from the interactions between actors, institutions, and resources, constrained and shaped by a given social-ecological setting" (Schlüter et al., 2014, p. 1). Ostrom's Socio-Ecological System (SES) framework takes the IAD one step further by giving the tools to examine the outreach of such systems both in terms of collective action outcomes and ecological performance. Its first-tier variables are visible in Figure 7.1.

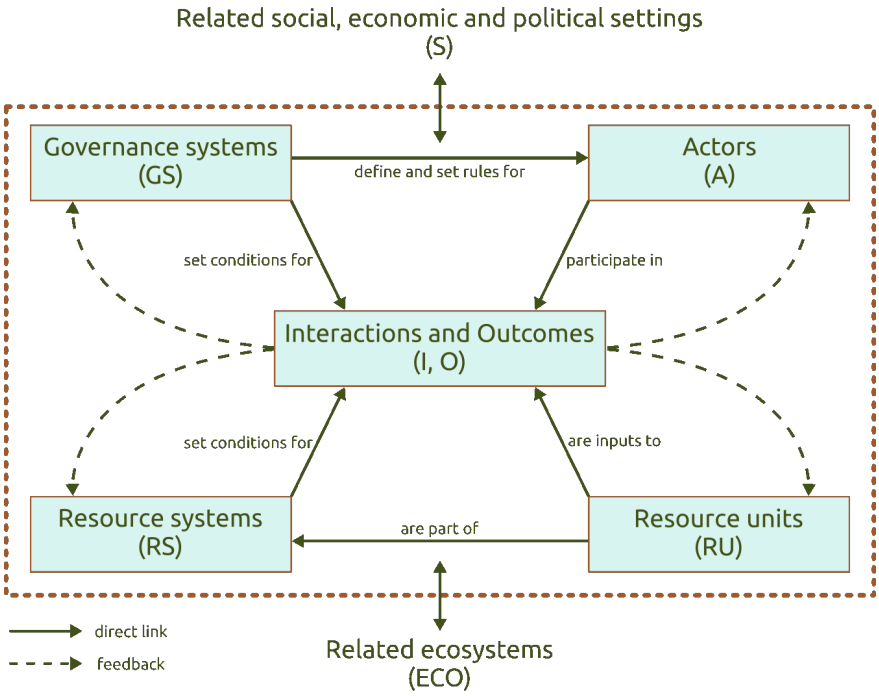


Figure 7.1 – Ostrom's SES framework (adapted from McGinnis and Ostrom, 2014 : the first-tier variables

**Resilience** currently implies that in the face of perturbations, certain functions of a system need to be maintained or adapted to avoid a less-desirable state (Folke

et al., 2005). Resilience thinking has recently shifted paradigm to focus on social-ecological resilience, with adaptability rather than robustness as its key characteristics (Quigley, Blair and Davison, 2018). There is no consensus yet regarding urban resilience definition (Meerow, Newell and Stults, 2016), although most of the dedicated research emphasises on adaptability and collective processes, such as those occurring in communities of practice (Wenger, 2010a).

There are currently two strands of literature on community resilience (Berkes and Ross, 2013): one with a social-ecological perspective and one building on psychology of development and mental health. The first strand focuses on the capacity of a system to absorb and adapt to disturbances, by returning to a stable state, equal or different to the pre-disturbance state. It is associated with more analytical concepts and is well adapted to describe communities closely interacting with their environment. The second strand highlights the ability of a community to deal with uncertainty through agency and self-organisation around a shared objective. This perspective offers more applicability, especially when such interactions do not involve resource dependence.

Both place-based communities (e.g. vegetable gardens) and spread-out communities sharing resource ties (e.g. lake for fishing) can develop resilience (Berkes and Ross, 2013). Important drivers are: people-place connections; values and beliefs; knowledge, skills and learning; social networks; engaged governance (involving collaborative institutions); a diverse and innovative economy; community infrastructure; leadership; and a positive vision towards change. Recent research has provided many examples of specific resilience towards natural disasters risk reduction, and less on generalised resilience. SES research tends to focus more on the functionality of an institutional system and determining ecological outcomes (depletion or conservation of resources), and less on socio-cultural issues (Cote and Nightingale, 2012). The proposed UCCR framework revolves around generalised resilience of urban communities, and is an attempt to shift the focus from the "functionalism" of earlier SES approaches in which resilience appears as a possible measure of ecological performance to the consideration of insights from the social sciences on agency, power and knowledge.

As we detailed in chapter 5, the urban commons can represent a fertile ground for urban community resilience, as their shared resources management requires some of the resilience drivers mentioned above: people-place connection through conviviality, beliefs and motivations, a governance system with institutions, co-production of goods (tangible or not) and a community infrastructure (network, platform and physical amenities) (Berkes and Ross, 2013).

## 7.2 Methods

To build the UCCR framework, we take inspiration from Ostrom's Socio-Ecological System (SES) framework (Figure 7.1). The SES framework allows to assess the sustainability of the governance of common-pool resources, including in urban system (McGinnis and Ostrom, 2014; Nagendra and Ostrom, 2014). Similarly, we aim to assess community resilience with the UCCR framework.

We build the framework based on the knowledge extracted from our comprehensive literature review of the urban commons (Chapter 3) and the outcomes of an agent-based model of the institutional dynamics triggering community engagement in urban community gardens, an example of urban commons (Chapter 4. The framework will then be used to analyse an example of cooperative in Amsterdam 5 to test its applicability. All three chapters correspond to published articles.

### 7.2.1 Urban commons review

The purpose of our literature review (Chapter 3) was to provide evidence of the diversity and characteristics of the urban commons. Taking an assemblage approach allowed us to browse through the multiple fields which talk about the urban commons. We proposed a map of the urban commons, based on Hess's work on the new commons (Hess, 2008), to showcase the diversity present in the literature over the last decades.

We also showed from multiple examples that ownership is less an issue than the specification of adequate property-rights regimes (Davy, 2014; Schlager and Ostrom, 1992). Urban commons may be public or private, but how they are being managed matters more.

We classified urban commons characteristics as benefits, challenges and supports, each across the three following dimensions: ecosystem, socio-economic and institutional. These dimensions are often used to evaluate adaptive and collaborative resource management systems (Conley and Moote, 2003; Plummer and Armitage, 2007). This structure becomes relevant when building the UCCR framework, and we explain how in section 7.3.

### 7.2.2 Community engagement dynamics: an agent-based model

Agent-based modelling (ABM) is an effective approach to study the emergence of institutions regarding the management of the commons (Ghorbani and Bravo, 2016). Such models allow to study the long-term evolution of social and institutional structures (Fishbein and Ajzen, 2011). We use this characteristic to model the social interactions of urban communities in community gardens in varying institutional arrangements. The details about the model, which we briefly introduce in this subsection, can be found in the original publication (Feinberg et al., 2021), split between Chapter 4 and Appendix A.

We build our model with the overall structure of the IAD framework (Ostrom, Gardner and Walker, 1994): external variables (Biophysical conditions, Attributes of Community and Rules-in-Use) determine the Action situations taken by the members of a system; the resulting Interactions and their Outcomes are evaluated to update the external variables and the actions taken. The Biophysical Conditions and Attributes of the community boxes are based on our case-study in Rotterdam (Netherlands). The Rules-in-Use box reflects its institutions.

We operate our model thanks to the gathering of theoretical information from literature on robust collective action and behavioural dynamics. We calibrated it

using a database of 123 cases of urban community gardens in Germany (Rogge, Theesfeld and Strassner, 2018; Rogge, 2020). Our agents are the community members participating in the urban garden on the principle of voluntarism. We codify the institutions by adapting Ostrom's Design Principles, which help characterise the robust management of common-pool resources [12]. The behavioural analysis takes its foundations in the Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 2011). For each agent, taking action is evaluated with the formalisation of behaviour dynamics, as defined in the TRA: a resulting behaviour depends both on attitudes and subjective norms. In brief, these respectively correspond to individual and collective beliefs, or motivations to participate in such collective action. We identified the main motivations for volunteering from literature and the database of urban gardens, labelled them and gave a related belief strength value and a belief evaluation value to each agent. The first, fixed, represents a weight of the beliefs's importance with respect to the other beliefs. The second is updated at every round according to how the agent's past experience in the cooperative matches its initial belief. A weighted sum of the beliefs provides the agent's intention to participate.

From our Rotterdam case-study, we identified three possible action situations: volunteering, taking a product and violating a rule, the first action being a prerequisite to the last two. The agent's behaviour (Action Situations box) is affected by the Rules-in-Use, subjective norms, the evaluation of previous Interactions and their related Outcomes. Volunteering requires the agent's intention to be higher than a given threshold. The model narrative below (Figure 2) represents the behavioural dynamics explained above.

Simulations are run with varying ranges for the adapted Design Principles (institutions) and for certain key parameters, such as the intention threshold, and the weight of individual versus collective beliefs. From the simulations' outputs, we measure the duration of the community participation (robustness), perceived levels of trust, social cohesion, the belief for the availability of garden yield and the belief for possible excessive volunteer work.. Trust can be defined as the "subjective expectation an agent has about another's future behavior based on a number of former encounters between them" (Mui, 2002, p. 75). Similarly to the notion of cohesiveness (Gross and Martin, 1952), we defined social cohesion as the extent to which the cooperative volunteers bond and offer mutual help to each other. Assessing trust and social cohesion gives us an estimation of the community's social capital, which reflects adaptability and in turn community resilience in our model (Quigley, Blair and Davison, 2018; Adger et al., 2004; Folke et al., 2005; Rusch, 2010).

Our output time-series indicated a strong dependence of the agents' trust on certain design principles: the probability of sanctioning increases the duration of the community participation, interpersonal trust and social cohesion in the community. Similarly, poorly implemented collective-choice arrangements, meaning a higher chance of rule violation in our model, negatively impact trust. The community participation lasted longer when volunteers placed more importance on collective outcomes (group trust) than on individual beliefs, such as taking yield from the garden.

The additional use of conditional inference trees put in evidence the influence of the combinations of design principles on a long-lasting and trustful community par-

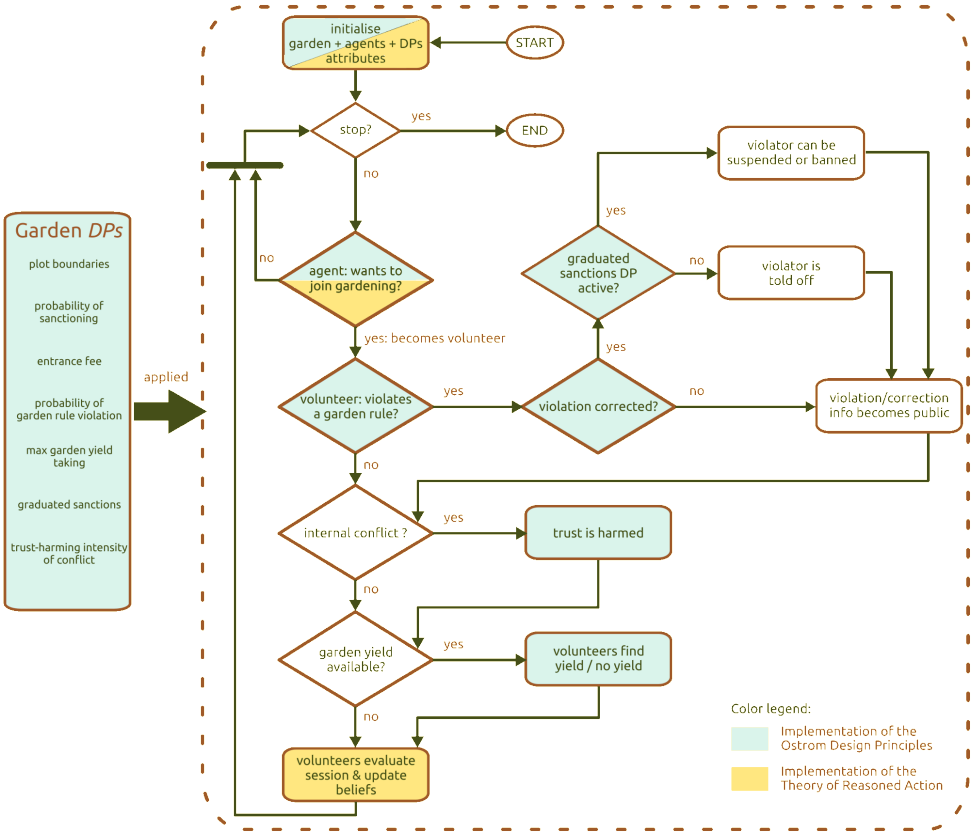


Figure 7.2 – Narrative of the urban community gardens agent-based model (Feinberg et al., 2021)

ticipation, rather than the sum of individual design principles. This result confirms earlier work which identified context-specific combinations of design principles leading to greater success (Baggio et al., 2016). Several combinations associated with low robustness had a high probability of sanctioning, suggesting uncertain effects of punitive measures on collective action. This confirms recent studies on archival records of European commons which highlighted a negative correlation between punitive measures and the longevity of the commons (Moor et al., 2016; Boyd et al., 2018). We also observed that the system is vulnerable when conflict-resolution mechanisms are poorly implemented: conflicts cause more harm and collective action is more likely to collapse. In our historic replay of the Rotterdam case study, the collective action indeed collapsed for this very reason: a conflict emerged, could not be dealt with efficiently causing the amount of volunteers to quickly decrease.

All the model results are confirmed with the urban community gardens database (Rogge and Theesfeld, 2018), including serious doubt on the relationship between sanctioning and higher trust.

## 7.3 A framework for urban commons community resilience (UCCR)

In this section, we present the structure and content of the UCCR framework. This framework is the result of an in-depth literature review on the Urban Commons, and of an analysis through agent-based modelling of its institutional, as summarised in the previous section, and behavioural dynamics (Feinberg et al., 2021) and its potential for urban community resilience (Feinberg, Ghorbani and Herder, 2020).

### 7.3.1 Coverage of the UCCR framework

The UCCR framework (Figure 7.3) borrows several first-tier variables from the SES framework. It includes the socio-ecological context: Social, economic, and political settings (S) and Related Ecosystems (ECO) variables. In the urban commons system, we also keep the SES Governance System (GS) variables. Actors (A) having a broader meaning than what we need, we restrict it in our framework to Community. Actors external to the community may intervene instead in (S). Finally, since the urban commons contain both subtractive and non subtractive resources, it is not relevant any more to separate Resource System and Resource Units (RS and RU) variables. Instead, we merge these into an Urban Commons category. Our framework's outcome of interest is urban community resilience (top of the pyramid-shaped framework). The diagnosis of the community resilience therefore depends on the interactions of the variables above: community, urban commons and governance system.

