CITIZEN SOCIAL SCIENCE IN SPATIAL PLANNING – POTENTIALS FOR RESILIENCE IN A COMPLEX UNPREDICTABLE WORLD (1064)

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Abstract. This paper reflects on the potential of citizen science in spatial planning when facing complex issues. It presents a framework that builds upon existing typologies and methods of citizen science and how it can be conceptualised as an adaptive tool in spatial planning to ensure active participatory engagement in the face of uncertainty and promote evolutionary resilience. Planners struggle to integrate citizens in their quest for certainty and evidence-based planning centred around technical expertise. Many studies have recently explored the plurality of citizen science and identified multiple benefits for policy-making such as engagement of citizens, its possibility to be initiated by any societal actor, as well as information flow and comprehension between involved actors. This paper investigates the potential benefits of citizen science in spatial planning for the input of new dynamic and situational perspectives on complex issues.

Keywords: citizen science, participatory planning, complex adaptive systems, evolutionary resilience

1. Introduction

Since a couple of decades, citizen science gained attention for its potentialities within policy-making and public management (Freitag, 2016). While there are different interpretations and typologies of citizen science, its main concept implies the participation of citizens in scientific inquiry by taking an active role (Strasser et al., 2018). In most cases, this active role solely entails data collection. However, experiments and pilot cases are on the rise to broaden the role of citizens and to use citizen science for addressing societal challenges (Kythreotis et al., 2019). Scholars identified numerous academic, civic and policy-making advantages through these experiments. For instance, citizen science allows enhanced research capacity and social relevance for academic research, increased awareness amongst citizens and a positive community impact, and public support as well as improved democratic and scientific legitimacy to policy decisions (Freitag, 2016; von Gönner et al., 2023). Since the initial conception of citizen science in the 1990s, academics have discussed the role assignments within citizen

science projects and its recognition as valuable scientific approach. On the one hand, practitioners underline the importance of a central management by recognized academics to ensure the scientific validity of the results. Others have highlighted the potential of citizen science to create new forms of citizen-centred knowledge and bring about a new recognized role for citizens as scientific actors in society (Strasser et al., 2018). Building upon the idea that citizen science might offer the opportunity to include citizen-centred knowledge in the scientific process as well as the ensuing policy-making, some academics presented the concept of citizen social science to study societal issues from the perspective of citizens (Albert et al., 2021; Amirrudin et al., 2021; Campos et al., 2021; Perelló, 2021; Pykett et al., 2020; Thomas et al., 2021). Such practice offers the possibility to tailor research and policy-making to the social and cultural norms of citizens (Albert et al., 2021; Kythreotis et al., 2019). Based on the identified academic, civic and policy-making advantages, this paper explores the potential of citizen social science to address spatial planning issues.

Comparably, citizen's participation is a central topic in spatial planning since much longer. Spatial planning aims initially at controlling space and its future evolution to prevent society from becoming chaotic and ineffective (Boelens, 2020a). It addresses a plurality of societal issues and tends to answer these issues through spatially oriented policies and practices. Influenced by its original conception, spatial planning traditionally tends to address these issues through a centralized technocratic lens. Criticism to this technical paradigm of spatial planning arose in the 1960's arguing that it did not take sufficiently into account the multitude of private and civic actors outside of the government. Spatial planning consequently made a communicative turn, in theory if not in practice, emphasizing the importance of an exchange of ideas and perceptions to address multi-faceted planning issues (Healey, 2003; Innes, 1998). Several participatory approaches emerged since the 1990s proposing shared partnerships and actor-network based processes for closing the gap between the government and society (Boelens, 2020a; de Roo, 2020). Currently however, spatial planning practices tend to prevail in a technocratic logic of control and supervision towards a predictable future (Boonstra and Boelens, 2011). The public institutional settings still continue to differentiate lay citizens from scientific and governmental experts, which makes it difficult to legitimise citizen engagement (Rose and Miller, 2010).

Another issue that spatial planning is facing relates to the unpredictability of today's societies which very notion is deeply contradictory with the initial planning paradigm of control and guidance (de Roo, 2020). The dynamism of the contemporary world has led political theorists and planners to view societies as part of a global network in an interconnected complex world (Murdoch, 1998). Societies cannot be understood anymore by analysing its different parts, but as complex dynamic world where multiple

realities influence each other at different space and time scales (Boelens and de Roo, 2016). It inspired scholars to analyse and understand societies as interacting complex adaptive systems with multiple components and actors have self-organising capacities and continuously co-evolve (Sengupta et al., 2016; Teisman and Klijn, 2008). This systemic look not only sheds light on the multitude of interacting components in a spatial system but also on their continuous dynamism in time. While complex system theories contribute in a better understanding of contemporary socio-spatial systems, they generally lack in presenting pro-active or effective instruments (Boonstra and Boelens, 2011).

Spatial planners also sought inspiration from other concepts such as the adaptive or resilient capacity of systems in the face of uncertainty (Bertolini, 2010; Davoudi et al., 2012). Such reflective viewpoint focuses not only on understanding the systems but also on means and measures to cope with unexpected events. While stability and resisting capacity influence the level of a system's resilience, its ability to adapt and subsequently transform plays a key-role (Folke, 2006). In spatial planning, enhancing the resilience of a defined spatial system requires a better understanding of the infrastructural and ecological capacity as well as the evolution of the behavioural characteristics and social norms of its population. This understanding widens the possibilities to develop situational solutions when dealing with complex issues in spatial planning (Bertolini, 2010; Davoudi et al., 2012). As mentioned however, public institutions are still traditionally inclined to rely on technocratic approaches that do not take into account the concrete life-world of citizens.