A Community of urban dwellers gathers around a mutual goal of using and managing an Urban Commons. Multiple motivations explain this, for example livelihood, socialising, education, health, spirituality or democracy. The Urban Commons provide tangible and intangible resources to the Community, in exchange of which the resources are sustained by the Community. To do so, the Community

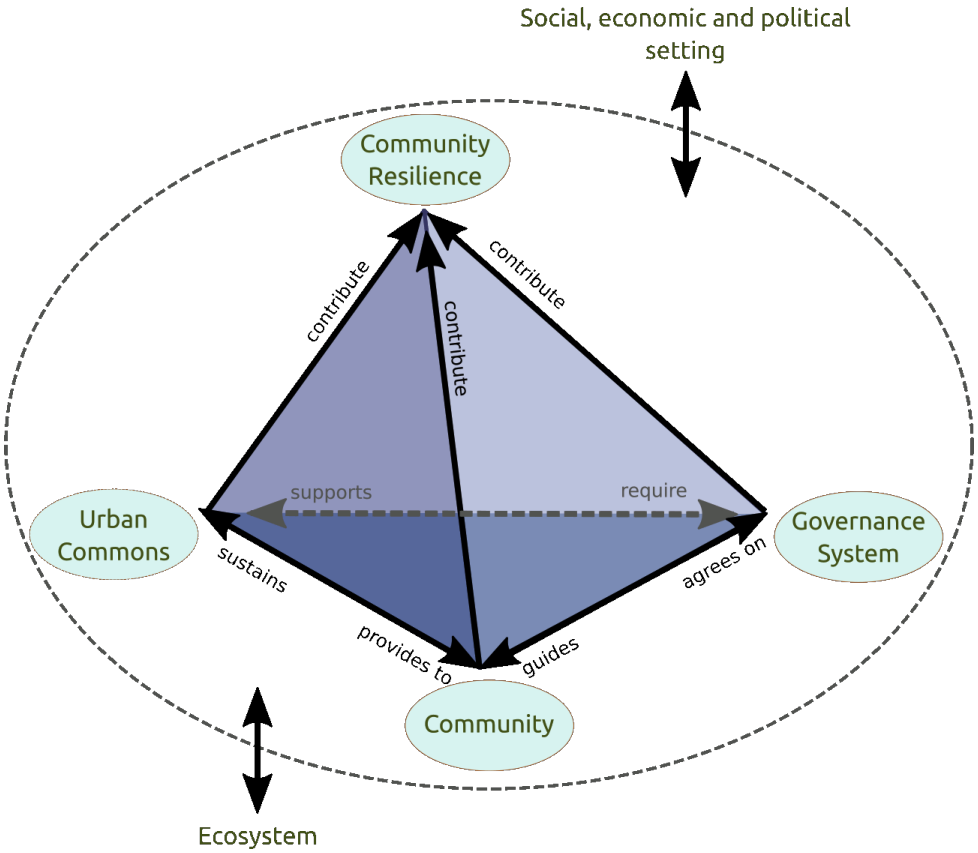


Figure 7.3 – Pyramid of the Urban Commons Community Resilience (UCCR) framework

| First tier | Second tier |
|---|---|
| Community (C) | C1 - number of actors<br>C2 - initial beliefs<br>C3 - memory of past interactions<br>C4 - social capital (trust, social cohesion)<br>C5 - co-produced knowledge<br>C6 - group expression (collective identity, empowerment)<br>C7 - socio-cultural background<br>C8 - communication tools |
| Urban Commons (UC) | UC1 - type of commons (cultural, infrastructure, knowledge, medical/health, neighbourhood, markets, traditional, global)<br>UC2 - system boundaries<br>UC3 - number of tasks (RS5)<br>UC4 - human-constructed facilities (RS4)<br>UC5 - physical products or resources (RU4)<br>UC6 - ecosystem services<br>UC7 – location (RS9) |
| Governance System (GS) | GS1 - governance structure<br>GS2 - operational institutions (e.g. Design Principles)<br>GS3 - external organisations<br>GS4 - property-rights regime |
| Community Resilience (CR) | CR1 - sustained social interaction<br>CR2 - adaptability |
| Ecosystem (E) | E1 - climate patterns<br>E2 - pollution patterns<br>E3 - urban biodiversity |
| Social, Economic and Political Setting (S) | S1 - urbanisation (demography, land use)<br>S2 - cultural values<br>S3 - social norms<br>S4 - education<br>S5 - welfare state<br>S6 - political context (e.g. neoliberalism)<br>S7 - knowledge (media, expert-based, empirical) |

Table 7.1 – First and Second tier variables of the Urban Commons Community Resilience (UCCR) framework

agrees on a Governance System with a governance structure (GS1), certain institutions (GS2), external organisations (GS3), and a property-rights regime (GS4). By guiding the Community in its goal to sustain the Urban Commons, the Governance System indirectly supports the Urban Commons. Thanks to their interconnection, the Community, the Urban Commons and the Governance System all can contribute to urban community resilience. We describe in detail the content of UCCR framework in the next subsection.

| UCCR first-tier variables | UCCR second-tier variables | UC literature review contribution |
|---|---|---|
| UC provide to Community | | socioeconomic and economic benefits (summarised from Table 3.1) |
| Community + Governance System sustain the UC | variables C2 to C8 except C6 (see below its link to resilience) | multi-actor cooperation, direct/indirect institutional support, civic consciousness, media communication, expert and peer knowledge (Table 3.1); socio-cultural background variables (section 3.4.4) |
| Community and Community Resilience | C6 and C5 | empowerment and collective identity effects on resilience; knowledge, though less clearly, through the multiple actors/experts interacting and thus contributing to adaptive capacity |
| UC requires Governance System | | institutional challenges, social tensions, pollution and land scarcity, multi-actor cooperation, institutional support (Table 3.1); enabling subsidiarity |

Table 7.2 – Elements of the UCCR framework rooted in the UC literature review (chapter 3)

### 7.3.2 UCCR framework variables

Table 7.1 lists the variables of the UCCR framework affecting urban community resilience, in a similar structure as for the SES framework. Indeed, several second-tier variables from the SES framework match the findings of chapters 3 to 6. We clarify the contribution of our urban commons review (chapter 3) to the UCCR framework in table 7.2.

In chapter 4, we represented volunteer participation in a case of Urban Commons (UC). This requires defining the type of commons (SES-RS1), the system boundaries (SES-RS2), the number of tasks, or productivity of the system (SES-RS5), the amenities (SES-RS4), the socio-economic value of its resources (SES-RU4) and the location (SES-RS9). Volunteers belong to a Community which in our model has the following attributes: number of participants (SES-A1), initial beliefs (SES-A7), cultural values (SES-A2), social norms and social capital (SES-A6), and the memory of past interactions (SES-A3). Finally, the community members' actions are guided by operational rules (SES-GS5 to 8) in a specific institutional context, comprising possible external organisations (SES-GS3 and 2), a network structure (SES-GS3) and a property-rights system (SES-GS4). The outcomes of the community's interactions are coded in terms of sustained social interaction and adaptability (SES-O1 and 2), based on social capital emergence (SES-A6). We evaluate these in Section 7.4.

The UCCR framework's first- and second-tier variables are therefore adapted from the original SES framework's labelling. In the following paragraphs, we further

detail our framework and, when relevant, refer in brackets to our new labelling (Table 7.1).

The socio-economic and ecological context (variables S and E) generally have a supporting role, and have to do with the physical location (UC7). Urbanisation (S1), (weak) welfare state (S5) and (neoliberal) political context (S6), may be thought of as threats, while they actually become opportunities to reinforce or reproduce the urban commons, to provide the "missing" resulting of economic crises (Di Feliciantonio, 2017a; Huron, 2015), housing crises (Aernouts and Ryckewaert, 2017; Bunce, 2016)or the welfare state drawback (Camps-Calvet et al., 2015; Petrescu, Petcou and Baibarac, 2016; Susser, 2017a). Collectively caring for the commons empowers local communities (Aernouts and Ryckewaert, 2017; Chatterton, 2016)and helps them build a collective identity (Borch and Kornberger, 2015)(C6). The community's socio-cultural background (C7) can facilitate this empowerment, for example if there is a pre-existing democratic culture (Arora, 2015; Wise, 2013), activism (Huron, 2015; Becker, Naumann and Moss, 2017; Gillespie, 2016; Harvey, 2014; Vrasti and Dayal, 2016), an artistic neighbourhood driving urban regeneration (Vrasti and Dayal, 2016; Frenzel and Beverungen, 2015),a tradition of collective attachment to a place (Derkzen et al., 2017; Di Feliciantonio, 2017b; Safransky, 2017; Mundoli, Manjunatha and Nagendra, 2017; Mundoli, Unnikrishnan and Nagendra, 2017; Colding and Barthel, 2013)or a cultural diversity (Susser, 2017a; Colding and Barthel, 2013).

The urban commons, especially the "urban green commons", further provide significant ecosystem services (UC6) which mitigate the effects of climate patterns (E1), pollution (E2) and the loss of biodiversity (E3): climate regulation exerted by the greenery, positive impact of green spaces on urban biodiversity and the capacity of these spaces to maintain soil fertility and reduce air, water and noise pollution (Camps-Calvet et al., 2015; Mundoli, Unnikrishnan and Nagendra, 2017; Colding and Barthel, 2013; Colding et al., 2013; Shah and Garg, 2017).

Knowledge (S7), from external actors (GS3) or practices (C5), is generally considered as a support of the urban commons. There, it can trigger collective learning through cyclic experimentation, in favour of urban resilience (Petrescu, Petcou and Baibarac, 2016; Elmqvist et al., 2019; Pahl-Wostl, 2009). However, it may be retained by private actors (Becker, Beveridge and Naumann, 2015; Teli et al., 2015; Crichton, Pegler and White, 2012), or culturally externalised for a long time, as in the case of urban food production systems (Tornaghi, 2017). Some knowledge may also be unreliable (Teli et al., 2015), incomplete (Camps-Calvet et al., 2015)or non-accessible because of lacking IT infrastructure (Batliboi et al., 2016). Nevertheless, the booming of communication tools (C8) had a strong effect on the spread of the digital commons (Rao, 2013) and knowledge in general.

Certain amenities of the urban commons (UC4) represent convivial spaces, which can help embrace multiple cultures (S2) and social norms (S3): repeated social interactions (CR1) trigger an accommodation to difference (Corsín Jiménez and Estalella, 2013; Wessendorf, 2014; Wood and Landry, 2008; Hinchliffe and Whatmore, 2006)and social learning (Bendt, Barthel and Colding, 2013). This natural conviviality of the urban commons enables their related communities of practice to overcome "market-driven, unsustainable, unequal and individualised approaches"

(Tornaghi, 2017, p. 797)and experiment re-capacitation. The urban commons thus facilitate civility towards diversity, as a strategy to mediate positive relations and possible tensions (Wessendorf, 2014). Through cooperative behaviour, social learning and inclusion of diversity, they become fertile ground for more adaptive and resilient communities (Resilience Alliance, 2010). Divergence of cultures (Di Feliciantonio, 2017b; Bogadi, 2017), interests and views (D'Souza and Nagendra, 2011; Rao, 2013)is the main cause for emerging conflicts (Huron, 2015; Petrescu, Petcou and Baibarac, 2016; Gilmore, 2017; Unnikrishnan, Manjunatha and Nagendra, 2016). This reinforces the importance of conviviality in community resilience building.

Conflicts and social tensions often weaken the urban commons. They result from exclusion rules originating from the practitioners themselves (Gilmore, 2017; Cooke, Landau-Ward and Rickards, 2019), the local government (Di Feliciantonio, 2017a; Di Feliciantonio, 2017b) or planners (Mundoli, Manjunatha and Nagendra, 2017). Exclusions are enacted to ensure a certain quality or target usage of the commons (Webster, 2007; Williams, 2018). In developing countries, urban land redevelopment tends to favour recreational over livelihood purposes, which benefiting wealthier populations (Nagendra and Ostrom, 2014; Derkzen et al., 2017; Mundoli, Manjunatha and Nagendra, 2017; Shah and Garg, 2017; Unnikrishnan, Manjunatha and Nagendra, 2016; Baviskar, 2011; Mundoli, Manjunatha and Nagendra, 2015). Such mechanisms can be described with property-rights regimes over public or private spaces (GS4), applied for example through internal institutions (GS2) and system boundaries (UC2). The boundaries of the urban commons, somewhat porous, are not always as clearly defined as those from the commons described by Ostrom (Huron, 2017; Zapata and Zapata Campos, 2019), and therefore can be contested (Bresnihan and Byrne, 2015).

The governance structure (GS1) plays a large role in regulating both interactions of the community with external actors (local government, planners or knowledge experts), and interactions within the community. In the first case, the amount of autonomy desired is a serious question: how much support from external actors does the community want without risking forced integration into a political agenda (a phenomenon called co-optation) or forced change of purposes (Cooke, Landau-Ward and Rickards, 2019; Follmann and Viehoff, 2015; Pithouse, 2014). While securing formal recognition is challenging (Lang, 2014; Scharf et al., 2019), external partnerships may in certain cases restrict the freedom and autonomy of the involved community (Bresnihan and Byrne, 2015). Regarding internal interactions, governance schemes vary from staying open and flexible (Corsín Jiménez, 2014), to more rigid institutions (Radywyl and Bigg, 2013; Petrescu, Petcou and Baibarac, 2016; Chatterton, 2016; Arora, 2015; Foster, 2011; Kuymulu, 2013; Parker and Johansson, 2011).

Before being in the position of choosing a governance structure, community members require a collective motivation to participate, which may be absent. The social norms (S3) built by our modern society may be contradicting with the values (S2) required to care for the urban commons: education for example impacts our food behaviour and willingness to join certain food commons (Tornaghi, 2017). The lack of rooting or common norms is often depicted (Gilmore, 2017; Sobol, 2017). It can originate from policies oriented towards only individual incentives (e.g. home-

ownership, median income) without considering collective efficacy (O'Brien, 2012).

To facilitate urban community resilience, communities therefore require certain incentives and institutions which can guarantee long-term participation in the face of conflicts, along with trustful interactions and social cohesion. In the next section, we investigate through agent-based simulations these processes, and propose some indicators of urban commons community resilience.

## 7.4 Applying the UCCR framework

### 7.4.1 An example of urban cooperative

We showcase the usability of our UCCR framework by describing an example of urban commons: the KasKantine urban cooperative in Amsterdam, Netherlands. This case study was chosen for containing not only an urban community garden, but also several other activities: a gift economy through a volunteer-run restaurant, workshops and discussion groups. Interviews with its members informed us on the institutions and individual motivations to participate (see Appendix, chapter B).

Many variables of the UCCR framework appear in the KasKantine case. Not only can we describe a valid urban commons case with the UCCR framework, but we can also build a model to test parts of it, as we develop next.

### 7.4.2 Using the UCCR framework in an agent-based model

We briefly describe here a social simulation method to assess the adaptability of the KasKantine urban commons community, one of the criteria for resilience building (section 7.1). The details of our model can be found in chapter 5 . The model gives 1) evidence of the interplay of the components of the UCCR framework and 2) a quantitative evaluation of urban commons community resilience through the notion of adaptability.

We measure adaptability with the amount of perceived trust and social cohesion along the duration of the simulated collective action. The collective action relies on each agent's intention to contribute, similarly to the urban community garden model (see subsection 7.2.2), although with a different set of individual beliefs. The simulation runs as long as there are enough participants: it stops when the number of participants is below 7 for the equivalent of 2 months time (these values are driven by the case study). The total duration of the agents' collective action becomes an indicator for community involvement in collective processes. We define a simulation run as resilient if it lasts more than 2 years (Feinberg, Ghorbani and Herder, 2020). Around 18% of the 200'000 experiments performed in Netlogo match this criteria. The rest of the analysis focuses on these resilient runs.

In all resilient experiments, trust and social cohesion are emerging: cohesion grows constantly following a saturation curve, while trust fluctuates with rule violations and yearly conflicts. The effects of conflicts visibly dampen over time: the quick decrease of trust following a conflict decreases in amplitude over time, in parallel to the growing number of encounters evaluated positively. In addition, trust grows back after each conflict (Figure 7.4). Agents indeed evaluate trust based on

| First tier | Second tier |
|---|---|
| Community (C) | C1 - number of actors: 3 initiators, 25 regular volunteers<br>C2 - initial beliefs: social development, education, tasks, sustainability, space, product, social interaction, work conditions<br>C3 - memory of past interactions: counting positive encounters<br>C4 - social capital (trust, social cohesion)<br>C5 - co-produced knowledge: blueprints of certain infrastructures<br>C6 - group expression (collective identity, empowerment): implementing urban autonomy<br>C7 - socio-cultural background: local inhabitants, young professionals, international students<br>C8 - communication tools: Whatsapp group, shared files |
| Urban Commons (UC) | UC1 - type of commons: cultural, neighbourhood, markets, traditional<br>UC2 - system boundaries: defined land parcel, unfenced<br>UC3 - number of tasks (RS5): 5<br>UC4 - human-constructed facilities (RS4): modular architecture from recycled or upcycled origin<br>UC5 - physical products or resources (RU4): garden yield, education (workshops, talk sessions)<br>UC6 - ecosystem services: biodiversity, soil fertility, de-pollution, climate mitigation<br>UC7 – location (RS9): defined (but not permanent) |
| Governance System (GS) | GS1 - governance structure: 3 initiators (one of which manages the volunteers)<br>GS2 - operational institutions: mostly informal<br>GS3 - external organisations: municipality of Amsterdam<br>GS4 - property-rights regime: mostly open access |
| Community Resilience (CR) | CR1 - sustained social interaction: cooperative still running after 9 years<br>CR2 - adaptability: has moved locations over time, developed a partnership with the municipal government regarding land access |
| Ecosystem (E) | E1 - climate patterns: not evaluated<br>E2 - pollution patterns: waste water filtrated on-spot<br>E3 - urban biodiversity: improved, not quantified |
| Social, Economic and Political Setting (S) | S1 - urbanisation: dense habitat, expensive land<br>S2 - cultural values: not evaluated<br>S3 - social norms: not evaluated<br>S4 - education: several universities nearby<br>S5 - welfare state: not evaluated<br>S6 - political context: neoliberalism, green-left municipality<br>S7 - knowledge: media, expert-based, empirical |

Table 7.3 – UCCR framework applied to the KasKantine case

the history of past encounters. The longer the simulation, the higher the number of favourable encounters experienced. This hardens their perception of trust against new rule violations and conflicts.

A higher importance placed on the group interest (*SocialNorm*) is associated with highly cohesive groups and long-lasting community engagement, but slightly lower

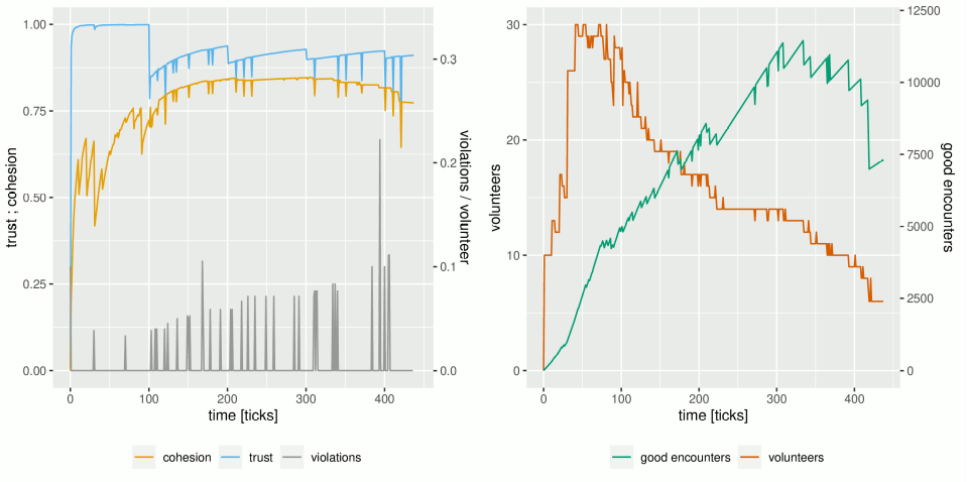


Figure 7.4 – Evolution of trust and cohesion, for a typical resilient run (duration of 426 ticks in this example)

levels of perceived trust (averaged over the total experiment duration). Longer experiments encounter more conflicts, each of those lowering temporarily trust, which affects its final averaged value.

Maximal group size appeared in our model as a significant secondary indicator of community resilience. Smaller group sizes are associated with higher trust and social cohesion, although larger groups tend to last longer. Recent research has been drawing attention on the higher success potential of smaller-sized urban communities (Nagendra and Ostrom, 2014; Rogge, Theesfeld and Strassner, 2018), although lower group sizes mean less available workforce (time and financial resources) for effective mobilisation (Poteete and Ostrom, 2004).

Our model enabled us to validate hypotheses which originate from desk research on community resilience and adaptability. These hypotheses are summarised in Figure 7.5.

From this diagram, we put in evidence in our model three main indicators of community resilience: perceived trust, social cohesion and involvement (collective action duration). Mutual assistance is another indicator for adaptability: it facilitates acting collectively in a trustful atmosphere (Adger et al., 2004). However, in our model, simulating such one-to-one interactions would have been too detailed.

In the KasKantine model, we showed that trust and social cohesion emerge from the social interactions, even in the case of rule violations and occasional conflicts. Trust is seen more as a product of social interactions than a precondition ; this could be observed on-site and in multiple cases of urban community gardening in Germany (Rogge, Theesfeld and Strassner, 2018). Engagement duration is in our example a less straightforward indicator of community resilience, because of its association with larger group sizes and potentially lower trust and cohesion. In this example, we have not experimented with diverse institutional arrangements, unlike in the agent-based model described before introducing our framework. Only a maximal group size and

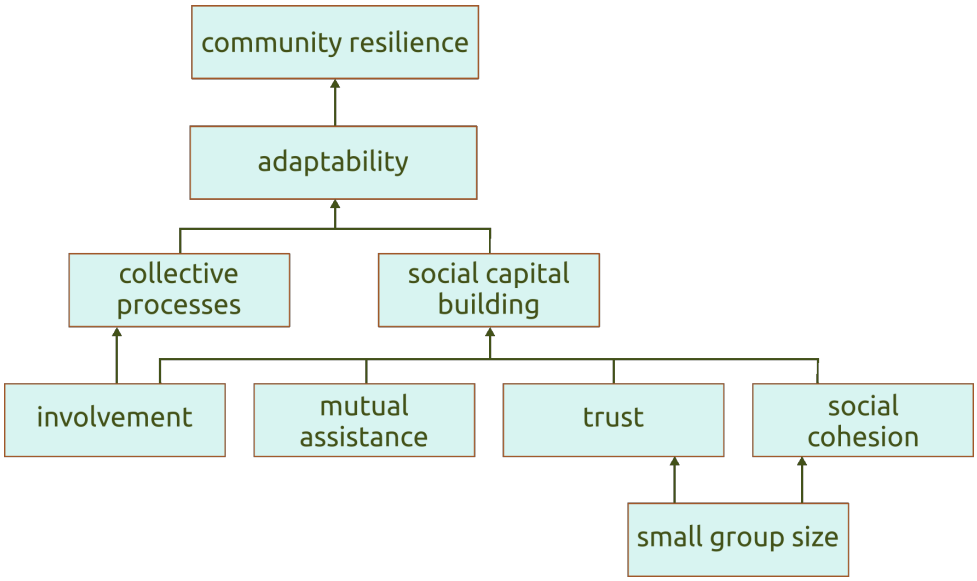


Figure 7.5 – Indicators of urban community resilience ; mutual assistance was not modelled

conflict-resolution mechanisms (implemented as *ConflictHarm*, which appears in the trust calculation formula) have been experimented upon.

This model has highlighted the role of several second-tier variables of the UCCR framework, as presented in Table 7.3:

- Community: group size (C1), initial beliefs (C2), memory of past interactions (C3) and social capital (C4) directly affect our measurement of community resilience;
- Urban Commons: diverse types of commons (UC1), contributing to several ecosystem services (UC6) through the co-production of resources (UC4), provide various reasons to participate to different tasks (UC3);
- Governance System: the governance structure (GS1), notably consisting of three initiators, contribute to sustain a minimal number of participants when not enough volunteers show up ; in addition, operational institutions (GS2) such as a group size limit and conflict-resolution mechanisms directly affect our measurement of community resilience;
- Community Resilience: we measured it through sustained social interaction (CR1) and adaptability (CR2) via the variables of interpersonal trust and social cohesion;
- Ecosystem: improving urban biodiversity (E3) has been mentioned to us as a motivation to contribute;
- Social, Economic and Political Setting: urbanisation (S1), driving the costs of real estate in Amsterdam, motivate several participants to invest in the

cooperative to access space (e.g. refurbishing recycled shipping containers for own economical activity)

Other variables, not tested in our model although potentially affecting community resilience in the case study, are indicated in Table 7.3. This example has well illustrated the dynamics of the UCCR framework by linking most of its variables and assessing the effect of these links on the community resilience.

## 7.5 UCCR framework evaluation

For interpretive research (Kihn and Ihantola, 2015), such as our construction of the UCCR framework, Ryan, Scapens and Theobald, 2002 isolated the following most used evaluation criteria: transferability, contextual validity and procedural reliability. This brings us to question our UCCR framework respectively along the three following axes: can it be theoretically applied to other systems than the urban commons cooperative? Does it make sense? Are the research methods used to build it reliable?

### 7.5.1 Transferability

We have built the UCCR framework based on Ostrom's Social-Ecological Systems framework (McGinnis and Ostrom, 2014) by adapting its first- and second-tier variables to the reality of the urban commons. Instead of looking at all possible interactions and outcomes (I, O), we focused on the interactions leading to resilient communities. The linkages between the UCCR first-tier variables directly derive from the SES framework, and are further grounded, where necessary, by those of the Theory of Reasoned Action (TRA) and the Institutional Analysis and Development (IAD) framework. As far as community resilience is concerned, we anticipate a high transferability of the UCCR framework to the analysis of other urban commons.

### 7.5.2 Contextual validity

We have illustrated the UCCR framework with the urban commons cooperative of KasKantine, which we have modelled with agent-based simulations which explore UCCR framework's variables and linkages (Feinberg, Ghorbani and Herder, 2020). We notably demonstrated the contribution of the Community to Community Resilience, via interpersonal trust and social cohesion, guided by a specific Governance System. From literature, we also put in evidence the contribution of the Urban Commons to Community Resilience, notably via convivial facilities (UC4). We further explored the Governance System, in particular its operational institutions (GS4) with another agent-based model focusing on urban community gardens (Feinberg et al., 2021). The modelled dynamics reflected well the reality observed in a database of 123 cases in Germany, with operational institutions (GS4) derived from Ostrom's Design Principles. We could test the effects of multiple institutional arrangements on volunteer involvement, one dimension of community resilience (Figure 7.5). This

further validate the contribution of the Governance System to Community Resilience, and the interdependence of the Community with its Governance System.

### 7.5.3 Procedural reliability

We secured this criteria by performing a thorough literature review of the urban commons characteristics (Feinberg, Ghorbani and Herder, 2021), and two subsequent research items showcasing the different linkages of the UCCR framework through ABM simulations and validation with case-studies (Feinberg et al., 2021; Feinberg, Ghorbani and Herder, 2020).

## 7.6 Conclusion

The UCCR framework owes much of its structure to Ostrom's SES framework, and represents most of the processes, as found in recent literature, which can lead to urban commons community resilience. Its generalisability, validity, and reliability are first justified by the fact that it is an urban commons specific version of the SES framework which is concerned with resilient community outcomes. All the UCCR variables were accounted for in literature, and we have detailed additional evidence for its intra-system processes via agent-based model simulations, conceptualised with the Institutional Analysis and Development framework and the Theory of Reasoned Action. We have applied the UCCR framework to a cooperative example in Amsterdam, and expect it to help analyse further examples of urban commons. Communities engage in the urban commons for various individual beliefs and social norms. The interactions of their members are regulated by institutions, such as a maximal group size or conflict-resolution mechanisms. These institutions are part of a governance system, which defines the community relationship with external actors: this may help getting access over certain urban parcels, or gain relevant expert knowledge.

The three first-tier variables of the UCCR framework, Community, Urban Commons and Governance system, contribute to urban Community Resilience. The urban commons represent places of conviviality where repeated encounters and social learning can happen. They provide goods, tangible or not, which can help communities in mitigating the effects of environmental and socio-economic crises. Through collective engagement in the urban commons, communities nurture trust and social cohesion, two indicators of adaptability. This engagement is regulated by a governance system, which helps ensuring its realisation, for example by securing access to land and defining institutions towards an effective and durable management of the community and its common resources.

# 8

# Discussion and Conclusion

## 8.1 Traits of the urban commons and governance challenges

In the next paragraphs, I reformulate the outcomes of this thesis in such a way to lay down the foundations of community resilience through the urban commons. This answers the first research question, with arguments not bound geographically.

### 8.1.1 Diverse urban commons for multiple purposes

The urban commons can take multiple forms in cities, which is reflected notably through the very diverse disciplines describing them: humanities, natural and social sciences, public administration or engineering. In an extensive literature review (chapter 3), we have mapped the urban commons diversity across the existing new commons types (Hess, 2008): cultural commons, knowledge commons, markets as commons, global commons, traditional commons, infrastructure commons, neighbourhood commons, medical and health commons. In addition to this plurality, the urban commons is strongly context-dependent: geographical attributes, local or national institutions, socio-economic background or angle of analysis (e.g. Smart Cities, contestation movements, alternative lifestyles or livelihood). Urban inhabitants have therefore multiple occasions to engage in the urban commons, in their close geographical surrounding.

Engaging in the urban commons is further fuelled by the direct benefits which it provides to its commoners, and by the alternative model of society it usually carries. Both reasons can drive community resilience. The urban commons provides urban ecosystem services such as biodiversity protection, soil fertility, de-pollution

and climate mitigation. In addition, it potentially reinforces the socio-economic environment of its communities in the face of crises: livelihood support, value co-creation, recreation and health, a sense of collective identity and empowerment. An alternative way of living is recurrently sought through the urban commons, as a reaction to neo-liberal threats. Privatisations, resource enclosures, urbanisation, authoritarian regimes, weak welfare state: all these factors drive people to engage into commoning and claim the rights and freedom which are threatened. The neo-liberal critique gives the urban commons a "reason-to-be" which Common-Pool Resources (CPR) did not particularly have. The urban commons represents convivial places, physical or digital, where strangers have the opportunity to meet and work around common goals. The KasKantine cooperative in Amsterdam (Netherlands) illustrates this perfectly. This enables their related communities to overcome "market-driven, unsustainable, unequal and individualised approaches" (Tornaghi 2017),experiment community empowerment through the application or claim of civic rights and regain capacity.

### 8.1.2 Unclear boundaries of the urban commons

The urban commons can occur either on public or private land. What makes an urban commons a commons has to do with the property-regimes and access rules. In chapter 3, we presented the property rights bundles (Schlager and Ostrom, 1992), which are commonly mentioned when describing accessibility to the commons. These bundles spread the possible rights (access, withdrawal, management exclusion, alienation) across diverse roles (owner, proprietor, claimant, authorised user, authorised entrant). Who owns the commons does not matter as much as the manner in which the access to a given space is regulated by its users, through institutions. It is the commoners' criteria of exclusion and inclusion which condition the openness of a given commons (Noterman, 2016). At the same time, in practice, the urban commons has unclear boundaries in cities (Zapata and Zapata Campos, 2019). As Huron, 2017, p. 1065 says, "[m]aybe this is what is urban about the urban commons: this attention to the needs of as-yet-unknown members, and a willingness to keep boundaries somewhat porous". This transcribes into a recognised openness of the urban commons to newcomers, which echoes well the discourses on city re-appropriation, a legacy of Henri Lefebvre's "right to the city" (Lefebvre, 1968).

In the urban commons literature review (chapter 3), I also faced this issue of unclear boundaries when gathering a corpus of existing literature. Although we used broadened our search on the urban commons using terms like"urban green commons", "urban ecological commons", "cultural commons" and "digital commons", we may have neglected contributions for example from the ecological and environmental fields. There, urban commons may be described under the term "urban ecosystem services". To avoid a bias consisting in selecting what is and what is not a commons, we preferred to restrict the review to papers selected with expressions containing the word *commons*. Further research is needed to clarify the contributions from other fields, but this needs to be done by stating clearly what one means with the word *commons*.

### 8.1.3 Setting-up the urban commons

Communities get involved in the urban commons through the action of commoning; this term describes the dynamics by which spaces and resources become urban commons (Bruun, 2015; Harvey, 2014). In this context, space is a process of relations which relies on patterns of coordination and interaction, and supposes a form of commonality in which solidarity is a creative force (Stavrides, 2017). This commonality relies on a collectively accepted governance system, with its structure, actors and shared rules.

Such a system is facilitated by a favourable socio-cultural background, such as a democratic culture, a sensitivity towards urban justice themes, shared norms (such as well-being concerns), social links and proximity. The diversity in community members, expressed for example through an explicit anti racial-focused or immigrant-opposed discourse, provides a fertile ground to commoning by providing more learning capacity and adaptation in groups. In addition, communities caring for the urban commons benefit from the use of various communication tools: conventional media and digital technologies. Communities thus raise awareness on the commons in the population, and can self-organise more efficiently. Expert and peer knowledge play an essential role in commoning, and we are getting back to this point in section 8.3.

Such communities may receive direct or indirect institutional support from their respective municipality, local government or social organisations. In many cases, the multiplicity of actors involved in the urban commons, for example through partnerships and decentralised governance systems, is a driver of adaptability .

When shaping the urban commons, communities indeed face certain challenges. The most visible ones are the externalities due to uncontrolled urbanisation, which causes land scarcity and pollution. Parts of the communities' struggles relate to the level of support they need from public authorities: how much autonomy and for what accountability? With public support, they run the risk either to see their goals redirected, or not to receive the same support as perhaps less radical urban projects (Giannini and Pirone, 2019; Bianchi, 2018). Other challenges are due to the governance structure: either too rigid or too open. On the one hand, rigidity slows down adaptability, and on the other hand the urban commons may shift from their initially intended purpose. Last, but not least, communities face internal social tensions, contradicting values and norms coming from our modern society (e.g. policies oriented towards only individual incentives, such as home-ownership or median income, without considering collective efficacy (O'Brien, 2012)). I detail some of these tensions in the next section, and how they can be solved.

In this subsection, I have identified a high potential of the urban commons to channel community resilience through the lens of adaptability. Their diverse forms can satisfy many communities, in different geographical and social contexts. In addition, through their porous boundaries, they are open to newcomers, although their functioning may require certain restrictions of use. Through the natural conviviality of the urban commons, communities have the opportunity to experiment processes of collective decision-making, cooperative behaviour and planning, collective learning, and governance as a political process involving society at large, which can help

Table 8.1 – Characteristics and challenges in the urban commons governance (Chapter 3)

| | BENEFITS | CHALLENGES | SUPPORTS |
|---|---|---|---|
| **institutional** | | • governance structure: rigidity, bureaucracy<br>• autonomous governance<br>• land availability and access<br>• group size and scaling-up | • direct/indirect institutional support<br>• beneficial multi-actor co-operation |
| **socio-economic** | • livelihood<br>• economy: value co-creation and shield to crises<br>• recreation and health<br>• collective identity<br>• empowerment | urban commons as a response to neo-liberal threats<br>• social tensions<br>• conflicting values and norms<br>• financial viability<br>• knowledge quality and mismanagement | • civic consciousness<br>• media communication<br>• expert and peer knowledge provision |
| **ecosystem** | • ecosystem services: biodiversity, soil fertility, de-pollution, climate mitigation | • urbanisation: scarce land and pollution<br>• evolving interactions of urban society with urban greenery | |

guarantee adaptability (Resilience Alliance, 2010). I identified possible obstacles to an urban commons durability, both due to internal conflicts and unfavourable institutional arrangements, some of which are recalled in the next subsection. We summarise below in Table 8.1 from Chapter 3 the main findings of the urban commons literature review.

## 8.2 Behavioural and institutional dynamics in the urban commons

In this subsection, I answer the second research question with bibliographic and case-study analysis, along with the results of agent-based simulations. I have studied multiple real cases of Western European urban commons and proposed a model of the behavioural and institutional dynamics which happen inside (Chapters 4 and 5).

### 8.2.1 Motivations to participate in the urban commons

The urban commons is functional to the individual and collective well-being, and the degradation of such places is generally perceived as a loss. Communities of practice become the caretakers of the urban commons by the gathering of individuals around shared goals. This requires a certain alignment of the individuals with the collective purpose of the urban commons. The motivations to join are very diverse and derive mostly from the lack of welfare state provision (livelihood purpose), well-being purposes and the lack of citizen representation in urban processes (empowerment purpose).

In the case of urban gardening, a well-spread example of urban commons, the individual motivations are multiple: social development, social cohesion, enhancing cultural and spiritual practices, sustainability, consuming fresh food, saving/making

money, improving health, enjoying nature, education, urban land accessibility. The social norms carried by the participants represent a collective drive towards reciprocity and trust. When engaging in such communities, individuals continuously assess the adequation between their set of motivations and what actually occurs in the urban commons: e.g. resources availability and quality of the social interactions. The institutions, on which the urban commons governance system is based, add an additional weight in the decision-making balance "joining or not?", for example regarding conflict-resolution mechanisms.

### 8.2.2 Institutional dynamics: learning from urban community gardens

Institutions are an ensemble of rules, prescriptive or constraining, set by a group of individuals in order to organise repetitive and structured interactions. Urban community gardens operate under more or less explicit institutions. They regulate the access to the garden, the interactions between the gardeners and those between the physical garden and the gardeners. We have tested in our agent-based model (Chapter 4) whether Ostrom's Design Principles for robust collective management of Common-Pool Resources (CPR) can also support long-term engagement in west European urban community gardens. These principles serve as the main institutional structure guiding and limiting the gardeners' community. This model requires a stronger validation than the one proposed in chapter 4.

Our main finding is that the Design Principles do not act in isolation, but that it is rather specific combination of these which explain the long-term engagement of the community, thus confirming other recent research. We have observed that rule violation (e.g. taking too much of the shared crops) tends to lower community engagement, through a lower perceived trust towards the other gardeners, and a weakened individual motivation (e.g. lower incentive to engage because of uncertain crops availability). Sanctioning, taken in the sense of Ostrom, i.e. reducing free-riding and therefore enhancing cooperation, has an ambiguous effect on community engagement: in certain institutional arrangements it may facilitate long-term participation, while in others it may not. This goes in line with recent research on European commons which discards the efficacy of punitive measures in their management (De Moor et al., 2021).

Rethinking the sanctioning hypothesis is an important objective for further research on the commons. This is especially the case with the urban commons, such as the urban community gardens, where individuals are more likely joining for the social dimension than the material dimension. In this sense, such places differentiate from CPRs and may be less affected by free-riding, and instead harmed by the simple formulation of punitive institutions. We measured longer community engagement and higher levels of trust when community members highly align with the group's social norms or collective drive. Repeated interaction with the right context-specific institutional arrangement builds trust by making the gardening community more capable to face conflicts. This highly suggests a form of adaptability of such communities.

### 8.2.3 Urban commons interactions and community resilience

We have investigated in more detail the community's capacity to adapt by exploring the emergence of trust and cohesion in another case of urban commons, a cooperative (Chapter 5). Adaptability is a key requirement in the socio-ecological resilience paradigm. In our study, we estimate the adaptability of the cooperative community through the evolution of trust (proportion of favourable encounters), cohesion (bonding in the group) and community engagement duration, in the presence of disruptions. Trust and social cohesion contribute to the community's social capital.

We have found through agent-based simulations that trust and social cohesion emerge from the social interactions occurring in the cooperative's community. This statement is however diminished by the rather medium-low values of the correlations measured. With hindsight, some dynamics occurring in the model relate to certain modelling choices that were made. For example, trust decreases sharply at each conflict ; conflict frequency is arbitrarily set and does not depend on the current interactions and variables. The rather low negative correlation of trust with the duration of the collective action should be put in perspective with the fact that, between two conflicts, the active community's perception of trust increases. More careful ways of measuring these correlations would better serve the results analysis.

Taking these remarks into consideration, we can say with precaution that cohesion is positively correlated with a higher collective drive to participate, while trust regularly increases due to ongoing interactions within the community. The negative impact of conflicts on the group's perceived trust decreases at each new conflict. We interpret this as a form of progressive group adaptation to disruptions, in the case of maintained engagement. We found group size to contribute unequivocally to community resilience. Smaller groups tend to be associated with higher levels of trust and social cohesion, and don't suffer from the higher transactional costs of getting larger decisional bodies to adopt institutional changes. However, larger groups last longer, as they usually benefit from more resources and cumulated contribution time.

Through our examples of urban community gardens and cooperative, we confirm earlier work that trust is more a product of repeated social interactions than a precondition to them. If individual motivations are important to participate in an urban commons community, mutual interests in commoning sustain social interactions, through which social capital can emerge. The success of such communities relies on their institutional arrangements, for example to deal with group heterogeneity and group size, and do not necessarily require sanctioning bad behaviour. Implicit sanctioning (or group pressure) is perhaps enough to deter violators. The urban commons, especially if kept small, represents convivial spaces, as breeding ground for trustful social interactions, community cohesion and the meaningful exploitation of individual differences. The urban commons therefore has a high potential to trigger adaptability, a precondition for higher community resilience.

Table 8.2 – Frequently-used mechanisms of knowledge co-production and exchange in the urban commons (Chapter 6)

| | OFFLINE | ONLINE |
|---|---|---|
| INTRA-community | Urban place co-creation, Conviviality, Joint events | Digital commons |
| INTER-community | Grassroots networks | Digital commons, Open-source resilience |

## 8.3 The role of knowledge

Among the various urban commons types identified in our bibliographic study (Chapter 3), knowledge peer-production is among the most mentioned ones. While expert-generated or peer-produced knowledge generally acts as support to the commons, multiple studies have emitted concerns regarding the quality, extensiveness and management of this knowledge. In addition, learning driven by commoning may trigger adaptive capacity of the involved communities, but education is sometimes subject to cultural norms, which may retrain the social resilience potential (Grabkowska, 2018; Tornaghi, 2017). We have therefore dedicated Chapter 6 to discuss the role of knowledge production in the urban commons as a possible driver of community resilience.

We can make a parallel between the commoners and the definition of a community of practice (CoP), which further endorses a high potential of such communities to increase their resilience through the urban commons. A CoP appears as a social learning system where members co-produce knowledge (Wenger, 1998). Indeed, CoPs are founded on a shared history of learning, which necessitates forms of knowledge co-production, one possible resilience-building strategy (Folke, Colding and Berkes, 2003). CoPs require a shared enterprise or goal, mutual engagement and the use of common rules and artefacts. The first two points are central properties of long-term functioning urban commons. The last point stresses the importance of common rules, such as the institutions mentioned earlier, but also on common artefacts and more generally knowledge. Like the urban commons, the boundaries of CoPs are usually fluid. CoPs have been described to build resilience in the urban context, in the examples of urban community gardens (Chan, DuBois and Tidball, 2015)and urban forestry through research-practice networks (Campbell, Svendsen and Roman, 2016).

Knowledge co-production is facilitated by convivial spaces, both physical and digital, and intervenes at two levels: within a community and between communities. The community knowledge artefacts should therefore embrace the four dimensions of Table 8.2 below.

Knowledge is first generated and extracted at the community level, before being broadcasted between communities. The first step requires a convivial place, offline or online, which guarantee learning through sustained time spent together, personal relationships and open communication.

The inter-community level of communication is still a challenge for most com-

munities, which often have enough issues to solve internally before putting effort in broadcasting their experience. Such experience could however benefit other communities, such as in the example of Community Land Trusts (CLT), a powerful model of alternative social housing, the expertise of which has spread around the world. Such expertise can spread through grassroots networks, and in some cases require local government support for the implementation. Commoners therefore need to find the right networks of actors to enable effective inter-community communication. This is also a challenge for policy-makers: stimulating bottom-up action requires institutional frameworks and digital infrastructures to facilitate knowledge co-production and sharing. Open source culture and digital commons artefacts (e.g. technological devices, online platforms) are a logical choice for practitioners, who already understand the logic of commoning. However, this requires an understanding from policy-makers in order for them to allow financial means to deploy the right tools and promote cross-sector collaborations, for example with researchers.

In the urban commons, communities can be associated to CoPs, drivers of learning and community resilience. To achieve this, they require relevant online and offline artefacts to co-produce knowledge and communicate it both within and between communities. Knowledge appears as a precious condition for bridging urban commons initiatives, so that they can learn from one another and thus increase their adaptability to socio-economic changes.

## 8.4 Relevance of this thesis

This thesis brought additional perspective on the commons literature, beginning with Elinor Ostrom's theories.

We have confirmed the practicality of using the structure of her Institutional Analysis and Development (IAD) framework to build social simulation models. Furthermore, we have highlighted its versatility by connecting it to the Theory of Reasoned Action (TRA), frequently used to study behaviour. By bridging it with the IAD framework in our two agent-based models, we enabled the agents' intentions to be modulated according to the ongoing conditions. A common critique made to the TRA is indeed its negligence of non-intentional behaviours (Bagozzi, Baumgartner and Yi, 1989; Trafimow, 2015). In our models, certain beliefs are not fixed and depend on the evaluation of past events and experiences. In addition, we could balance the causality intention-behaviour with the introduction of probabilities (e.g. propensity to violate a rule), which derive from locally-set institutions. This is made possible thanks to the IAD framework working side-by-side with the TRA.

It is also the first time that Ostrom's Design Principles have been used to test the robustness of a collective action example in computer simulations. By doing so, we could run sufficient experiments with varying arrangements of design principles to conclude that what matters is the combination of these principles ; in other words, we have showed that the some arrangements lead to more robust results than others, similarly what was found in a case-based recent study (Baggio et al., 2016). This, along with field observations, led us for example to seriously question the role of sanctioning rules, as highlighted by Ostrom's hypotheses ; a reassessment also put

forward in recent research (Moor et al., 2016; Boyd et al., 2018; De Moor et al., 2021).

This thesis also contributes to the relatively neglected resilience discourse at the level of a community. We have proposed a diagram describing the variables affecting adaptability, an important driver of community resilience 5.1.

Another finding in this thesis found direct echo in practice. In Chapter 6, we have brought forward the importance of inter-community communication for more resilience, a challenge for practitioners which are often too busy operating a commons to connect to other similar initiatives. We suggested that policy makers could precisely play this role of facilitating inter-community knowledge exchange. As a matter of fact, I am presently working in a regional administration in France that agreed on a policy lasting at least 4 years which aims to support commons initiatives in rural areas under its jurisdiction. It does so financially, by securing links to relevant public bodies and more importantly, by implementing a network of the existing and future commons initiatives in order to facilitate exchanges of good practices, mutualisation of tools such as a web platform, training sessions, an emergency financial fund, and joint communication towards target audiences and local authorities.

Finally, through their engagement within the urban commons, citizen may learn about practical democracy and the concepts of sustainability and resilience. They may also learn how to deal with differences and how to solve conflicts. These consequences extend beyond the realm of the commons, in private or professional life.

## 8.5 Further research

This thesis and recent work have highlighted the increasing value of the commons precisely from its use, making these less subject to free-riding. How this value emerges, for example through the diversity of members and activities, should be looked into, notably in different cultural contexts.

Conjointly, this thesis strongly suggests to update the sanctioning assumption in the commons literature. To be considered are: the negative perception of sanctioning among such communities of practice, the non-systematic inclination to violate rules (e.g. to mimic other violators), indirect forms of sanctioning through the perception of the other members. An idea relating to this last point is that predefined coordinating procedures, such as contracts (formal or not), can trigger interpersonal commitment in a way to out perform the simple relations of reciprocity which we considered in this thesis. More details on this are given at section 4.7.3. The use of sanctioning may be the symptom of a group struggling to achieve successful collaboration, and not necessarily the solution. In this sense, certain institutions in the commons should be studied further, e.g. access/use regulations, conflict-resolution mechanisms and the proportional equivalence benefits-costs.

In our modelling work, we did not model the processes of social learning. As developed in Chapter 6, these occur at both intra- and inter-community scales. First, it is crucial to better understand the building of a history of learning, which defines a community of practice, such as in the urban commons. In particular, the mechanisms through which digital communication technologies facilitate knowledge

co-production by and for urban communities have not yet been clarified conclusively. The difficulty to engage all potential actors, and the shallowness of this engagement often witnessed because of short messages represent recurrent flaws. In the German urban community gardens, communication occurred mostly offline.

Regarding inter-community dynamics, several studies have pointed to the high potential of the alliances of commoners with public bodies, either for direct support, or to facilitate inter-community learning. These two dynamics could be further described, for example through social simulations in order to qualify the chances of mutual benefit, versus the possibility of co-optation by the local authorities. In addition, ways to increase open-source resilience through knowledge exchange in the commons still need to be found and evaluated in terms of learning potential and community adaptability: what mechanisms should be used and at what cost for the community?

In addition, we need to rethink what commons means in an urban context. This requires more ethnographic accounts. Indeed, certain thinkers defend the idea that the urban commons relies less on physical or digital infrastructure, and more on these "transit spaces created by informal socialising" (e.g. Löfgren, 2015). This new frame requires further investigation, and adapting if needed our models: I doubt that the use of Ostrom's Design Principles, intended initially for the common-pool resources, would still be relevant for such a "volatile" conception of the commons.

Finally, this thesis only modelled the institutional and behavioural dynamics in western-European urban commons. From the literature review presented in chapter 3, we know that most of the urban commons' benefits, challenges and supports on which we constructed our agent-based models are shared across the world. However, local cultural habits can impact collective action differently, as reflected in Ostrom's SES framework, and by extension in our UCCR framework's social, economic and political setting variables. We did not model a case of urban commons where livelihood would be the main motivation, e.g. for food only, or for spiritual practices. Would the intention to participate still rely on past experiences? How important would be the institutional arrangements in such cases? Such questions could be explored with further social simulations and a comprehensive anthropological approach.

# 9
# Epilogue

Urban commons governance can contribute to community resilience by providing adequate institutional arrangements within a well-defined place of conviviality, physical or digital. This place supports trustful social interactions, social cohesion and learning in the contact of strangers, which increase the adaptability of its community. In addition, the multiplicity of existing types of urban commons, independently from land ownership, and their intimate context-dependence ensures to communities world-wide the access to urban commons experimentation. Communities involved in the care of the urban commons still face multiple challenges, due to institutions, the socio-economic context and the evolving urban/nature ecosystem. Solving these challenges requires experimentation through trustful social interactions, and most importantly, communication across communities ; communication across diversity. In the UCCR framework proposed in chapter 7, I present the variables which play a role in resilience bilding via the urban commons.

The idea of urban commons, especially through my example of urban community gardens, may recall Plato's Republic or Thomas More's Utopia (1516):

*" [...] there being no property among them, every man may freely enter into any house whatsoever. At every ten years' end they shift their houses by lots. They cultivate their gardens with great care, so that they have both vines, fruits, herbs, and flowers in them; and all is so well ordered and so finely kept that I never saw gardens anywhere that were both so fruitful and so beautiful as theirs".*

However, as far as the urban commons is concerned, I am inclined to agree with Georges Perec in Think/Classify (1985), for whom:

*"all utopias are depressing because they leave no room for chance, for difference, for the "miscellaneous." Everything has been set in order and order reigns. Behind every utopia there is always some great taxonomic design: a place for each thing and each thing in its place".*

The urban commons stems from experimentation and thrives through chance, difference and "miscellaneous". And this is good news for them, as cities are far from the gentle and fixed-structured Utopia. Rather:

*"The town is the correlate of the road. The town exists only as a function of circulation, and of circuits; it is a remarkable point on the circuits that create it, and which it creates. It is defined by entries and exits; something must enter it and exit from it. It imposes a frequency. It effects a polarization of matter, inert, living or human; it causes the* phylum*, the flow, to pass through specific places, along horizontal lines. It is a phenomenon of* transconsistency*, a network, because it is fundamentally in contact with other towns"* (Deleuze and Guattari, 1980, p. 432-433) (emphasis by original authors).

Funnily enough, this description of the city resonates by analogy with the dynamics of some of its "specific places", namely the urban commons.

# Appendices

# A

# Supplements to the Agent-Based Model study of urban community gardens

## A.1 ODD model description

### A.1.1 Model overview

#### Purpose

The purpose of this agent-based model is to study the evolution of volunteer participation over time in urban community gardens, in different institutional contexts (internal rules).

#### State variables and scales

The model consists of the following concepts:

- Agents - initiators, gardeners and potential gardeners of the community garden. Initiators set up the garden and accept to participate a certain amount of times, regardless of their motivation.
- Individual strategies
  - contributing: the agents decide to participate (as gardener) based on behavioural beliefs (individual level, see Table A.1) and normative beliefs (social pressure, in our case called social norm);
  - taking yield: a gardener chooses an amount of garden yield to take;
  - violating a rule: a gardener can violate a garden rule with a certain probability.

- Institutions - The gardeners are bound to follow institutions, which in our case are coded based on Ostrom's Design Principles (Table A.2).
- Outcomes - Agents expect various forms of gratification from participating in urban community gardens. The outcomes are in line with the motivations explained in Appendix. They are measured, for each experiment, in terms of positive expectation of yield, social cohesion and trust. We also measure the gardening duration, which is defined by the simulation tick at which the collective action stopped.

The model contains several state variables and parameters, either characterizing the agents or the system (Tables A.2, A.3, A.4).

The model runs for a single experimental site over a maximal time of 600 ticks, which corresponds to 6 years.

| **beliefs** | **practical need** | **label** |
|---|---|---|
| Social cohesion/development | Social ties | cohesion |
| Enhancing cultural practices | Interaction | social |
| Consuming fresh food | Yield | yield |
| Saving/making money | Yield | yield |
| Enjoying nature | Time on the garden | enjoyinggarden |
| Enhancing spiritual practices | Time on the garden | enjoyinggarden |
| Environmental sustainability | Contributing to the garden | sustainability |
| Education | New knowledge | education |
| Land accessibility | Ideal of garden being accessible | landavailability |
| Improving health | Time on the garden or yield | yield / enjoyinggarden |
| Uncomfortable conditions (negative) | Bad weather or bad conditions | conditions |
| Too much work (negative) | Too many tasks | toomuchwork |

Table A.1 – Individual beliefs and their labels

| Design principle | Assigned Institutional variable | Type variable | Description implementation |
|---|---|---|---|
| garden boundaries* | *DPplotboundaries* | true/false | boundaries around gardens influence the probability for yield to be stolen, probabilities are indicated by garden |
| garden boundaries<br>monitoring<br>garden boundaries | *DPprobabilitysanctioning* | floating point $\in [0.1, 0.9]$ | determines the probability that a rule violation is sanctioned |
| garden boundaries | *DPfee* | floating point $\in [0, 0.9]$ | determines the fee to join gardening (0.9 is maximal) |
| collective-choice arrangements | *DPglobalprobabilityruleviolation* | floating point $\in [0.1, 0.9]$ | determines the initial probability of rule violation of a volunteer |
| proportional equivalence benefits/costs | *DPMaxTakingMoreThanShare* | floating point $\in [1, 5]$ | determines the max value of the range from which volunteers randomly choose their desired amount of yield |
| graduated sanctions | *DPgraduatedsanctions* | boolean true/false | determines whether graduated sanctions are active or not |
| conflict-resolution mechanisms | *DPconflictharm* | floating point $\in [0, 100]$ | determines the extent to which a conflict harms trust |

* the potential effect of fences diminishing belief in land availability is not taken into account

Table A.2 – Ostrom Design Principles in the model

| **state variable** | **definition** |
|---|---|
| Lifetime | first moment there is 1 or no volunteer on the garden |
| Trust | sum of *gardeners*' trust after every tick / total visits. Trust is defined as good encounters / total encounters. |
| Cohesion | Sum of *gardeners*' cohesion belief after every tick / total visits. Cohesion is defined by the rate of *gardeners* in the group with whom a *gardener* has a tie. |
| Yield | Sum of *gardeners*' yield belief after every tick / total visits. Yield is evaluated positively if the wished amount of yield is received. |
| Too much work | Sum of *gardeners*' belief for too much work after every tick / total visits. It is evaluated positively if the amount of volunteers is higher than a given threshold. |
| Amount of visits | Total number of times an agent became gardener |
| Amount of good encounters | Total number of encounters perceived as positive |
| Amount of violations | Total number of unsanctioned violations seen |
| Amount of own sanctions | Amount of sanctions an agent received. |
| Total encounters | Amount of encounters an agent has experienced. |

Table A.3 – Overview of the state variables

| parameter | definition |
|---|---|
| Cohesion belief strength | Ratio of gardeners with a high belief strength for cohesion. |
| Conditions belief strength | Ratio of gardeners with a high belief strength for comfortable conditions. |
| Education belief strength | Ratio of gardeners with a high belief strength for education. |
| Enjoying garden belief strength | Ratio of gardeners with a high belief strength for enjoying gardening. |
| Sustainability belief strength | Ratio of gardeners with a high belief strength for environmental sustainability. |
| Land availability belief strength | Ratio of gardeners with a high belief strength for land accessibility. |
| Social belief strength | Ratio of gardeners with a high belief strength for social interaction. |
| Too-Much-Work belief strength | Ratio of gardeners with a high belief strength for too much work. |
| Yield belief strength | Ratio of gardeners with a high belief strength for yield. |
| Contributing Threshold | Threshold above which the intention value is high enough for a *potential gardener* to become *gardener* |
| NoAccessSessions | Amount of sessions an agent cannot join gardening when suspended. |
| MaxAmountTellingOffAfterSuspension | Maximum amount a volunteer is told off after being suspended, before having denied access to the garden permanently. |
| Membershipduration | Amount of gardening sessions a membership lasts. |
| MinAmountOfTellingOff | Minimum amount of times a volunteer is told off before being suspended. |
| MaxAmountOfTellingOff | Maximum amount a volunteer can get told off before being suspended |
| BalanceAttitudeSocialNorm | The weight of the social norm over individual beliefs (see Behavioural Intention formula below). |
| ChanceYieldAvailability | Probability that yield is available on a gardening session. |
| ChanceYieldStolenWhenBoundaries | Probability that yield gets stolen when it is available, when there are boundaries around the garden. |
| VolunteersToFullySee | Number of other gardeners a gardener can see and evaluate |
| AmountOfTasks | Amount of tasks necessary to properly maintain the garden |
| Initiators | Amount of initiators the garden started with. |
| InitiatorCommittedTime | Amount of time initiators commit. |
| Conflict time | Periodic time of conflict. |

Table A.4 – Overview of the parameters

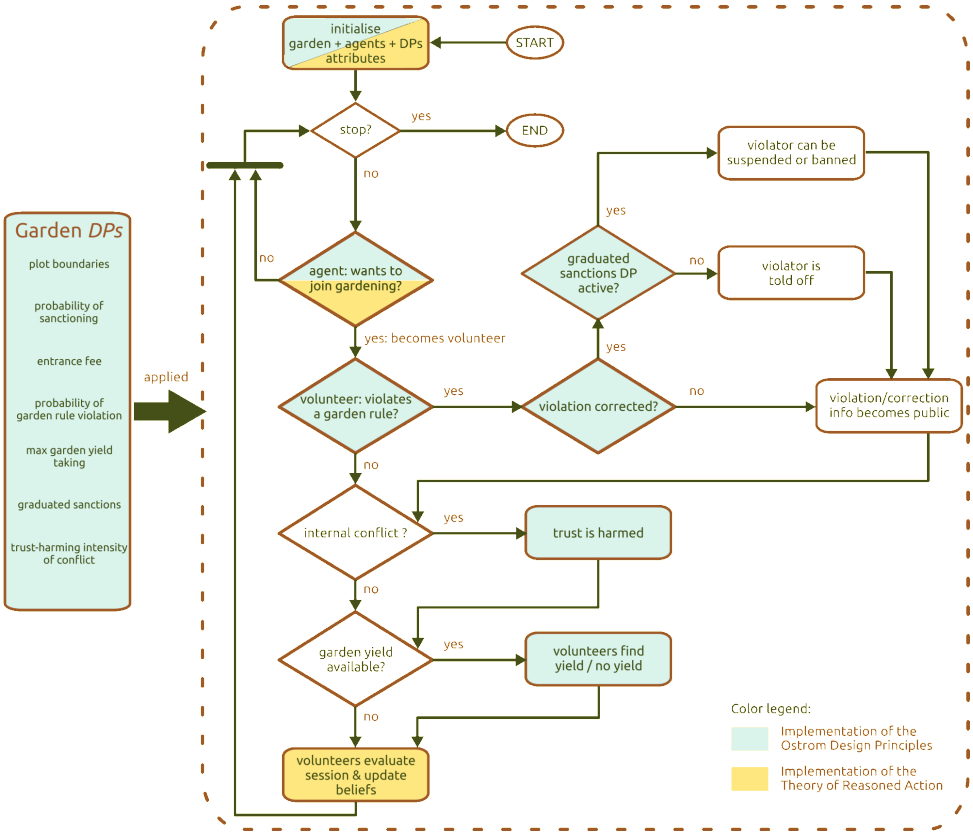


Figure A.1 – Narrative model of the urban gardening case with applied Design Principles(translated into Institutional variables from Table A.2)

### Process Overview and Scheduling

The simulation model consists of two general processes which are depicted in Figure A.1.

1. Agents participate to the gardening when their intention is higher than the contributing threshold (see subsection Individual Decision Making). The *initiators* participate for a certain time no matter their motivation.

2. Participants, i.e. *gardeners*, contribute by spending time in the garden. If yield is available, they can take a fair share of it or not, in which case they violate a rule, with a set probability. A violation can be sanctioned, the probability for which depends on the institutions set. The sanction may affect the agent's rights to come back at the next round. The number of sanctioned violations are counted and influence the participating agents' belief evaluation values. If yield is not available, the agent's yield belief evaluation value is updated. Conflicts regarding rules arise periodically: according to how conflict-resolution mechanisms are implemented, this may result in a more or less severe perception

of bad encounters. At the end of the round, the actions and outcomes are assessed by the agents: their belief evaluations and probability of violating a rule are hence updated ; the same goes for the attributes of the community and biophysical conditions of the system.

### A.1.2 Design concepts

**Theoretical and empirical background**

We build our model with the overall structure of the Institutional Analysis and Design (IAD) framework (Figure 4.1, article body): external variables (Biophysical conditions, Attributes of Community and Rules-in-Use) determine the Action situations taken by the agents ; the resulting Interactions and their Outcomes are evaluated to update the external variables and the actions taken. In our case the Biophysical Conditions and Attributes of the community boxes are initially defined thanks to structured interviews in our case-study and to the database of urban community gardens. The Rules-in-Use box derives from Ostrom's Design Principles, adapted and simplified as visible in Table A.2.

For each agent, taking action is evaluated with the formalisation of behaviour dynamics defined in the Theory of Reasoned Action (Figure 4.2, article body): a resulting behaviour depends both on attitudes and subjective norms (see next subsection).

**Individual Decision-Making and Sensing**

Based on the TRA, we can formulate the behavioural intention as follows:

$$BI = (A_B)W_1 + (SN)W_2$$

with
$BI$ Behavioural Intention
$A_B$ Attitude towards performing the behaviour
$W_1$ Empirically derived weight (see 4.11)
$SN$ Subjective norm related to performing the behaviour
$W_2$ Empirically derived weight

The attitude can be calculated by the sum of the belief strength and belief evaluation:

$$A_B = \sum_{i=1}^{n} b_i e_i$$

with
$b_i$ Belief strength, or the certainty to which the belief is held
$e_i$ Belief evaluation, the extent to which the attribute is judged to be positive or negative
$n$ Number of beliefs considered

The social norm is calculated in a similar way:

$$SN = \sum_{i=1}^{n} b_i m_i$$

with
$b_i$ Normative belief strength, or perceived expectation of salient others
$m_i$ Motivation to comply with the perceived expectation of others.
$n$ Number of normative beliefs considered

The evaluation of the willingness to participate in community urban gardening is therefore the combination of the functions above:

$$\begin{aligned} Intention \quad = \quad & ((b_{cohesion} \times e_{cohesion}) + (b_{social} \times e_{social}) + (b_{yield} \times e_{yield}) \\ & +(b_{education} \times e_{education}) + (b_{landavailability} \times e_{landavailability}) \\ & +(b_{enjoyinggarden} \times e_{enjoyinggarden}) + (b_{sustainability} \times e_{sustainability}) \\ & -(b_{conditions} \times e_{conditions}) - (b_{toomuchwork} \times e_{toomuchwork})) \times W_1 \\ & +(b_{needcontribution} \times m_{needcontribution}) \times W_2 \end{aligned}$$

with
$b_x$ Belief strength for $x$
$e_x$ Belief evaluation for $x$
$W_1$ The weight of the attitudes
$W_2$ The weight of the social norm

The belief evaluation only impacts the overall behavioural intention if the related belief strength is higher than 0. In other words, a *gardener* for example not volunteering for the purpose of receiving yield, would not see its motivation decrease when no yield is available.

The belief strengths are characteristics of the agents, and range between 0 and 1. They are derived from the survey data in Germany. For example, 80 % join in order to take some garden products, therefore 80 % of the agents generated are given a high value for the corresponding belief strength, between 0.5 and 1. The evaluations also range between 0 and 1. An agent decides to go gardening when the intention is higher than a set decision threshold called *ContributingThreshold*. An agent either decides to contribute, and thus becomes a *gardener*, or not to contribute, and becomes or remains a *Potential gardener*. *Gardeners* proceed to the next action situations, while *Potential gardeners* can make the choice to contribute again on the next decision opportunity. This is summarised in Figure A.2. The value of this parameter is found by performing a sensitivity analysis with all design principles active and then inactive (see results section).

The weights $W_1$ and $W_2$ relate to each other as follows. Each element $b_i m_i$ from the previous formulas has a maximal value of 1. We have 7 positively counted

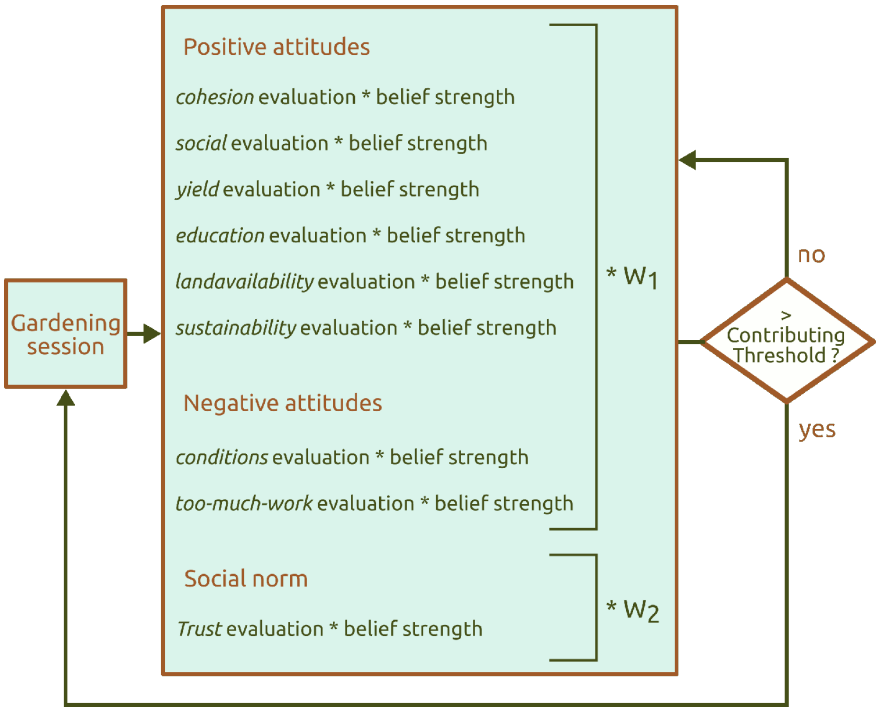


Figure A.2 – Evaluation of the behavioural intention to contribute

attitudes and 1 social norm, which gives us a maximum total value of our intention formula equal to 8. The weights ratio is therefore:

$$7 \times W_1 + 1 \times W_2 = 8$$

$$W_1 = \frac{8 - W_2}{7}$$

The range of values for $W_2$ is determined through sensitivity analysis around the ratio $W_2/W_1$, based on the study of Eves, Hoppé and McLaren, 2003. This behavioural study is built on the Theory of Planned Behaviour, which is similar to the Theory of Reasoned Action but with the additional component of perceived behavioural control. They determined the weight of attitudes subjective norm by asking 250 people how likely they would perform certain leisure activities in the near future with several scales of 7 possible answers, and how frequently they engaged in such activities in the previous month. The authors thus calculate a numerical value for attitudes and subjective norm. They thus found a values of 5.11 and 5.08, respectively for $W_2$ and $W_1$, in the case of participation in team-sports. Gardening is also a collective activity, and we consider a range for $W_2$ comprised between 0.5 and 4 in order to explore the implications of higher weights of subjective norm. This gives a ratio $W_2/W_1$ ranging from 0.47 to 7.

Each agent can assess the behaviour of a certain number of other agents (whether they violated a rule, during contribution on a gardening session). This is parameterised by $VolunteerToFullySee$.

**Learning**

At the end of each volunteering session, *gardeners* evaluate their beliefs according to what happened in the garden. The values of belief evaluation $e_x$ for all beliefs are therefore updated individually for each *gardener*, with the formula below.

$$e_{belief} = \frac{\sum_{i=1}^{n} e_{belief,gardeningSession_i}}{AmountOfVisits}$$

with:

| | |
|---|---|
| $e_{belief,gardeningSession_i}$ | The evaluation of a belief on gardening session $i$ |
| $AmountOfVisits$ | The number of times that an agent chose to become a *gardener* |

- Yield – When the *gardener* receives a fair share of yield, the belief is evaluated positively. When the gardener does not receive a fair share of yield while it should, the belief is evaluated negatively.
- Social development or cohesion – It is assessed by the density of interpersonal relationships in a group (Friedkin, 2004).

$$CurrentCohesion = \frac{PresentTies}{N_{gardeners}}$$

with:

| | |
|---|---|
| $PresentTies$ | Amount of relationships an individual has with the other present *gardeners* |
| $N_{gardeners}$ | Number of *gardeners* present |

- Some beliefs are always evaluated positively: enjoy gardening, environmental sustainability, cultural practices (requiring at least one other participant on the garden) and land accessibility, when there are no fences.
- Education – Learning happens on the garden (Duchemin, Wegmuller and Legault, 2009; Saldivar-Tanaka and Krasny, 2004). Following the concept of learning curves, the more an individual learns, the more time and effort it takes to gain more expertise. Therefore, we assume the belief for education starts at 1, and then exponentially decays until 0. The maximum amount of visits after which an agent's belief for education is 0, is an input parameter. Each agent randomly gets assigned a value between 0 and that input parameter.
- Too-much-work – More tasks require more people. We use a parameter, specific to the garden: the amount of gardeners necessary on a session to sufficiently maintain the garden. Only below this threshold is the session evaluated negatively.

- Uncomfortable conditions – We use a fixed percentage of days with uncomfortable conditions, as provided by the garden leaders of Vredestuin (Netherlands). At the beginning of each session, the agents are given a random number between 0 and 100. If this number is below the percentage above, the conditions are bad and $e_{conditions}$ has the value 1. Otherwise, it has the value 0.

- Social norm / need of contribution – This evaluation is based on trust and indirect reciprocity. Indirect reciprocity is the belief strength for trust, and gets assigned the highest value, 1. Trust is updated per *gardener* each round, and becomes the belief evaluation. A gardener can either collaborate or defect during an encounter. Trustworthiness of the group is assessed across encounters with all *gardeners*. We assume that the reputation of the group directly impacts the individual's trust.

$$Reputation = \frac{p}{n}$$

with:

| | |
|---|---|
| $p$ | number of cooperative actions (encounters with someone who is not seen violating a rule or in a bad conflict) |
| $n$ | number of encounters with others in total |

- Probability of rule violation – Seeing others violating rules increases one's probability of violating rules (Ostrom, 2005; Anderies, Janssen and Schlager, 2016). The initial value of $ProbabilityRuleviolation$ is determined by the set value of $DPglobalprobabilityruleviolation$ (Table A.2).

$$ProbabilityRuleviolation = \frac{AmountOfSeenViolationsWithoutSanctions}{TotalEncounters}$$

with:

| | |
|---|---|
| $ProbabilityRuleviolation$ | probability for an agent to violate a rule during gardening |
| $AmountOfSeenViolationsWithoutSanctions$ | amount of violations without sanctions an agent saw |
| $TotalEncounters$ | total encounters an agent experienced |

Our assumptions are summarised in Appendix A.2 (Table A.9).

**Interaction and Collective**

Interactions only occur between the *gardeners* agents, the time of the gardening session. This is open to agents that show a sufficiently high intention to participate (see above), and that are not suspended because of rule violations and the way in which the institutions are implemented (Ostrom Design Principles).

#### Heterogeneity

Agents are heterogeneous with respect to their belief strengths and homogeneous with respect to all other parameters.

### A.1.3 Details

The model has been built in Netlogo. The code to replicate our model is stored on the CoMSES Computational Model Library under the following url :https://www.comses.net/codebases/6ad1edde-d9f3-49f6-ba36-d251ff1886b5/releases/1.1.0/.

#### Implementation Details

Open NetLogo software. Go to File>Open... [select urbgarden.nlogo]. Select Tools > BehaviorSpace. Choose experiment [ExpFinal] and click Run.

#### Initialisation

The model starts with giving fixed belief strengths values to agents, according to the general characteristics of an urban community gardening community. All agents start with a belief evaluation of 1 (maximum) for education, land availability, enjoying gardening, sustainability and reciprocity (or trust). They start with a belief evaluation of 0 (minimum) for cohesion. Belief evaluation values evolve over time, with the learning processes described above.

## A.2 Additional data

| Motivations | Justification |
|---|---|
| Social development | The activities of gardening foster a social environment that enhances the activity itself by providing participants with a social network that becomes important particularly when they are feeling isolated (Duchemin, Wegmuller and Legault, 2009). |
| Social cohesion | People feel connected to each other (Kam and Needham, 2003); participants form relationships with one another and offer mutual help, which does not occur in individual gardening systems (Veen et al., 2016) |
| Consuming fresh food | It depends on the stage of the garden, biophysical variables but also on the active institutions and the participants' behaviour (Duchemin, Wegmuller and Legault, 2009); it is a possible source of conflict when it comes to (fair) yield taking (Butler, 2013; Charles, 2012) or even stolen yield from non-participants (Ruggeri, Mazzocchi and Corsi, 2016) |
| Saving/making money | Eating or selling own garden production is a current practice (Guitart, Pickering and Byrne, 2012; Patel, 1991). |
| Improving health | Improving a diet, increased exercise and involvement in nature (Guitart, Pickering and Byrne, 2012) |
| Enjoying nature | This point is debatable when it comes to man-made gardens ; however, this belief is intended as the well-being provided by being outdoor (Rogge, Theesfeld and Strassner, 2018). |
| Education | Specific education about gardening (Drake and Lawson, 2015) or more general: science, nutrition and environmental education (Guitart, Pickering and Byrne, 2012) ; indirect social education can also be gained by simply participating (Duchemin, Wegmuller and Legault, 2009) |
| Enhancing cultural practices | Cultural practices are broadly defined as the knowledge of 'what to do, when and where', and how to interact within a particular culture; in the urban gardening context, this can be translated to integration, particularly for foreign immigrants; in our work, this belief is satisfied by the presence of others in the garden (Rogge, Theesfeld and Strassner, 2018). |
| Increasing land accessibility | This belief reflects the very common issue of claim to the urban public space, when its accessibility is reduced due to land developments and privatisations (Huron, 2015; Williams, 2018). Urban community gardens also add the idea of increasing the share of green spaces in the city (Schmelzkopf, 2002). This belief can be diminished by the presence of group or garden boundaries (Milburn and Vail, 2010). |
| Environmental sustainability | Green spaces highly contribute to urban sustainability, such as microclimate regulation, water runoff, pollution mitigation, water filtering or biodiversity (Colding and Barthel, 2013, (Wolch, Byrne and Newell, 2014), to which community gardening practices (permaculture, organic farming or conventional) contribute. However, few studies, such as Rogge, Theesfeld and Strassner, 2018 have actually evaluated this impact. We translate this belief as the participants' belief of acting positively towards the environment. |
| Enhancing spiritual practice | This relates to the connection to nature achieved through gardening; it acts as meditation, a way to release tensions and developing spirituality (Kingsley, Townsend and Henderson-Wilson, 2009), and engaging in more caring connections with other people (Okvat and Zautra, 2011). |
| Social norm | Trust in contributing to the community, which is higher when other users are reciprocating (Chalise, 2015), more likely occurs in smaller groups (Poteete and Ostrom, 2004). Reciprocity can be measured in two ways: as a norm in the group and as a variable between two agents. Because we are looking at the relation of an individual with the group, reciprocity as a norm is more applicable. The higher this societal reciprocity, the more one expects all agents to reciprocate (Mui, 2002); the group's overall reputation is an important factor when deciding whether or not to contribute at the individual level. |
| Amount of work | It is the amount of activities leading to a desired quality ; *gardeners* leave if maintaining the garden requires more effort than they expected (Chalise, 2015), which can happen when there are not enough gardeners. |
| Uncomfortable conditions | We consider here physical conditions, such as bad weather, limiting the willingness to participate (Vercauteren et al., 2013; Drake and Lawson, 2015). Other conditions, such as the feeling of not being welcome, are not considered in this work. |

Table A.5 – Motivations for urban community gardening, drivers of the beliefs variables of the Theory of Reasoned Action in our model

| Question | Gandhi Tuin | Vredestuin |
|---|---|---|
| Are there plot boundaries? | Yes | No |
| Are there group boundaries? | No | No |
| When a membership structure is active, people can try the garden 3 times before they have to become a member | / | / |
| Are there rules towards balanced benefits/costs? | no | no |
| Are decisions taken collectively? | yes | no * |
| Are there conflict-resolution mechanisms? | yes, but poorly executed | no, but no conflicts arose yet |
| How often does a large conflict, which could harm the volunteer's trust in a collaborative community, occur? | 150 to 200 sessions | / |
| Without effective conflict resolution mechanisms in place, what is the probability for such a large conflict to harm the trust of an individual volunteer ? | 1/2 | 1/4 |
| Is there monitoring in place? | no | no |
| Are there graduated sanctions? | yes | no |
| What is the probability that someone is punished (told off) when violating a rule? | between 0.25 and 0.6 | / |
| Is your initiative officially recognised and allowed? | yes | yes |
| How many other volunteers can a volunteer assess the contribution of during a gardening session? | 3-4 | 3-4 |
| What is the chance for an individual to violate a rule during a session (such as not tidying the kitchen, or bringing a dog)? | 1/30 | 1/30 |
| What is the minimal amount of volunteers necessary for proper maintenance of garden? | 10 | 10 |
| How many core members are there? | 4 | 20-25 |
| What is the size of the volunteer pool? | >1000 | >1000 |
| What is the fraction of sessions with uncomfortable conditions? | 1/4 | 1/4 |
| What is the fraction of sessions with available yield? | 1 | 1 |
| What is the fraction of sessions when yield gets stolen while there are no boundaries around the garden? | / | 1/100 |
| After how much time does a volunteer stop learning in the garden? | / | 1.5 year |

Table A.6 – Field questions to the garden leaders (Netherlands cases)

| IAD component | Output variables | Input parameters | Data source |
|---|---|---|---|
| biophysical conditions | product availability | chance of uncomfortable conditions<br>chance of available product | Gandhi Tuin |
| community attributes | | beliefs types<br>number of initiators<br>pool of potential volunteers<br>beliefs strength (all agents)<br>chance of bonding with others<br>age of initiative (maximum)<br>interaction rate | German database, Gandhi Tuin, Vredestuin, literature, case-study |
| rules-in-use * | | Ostrom Design Principles (adapted) | literature, Gandhi Tuin, Vredestuin |
| action situations | | tasks | Gandhi Tuin |
| outcomes | beliefs evaluation<br>social ties<br>good encounters<br>gardening duration | conflict rate | Gandhi Tuin |

* field quantitative values are only used during validation

Table A.7 – Data sources

| Belief label | Proportion of gardeners concerned (%) |
|---|---|
| social | 30 |
| cohesion | 90 |
| yield | 60 |
| enjoyinggarden | 80 |
| sustainability | 60 |
| education | 50 |
| landavailability | 30 |
| conditions | 60 |
| toomuchwork | 20 |

Table A.8 – Motivations for community gardening, from the social sustainability survey (German database)

| Assumption | Comment |
|---|---|
| The impression of being helpful in the garden increases the behavioural intention to contribute as well | |
| Initiators usually stay committed to maintaining the garden longer than regular volunteers | |
| *Gardeners* only negatively evaluate yield taking when their fair share of yield is unavailable | |
| Enjoy gardening, environmental sustainability, cultural practices (requiring at least 1 other participant on the garden) and land accessibility (when no garden boundaries) are always evaluated positively | |
| After 100 to 400 sessions, educational purpose is not a relevant attitude anymore | Varying range |
| Agents can be told off 2 to 40 times before being suspended | |
| An agent is suspended for 5 to 20 sessions | No cases with suspensions were noted in the examples from Germany |
| After having been suspended, an agent can be told off 2 to 10 times before being denied access | |
| A conflict can harm trust up to a 100 times worse than seeing someone violate a rule | |
| Taking too much yield means taking up to 5 times the fair amount | 5 could be too much |
| The probability for rule violation during gardening is between 0.01 and 0.9 | Varying range |
| When violating a rule, the probability of being sanctioned is between 0.01 and 0.9 | Varying range |
| Membership can last 13 to 52 weeks | |
| The perception of Too-much-work is a barrier to participation | Confirmed by (Chalise, 2015) |

Table A.9 – Additional model assumptions

# B

# Questionnaire sent to the KasKantine volunteers

## B.1 Goal and definitions

For my research, I study the social interactions around shared resources or spaces. I need to know why you contribute to KasKantine: think of personal or collective motivations.

| | | |
|---|---|---|
| Definitions | social development | you like to be connected to one another and, through your activity, enjoy working for "something bigger": what happens in KK increases the value of the tasks you are doing |
| | education | you come to learn |
| | tasks | you like certain aspects in your tasks: being outdoor, cleaning (meditative?), creating, building with hands... |
| | (social) sustainability | you like the societal and environmental values in KK, the sense of freedom, the sharing or "gift economy" |
| | land / space | you can finally use a space to express yourself: arts, smoothie, gardening... |
| | free time | you have too much time available ! (weekend, holiday...) |
| | product | you come to get some outcomes of the tasks in KK (food, fresh veggies/herbs, knowledge, locally-made stuff...) |
| | social interaction | you like hanging out with other volunteers and customers at KasKantine |
| | environmental conditions | [negative motivation] sometimes it's bad weather, or insect come out of nowhere: tick this box if you are affected by that |
| | work conditions | [negative motivation] sometimes there's too much work, and too little volunteers: tick this box if you are affected by that |

## B.2 Answers

Why do you come volunteering at KasKantine ? (see definitions above)

| ratios for: | KasKantine | (German database) | Averaged result |
|---|---|---|---|
| social development | 0.83 | 0.30 | 0.67 |
| education | 0.5 | 0.5 | 0.5 |
| tasks | 0.83 | 0.8 | 0.82 |
| (social) sustainability | 0.5 | 0.6 | 0.53 |
| land / space | 0.17 | 0.3 | 0.21 |
| free time | 0 | / | / |
| product | 0.33 | 0.6 | 0.41 |
| social interaction | 1 | 0.9 | 0.97 |
| environmental conditions | 0 | 0.6 | 0.18 |
| work conditions | 0.17 | 0.2 | 0.18 |

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Environmental, socio-economical, or sanitary crises constantly question our adaptability as individuals within a community. How can we overcome the present situation? How to mitigate future crises? What role can we, citizens, play in this collective effort? More and more research and international reports point to the key role of human communities, especially at the level of cities, to increase our societal resilience. In this thesis, I therefore investigate some of the mechanisms leading to more community resilience in cities.

This thesis focuses a broadly spread collective action practice which occurs in the urban space, extensively described from the point of view of individual cases or from specific disciplines, with yet no significant attempt to generate a loosely constrained overview of this practice, called the *urban commons*.

Very simplistically, the urban commons consists of shared material, immaterial or digital goods in an urban setting. It is also recognised as functional to the individual and collective well-being. But let us put the stakes clear: this practice is highly malleable, as it is user- and context-defined, and evolves over time. In other words, it has no definition, and no definition could embrace it fully. So what is the point of this thesis's 190 pages ?

Firstly, it gives additional insight into urban systems, widely known as complex because of the mutual effects their inhabitants and the city's infrastructures and institutions have on each other. Secondly, place-based communities, such as those gathering around the urban commons, represent a high potential for community resilience: beyond natural disasters risk reduction, I mean the ability to deal with institutional, social-economical and ecosystem uncertainty through agency and self-organisation around a shared objective.

Appropriate institutions regulate such interactions. Some are formal and codified, such as laws or property rights, while others are informal and reflect social and behavioural norms. Institutional dynamics, for example Ostrom's work on the Common-Pool Resources (CPR), represents a major starting point to this thesis. Ostrom largely contributed to structuring institutional analysis and the study of socio-ecological systems. We use these well-recognised frames to address community resilience through the urban commons.

This thesis draws a map across urban issues and institutions to explore the urban commons pathways to community resilience. This requires navigating through the *urban archipelago*, "islands [...] of order in the middle of urban chaos", a metaphor of the urban space in Stavrides' words. Several reference points on the map need to be placed:

1. the urban commons characteristics and its governance challenges;
2. the behavioural and institutional dynamics in the urban commons;
3. mechanisms triggering community resilience in the urban commons;
4. the role of knowledge production in the urban commons to support community resilience.

These represent the four sub-questions guiding this thesis. The four corners of the map are given by relevant geographical and temporal constraints: this thesis

focuses on Western Europe urban commons and the second half of the 20th century onward. Exception is made for sub-question 1, which explores the urban commons characteristics from worldwide examples.

A template of this map is provided by Hess's existing map of the new commons. This map lists several sectors across which the commons can be classified: cultural, knowledge, markets, global, traditional, infrastructure, neighbourhood, medical and health commons. These apply to the urban commons with minor adaptations and span widely from tangible to less tangible resources. The diversity also extends to its associated bundles of rights: from open-access to private regimes. The urban commons are threatened by urban processes linked to the market economy, for example through privatisations or resources enclosures and urbanisation. However, these processes become the spearhead to reinforce or reproduce the urban commons, by driving people to engage into *commoning* and claim the rights and freedom which otherwise would be diminished.

The urban commons further provides major ecosystem services, including for livelihood, it helps shape a collective identity and shared values beyond multicultural issues and contributes to the local economy. The urban commons thus has the potential to trigger social resilience to better face societal and environmental crises. This can be supported by certain external institutions, such as environmental regulations or municipal help through beneficial multi-actor cooperation.

However, the urban commons also faces internal difficulties: lack of finances, land access, exclusion of specific users, lack of formal recognition, autonomy and rigid institutions. This decreases its potential to trigger social resilience and to survive over time. One of the symptoms of this is the recurrent issue of lacking volunteer involvement.

In chapter 4, we have investigated the characteristics of volunteer participation in urban community gardens. We combined an institutional structure (Ostrom's IAD framework) and behavioural theory to build an agent-based model of the related interactions: (1) choice of volunteering based on individual and collective beliefs, (2) course of action chosen as volunteer and (3) volunteering session evaluation, possibly affecting one's beliefs. Rule violations and conflicts occasionally occur. Although borrowing assumptions from the Ostrom literature, that the Design Principles lead to a more robust collective resource management and that sanctioning reduces free-riding towards more cooperation, we found equivocal results which should be taken into account both in further collective action research and in practice.

While certain results confirmed the assumption that more sanctioning is correlated with more durable collective action, we also found in our model many institutional arrangements of Design Principles contradicting this assumption. This shows the prevalence of combinations of Design Principles, and questions the validity of Ostrom's sanctioning assumption in the urban commons, also reported in other recent research on the commons. A possible explanation is the presence of non-subtractable resources (e.g. education, socialising, sustainability) which also contribute to the place's attraction. This differentiates the urban commons from Common-Pool Resources. The system performed better, with higher trust among participants, when collective beliefs (social norm) or social cohesion were put ahead of individual interests, such as yield taking, which aligns with our hypothesis above.

We explore the emergence of trust and social cohesion, indicators of community resilience, in a second agent-based model (chapter 5).

This time we investigate the conditions under which an urban cooperative's community can reach higher resilience. We thus ran numerous computer simulations, varying parameters like maximum volunteer group size and weight of social norm over individual beliefs. We found that the negative effects of intermittent conflicts dampened over time, as the number of positive experiences outgrew the ones with conflicts. Conjointly, the sense of interpersonal trust and social cohesion emerged from the modelled social interactions in the cooperative. Additionally, we isolated a significant link between lower group sizes and higher trust among the participants. The adaptability of local communities to institutional, social-economical and ecosystem issues can thus be improved through repeated interactions around a shared objective generating social capital and social memory, thus increasing their social resilience, notably through the emergence of trust and social cohesion in such convivial spaces.

These results hint to social learning, which, according to literature, induces more community resilience (chapter 6). Knowledge co-production in the urban commons occurs both at the inter- and intra-community scales, and spans across the physical and the digital domains. Physical events, meetings and direct knowledge transmission may be combined with digital devices which help generate, store and propagate knowledge: the digital commons. The use of open-source tools is prevalent, and justifies the term "open-source resilience". Inter-community networks are efficient, but practice shows that maintaining them requires additional efforts, for example to look for funding, which can be very time-consuming. Such networks often rely on digital technologies and open-source tools, the full potential of which is seldom used. Most of the co-produced knowledge doesn't appear online, or is not codified, limiting its value for further use. Keeping in mind challenges of online engagement, efficient ways to increase open-source resilience in the commons still need to be found.

The outcome of this thesis takes the shape of an urban commons community resilience (UCCR) framework, presented in Chapter 7. Its generalisability, validity, and reliability are justified by the fact that it has the structure of the Ostrom's SES framework, restricted to resilient community outcomes in the context of the urban commons. It comes out that the urban commons represent places of conviviality where repeated encounters and social learning can happen. They provide goods, tangible or not, which can help communities mitigate the effects of environmental and socio-economic crises. Through collective engagement in the urban commons, communities nurture trust and social cohesion, two indicators of adaptability. This engagement is regulated by a governance system, which helps ensuring its realisation, for example by securing access to land and defining institutions towards an effective and durable management of the community and its common resources.

Milieu-, sociaaleconomische of sanitaire crises stellen voortdurend ons aanpassingsvermogen als individuen binnen een gemeenschap op de proef. Hoe kunnen we de huidige situatie overwinnen? Hoe toekomstige crises te mitigeren? Welke rol kunnen wij, burgers, spelen in deze collectieve inspanning? Steeds meer onderzoek en internationale rapporten wijzen op de sleutelrol van menselijke gemeenschappen, vooral op het niveau van steden, om onze maatschappelijke veerkracht te vergroten. In dit proefschrift onderzoek ik daarom enkele van de mechanismen die leiden tot meer veerkracht van de gemeenschap in steden.

Dit proefschrift richt zich op een wijdverbreide praktijk van collectieve actie (collective action) die plaatsvindt in de stedelijke ruimte, uitgebreid beschreven vanuit het oogpunt van individuele gevallen of vanuit specifieke disciplines, de stedelijke commons genaamd, met slechts beperkte pogingen in de literatuur om een overzicht van deze praktijk te genereren.

Heel simplistisch gezien bestaat de stedelijke commons uit gedeelde materiële, immateriële of digitale goederen in een stedelijke omgeving. Het wordt ook erkend als functioneel voor het individuele en collectieve welzijn. Maar we moeten duidelijk stellen: deze praktijk is zeer kneedbaar, omdat deze door de gebruiker en de context wordt gedefinieerd en in de loop van de tijd evolueert. Met andere woorden, het heeft geen scherpe definitie en geen enkele definitie zou het volledig kunnen omvatten. Dus wat is het nut van de 190 pagina's van dit proefschrift?

Ten eerste geeft het extra inzicht in stedelijke systemen, algemeen bekend als complex vanwege de wederzijdse effecten die hun inwoners en de infrastructuur en instellingen van de stad op elkaar hebben. Ten tweede vertegenwoordigen plaatsgebonden gemeenschappen, zoals gemeenschappen die zich verzamelen rond de stedelijke commons, een groot potentieel voor veerkracht van de gemeenschap: naast het verminderen van de risico's van natuurrampen, bedoel ik het vermogen om te gaan met institutionele, sociaal-economische en ecosysteemonzekerheid door middel van keuzevrijheid en zelforganisatie rond een gedeeld doel.

Geschikte instituties reguleren dergelijke interacties. Sommige zijn formeel en gecodificeerd, zoals wetten of eigendomsrechten, terwijl andere informeel zijn en sociale en gedragsnormen weerspiegelen. Institutionele dynamiek, bijvoorbeeld Ostrom's werk aan de Common-Pool Resources (CPR), vormt een belangrijk uitgangspunt voor dit proefschrift. Ostrom heeft grotendeels bijgedragen aan het structureren van institutionele analyse en de studie van sociaal-ecologische systemen. We gebruiken deze algemeen erkende kaders om de veerkracht van de gemeenschap te analyseren via de stedelijke commons.

Dit proefschrift schetst een kaart van stedelijke problemen en instituties om daarmee de stedelijke commons-paden naar veerkracht van gemeenschappen te verkennen. Dit vereist navigeren door de stedelijke archipel, "eilanden [...] van orde in het midden van stedelijke chaos", een metafoor van de stedelijke ruimte in de woorden van Stavrides. Er moeten verschillende referentiepunten op deze kaart worden geplaatst:

1. de stedelijke commons-kenmerken en de bestuurlijke uitdagingen;

2. de gedrags- en institutionele dynamiek in de stedelijke commons;

3. mechanismen die de veerkracht van gemeenschappen in de stedelijke commons stimuleren;

4. de rol van kennisproductie in de stedelijke commons om de veerkracht van gemeenschappen te ondersteunen.

Dit zijn de vier deelvragen die aan dit proefschrift ten grondslag liggen. De vier hoeken van de kaart worden gegeven door relevante geografische en temporele beperkingen: dit proefschrift richt zich op de stedelijke commons van West-Europa in de tweede helft van de 20e eeuw. Een uitzondering wordt gemaakt voor deelvraag 1, die de stedelijke commons-kenmerken uit wereldwijde voorbeelden onderzoekt.

Een sjabloon van deze kaart wordt geleverd door Hess' bestaande kaart van de nieuwe commons. Deze kaart somt verschillende sectoren op waarin de commons kunnen worden ingedeeld: culturele, kennis, markten, globale, traditionele, infrastructuur, buurt, medische en gezondheidscommons. Deze zijn van toepassing op de stedelijke commons met kleine aanpassingen en strekken zich uit van tastbare tot minder tastbare hulpbronnen. De diversiteit strekt zich ook uit tot de bijbehorende bundels van rechten: van open access tot private regimes. De stedelijke commons worden bedreigd door stedelijke processen die verband houden met de markteconomie, bijvoorbeeld door privatiseringen of insluiting van hulpbronnen en verstedelijking. Deze processen worden echter het speerpunt om de stedelijke commons te versterken of te reproduceren, door mensen ertoe aan te zetten deel te nemen aan *commoning* en de rechten en vrijheid op te eisen die anders zouden worden verminderd.

De stedelijke commons bieden verder belangrijke ecosysteemdiensten, onder meer voor levensonderhoud, ze helpen een collectieve identiteit en gedeelde waarden vorm te geven die verder gaan dan multiculturele kwesties, en ze dragen bij aan de lokale economie. De stedelijke commons hebben dus het potentieel om sociale veerkracht te stimuleren waarmee we maatschappelijke en ecologische crises beter het hoofd kunnen bieden. De commons kunnen worden ondersteund door bepaalde externe instituties, zoals milieuregelgeving of gemeentelijke hulp door middel van een constructieve samenwerking tussen meerdere actoren.

De stedelijke commons kampen echter ook met interne problemen: gebrek aan financiën, toegang tot land, uitsluiting van specifieke gebruikers, gebrek aan formele erkenning, autonomie en starre instituties. Dit vermindert het potentieel om sociale veerkracht te activeren en in de loop van de tijd als common te overleven. Een van de symptomen hiervan is het steeds terugkerende probleem van een gebrek aan betrokkenheid van vrijwilligers.

In hoofdstuk 4 hebben we daarom de kenmerken van vrijwilligersparticipatie in stedelijke gemeenschapstuinen onderzocht. We combineerden een institutionele structuur (het IAD-raamwerk van Ostrom) en gedragstheorie om een agentgebaseerd model van de interacties te bouwen: (1) keuze voor vrijwilligerswerk op basis van individuele en collectieve overtuigingen, (2) handelwijze gekozen als vrijwilliger en (3) evaluatie van vrijwilligerssessies, die mogelijk iemands overtuigingen beïnvloeden. Regelovertredingen en conflicten komen af en toe voor. Uit de Ostrom-literatuur hebben we overgenomen dat haar Design Principles leiden tot een robuuster collectief beheer van hulpbronnen en dat sanctionering het meeliften

naar meer samenwerking vermindert. We hebben in onze modelstudies echter tegenstrijdige resultaten gevonden waar zowel verder onderzoek naar collectieve actie voor nodig is, als extra oplettendheid in de praktijk.

Hoewel bepaalde resultaten de veronderstelling bevestigden dat meer sancties samengaan met duurzamere collectieve actie, vonden we in ons model ook veel institutionele arrangementen van Design Principles die deze veronderstelling tegenspreken. Dit toont de prevalentie van combinaties van ontwerpprincipes aan en stelt de vraag of Ostrom's aannames rondom sanctiesook valide zijn in de stedelijke commons, zoals ook gerapporteerd in ander recent onderzoek naar de commons. Een mogelijke verklaring is de aanwezigheid van niet-aftrekbare middelen (bijvoorbeeld onderwijs, gezelligheid, duurzaamheid) die ook bijdragen aan de aantrekkingskracht van de plek. Dit onderscheidt de stedelijke commons van Common-Pool Resources waar Ostrom haar theorie op baseerde.

Het systeem presteerde beter met meer vertrouwen onder de deelnemers, en wanneer collectieve overtuigingen (sociale norm) of sociale cohesie belangrijker werden dan individuele belangen, zoals het nemen van individuele opbrengsten. Dit komt overeen met onze hypothese hierboven. We onderzochten de opkomst van vertrouwen en sociale cohesie, indicatoren voor veerkracht van gemeenschappen, in een tweede agent-gebaseerd model (hoofdstuk 5).

Deze keer onderzochten we de voorwaarden waaronder de gemeenschap van een stedelijke coöperatie een hogere veerkracht kan bereiken. We hebben een groot aantal computersimulaties uitgevoerd, en daarbij verschillende parameters laten variëren, zoals de maximale groepsgrootte van vrijwilligers en het gewicht van de sociale norm boven individuele overtuigingen. We ontdekten dat de negatieve effecten van intermitterende conflicten in de loop van de tijd afzwakten, aangezien het aantal positieve ervaringen groter werd dan die met conflicten. Tegelijkertijd kwam het gevoel van interpersoonlijk vertrouwen en sociale cohesie naar voren uit de gemodelleerde sociale interacties in de coöperatie. Bovendien isoleerden we een significant verband tussen kleinere groepsgroottes en meer vertrouwen onder de deelnemers.

Het aanpassingsvermogen van lokale gemeenschappen aan institutionele, sociaaleconomische en ecosysteemkwesties kan dus worden verbeterd door herhaalde interacties rond een gedeelde doelstelling die sociaal kapitaal en sociaal geheugen genereren, waardoor hun sociale veerkracht wordt vergroot, met name door het ontstaan van vertrouwen en sociale cohesie in dergelijke ruimtes.

Deze resultaten duiden op sociaal leren, dat volgens de literatuur leidt tot meer veerkracht van de gemeenschap (hoofdstuk 6). Coproductie van kennis in de stedelijke commons vindt plaats op zowel inter- als intracommunautaire schaal, en strekt zich uit over het fysieke en het digitale domein. Fysieke gebeurtenissen, ontmoetingen en directe kennisoverdracht kunnen worden gecombineerd met digitale apparaten die helpen bij het genereren, opslaan en verspreiden van kennis: de digitale commons. Het gebruik van open-source tools is gangbaar en rechtvaardigt de term "open-source veerkracht". Intercommunautaire netwerken zijn efficiënt, maar de praktijk leert dat het onderhouden ervan extra inspanningen vereist, bijvoorbeeld het zoeken naar financiering, wat erg tijdrovend kan zijn. Dergelijke netwerken steunen vaak op digitale technologieën en open-sourcetools, waarvan het volledige potentieel zelden wordt benut. De meeste co-geproduceerde kennis verschijnt niet online, of

is niet gecodificeerd, waardoor de waarde voor verder gebruik wordt beperkt. Rekening houdend met de uitdagingen van online betrokkenheid, moeten er nog steeds efficiënte manieren worden gevonden om de open-source veerkracht in de commons te vergroten.

De uitkomst van dit proefschrift heeft de vorm van een Urban Commons Community Resilience (UCCR) raamwerk, gepresenteerd in Hoofdstuk 7. De generaliseerbaarheid, validiteit en betrouwbaarheid ervan worden onderbouwd door het feit dat het de structuur heeft van het Ostrom SES raamwerk, en is beperkt tot veerkrachtige gemeenschapsresultaten in de context van de stedelijke commons.

Dit proefschrift concludeert dat de stedelijke commons plaatsen van gemeenschapszin vertegenwoordigen waar herhaalde ontmoetingen en sociaal leren kunnen plaatsvinden. Ze leveren goederen, tastbaar of niet, die gemeenschappen kunnen helpen de effecten van milieu- en sociaaleconomische crises te verzachten. Door collectieve betrokkenheid bij de stedelijke commons voeden gemeenschappen vertrouwen en sociale cohesie, twee indicatoren van aanpassingsvermogen en veerkracht. Deze betrokkenheid wordt gereguleerd door een governancesysteem, dat helpt om de realisatie ervan te verzekeren, bijvoorbeeld door toegang tot land te verzekeren en instituties te definiëren voor een effectief en duurzaam beheer van de gemeenschap en haar gemeenschappelijke hulpbronnen.

# Journal publications

Feinberg, Arthur, Amineh Ghorbani and Paulien Herder (2021). "Diversity and challenges of the urban commons: a comprehensive review". In: *International Journal of the Commons*, 15(1), 1–20. DOI: http://doi.org/10.5334/ijc.1033

Feinberg, Arthur, Elena Hooijschuur, Nicole Rogge, Amineh Ghorbani and Paulien Herder (2021). "Sustaining collective action in urban community gardens". In: *Journal of Artificial Societies and Social Simulation*, 24(3), 3. DOI: http://doi.org/10.18564/jasss.4506.

Feinberg, Arthur, Amineh Ghorbani and Paulien M. Herder (2020). "Commoning toward urban resilience: The role of trust, social cohesion, and involvement in a simulated urban commons setting". In: *Journal of Urban Affairs*. ISSN: 14679906. DOI: http://dx.doi.org/10.1080/07352166.2020.1851139.

# Conference publications

Feinberg, Arthur, Elena Hooijschuur, and Amineh Ghorbani (2020). "Simulation of Behavioural Dynamics Within Urban Gardening Communities". In: Verhagen H., Borit M., Bravo G., Wijermans N. (eds) Advances in Social Simulation. Springer Proceedings in Complexity. Springer, Cham. https://doi-org.tudelft.idm.oclc.org/10.1007/978-3-030-34127-5_15

Feinberg, Arthur, Amineh Ghorbani, and Paulien Herder. "The role of online community platforms for the management of the urban commons". IASC Conference 2017, Utrecht, Netherlands.

# Curriculum vitæ of Arthur Feinberg

## Main working experiences

| | |
|---|---|
| 2021-now | Project Manager, Conseil Départemental de l'Isère (regional administration), Grenoble, France |
| 2015 | Technology developer, IN-FINITUDE, Zürich, Switzerland |
| nov. 2014 - jan 2015 | Guest researcher, Copernicus Institute of Sustainable Development, Utrecht University, Netherlands |
| 2014 | Research trainee, ENAC faculty (EPFL) , Switzerland |

## Education

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|---|---|
| 2016-2021 | PhD candidate, Delft University of Technology |
| 2012-2014 | Master of Sciences, Environmental sciences and engineering, EPFL, Switzerland. |
| 2010-2012 | Bachelor of Sciences, Environmental sciences and engineering, EPFL, Switzerland. |