Three main issues are presented here that represent challenges for spatial planning: 1) the recognition of citizen's role for active participatory planning, 2) the search for instruments or approaches in the face of unpredictable complexity and 3) the translation of spatial policies coherent in the concrete life-world of citizens. Based on the potentialities of citizen social science in policy-making, this paper explores how citizen social science could be serve in tackling these contemporary issues of spatial planning is facing. The paper links the different understandings of citizen social science with three theoretical considerations in spatial planning: communicative rationality, complex adaptive systems and resilience. The main guiding question of the paper is: "How can the societal benefits of citizen social science result in better planning policies and provide solutions to the complex issues spatial planners are facing". In current instances, citizen social science remains a wide concept. Its different interpretations yet distinctly encourage higher active participation of citizens in every step of policy-making, imply that it can be initiated by any societal actor and entail improved policy-making more relevant to the concrete lifeworld of citizens. The paper first presents existing theoretical considerations and understandings of citizen science and the subsequent introduction of

citizen social science concepts. Following this, the paper draws significant potentialities in spatial planning from a communicative, complexity and resilience perspective.

2. Delineation of Citizen Science

2.1. Definitions

The term citizen science emerged in the mid-90s to designate diverse scientific activities in which citizens have either an active or a passive role (Strasser et al., 2018). The interpretation of citizen science largely depends on the scientific discipline, the societal context, the objectives of the activity and the involved stakeholders (Haklay et al., 2021). The exhaustive list of current definitions encompasses a wide set of purposes and approaches applied in different contexts.

Citizen science already had different interpretations since its first use in the 90s. Alan Irwin (1995) and Richard Bonney (1996), who are often credited as the first to use the term, each presented their own concept. As a science policy analyst, Irwin's original idea is set in a policy and social context, and sees it as science performed by citizens to serve the interest of citizens. His approach focuses on sustainable development, on a democratisation of science and on types of knowledge production that could not be produced by scientific institutions. Irwin sought the creation of a new role for citizens as legitimate scientific actors in society through citizen science (Irwin, 1995). As an ornithologist, Bonney's approach much more strongly stressed the input of observational data for scientists from citizens. He still considered the coordination of recognized academics as mandatory for a citizen science activity to be successful and receive the necessary recognition. He subsequently oriented his research on the scientific methodologies of citizen science and their added value for participants such as knowledge gain and increased awareness of scientific processes (Bonney et al., 2016, 2009).

More recently, Haklay et al. (2021) wrote an exhaustive review and evaluation of 34 definitions of citizen science from public agencies, universities, NGO's or multi-national organisations. They identified three main contexts with common characteristics in which citizen science is defined: a scientific, a societal and a political context. In the scientific context, citizen science is defined as citizen's participation in research academic knowledge production and enlargement of the scientific community. In a societal context, citizen science is applied to address community challenges, raise awareness, enhance knowledge amongst the population and create new networks. In the political context, the definitions of citizen science seek to enhance awareness and knowledge of

policy -makers, build consensus and serve democratic legitimacy. Compared to the dichotomy of its original definitions of the mid-90s, the scientific characteristics echo with Bonney's (1996) conceptualisation. On the other hand, the societal and political characteristics pursue Irwin's (1995) thoughts on the potential of citizen science in a larger frame of society.

Citizen science has increasingly received recognition since its original conceptualisations, both for the production of scientific knowledge as for its added value to society (Voigt-Heucke and Riemenschneider, 2022). In this paper, citizen science is delineated as the participation of citizens in one or several steps of scientific inquiry, which consequently enhances the outreach and societal relevance of the scientific inquiry.

2.2. Typologies

The diversity of definitions indicate that the concept of citizen science is situational in time and space. Several academics reflected on ways of categorization and proposed a number of typologies. These typologies indicate a wide diversity of citizen science practices, which sheds light in the potential relevance in the context of spatial planning.

The recurrent typology for citizen science arguably is based on the level or degree of participation. This level of participation is generally situated in the frame of the different steps of scientific process (Wiggins and Crowston, 2011). These typologies commonly categorize citizen science projects based on the amount of steps where citizens play a role. This approach show similarities with dated Arnstein's ladder of participation (1969), which highlights the power and enforcement in spatial planning of citizens. Comparably, the typologies of Wiggins and Crowston also emphasize the power relationships in scientific research between citizen and academics. Perhaps the most referenced typology of citizen science is the one presented by Haklay (2013), which is based on the cognitive engagement of citizens:

Crowdsourcing, where participation is limited to the provision of resources and the cognitive engagement. Citizens can act as sensors to collect data or volunteer in shared computing.

Distributed intelligence, in which citizens act as basic interpreters of the collected data after some basic training.

Participatory science, in which the problem definition and collection method is set by the participants. Academics or experts subsequently perform the detailed analysis.

Extreme citizen science or collaborative science, in which citizens' activities are considered as a completely integrated where professional and non-professional

scientists are involved in each step of the scientific process.

Figure 1. The four modes of citizen science based on the level of cognitive engagement
Source: Haklay, 2022.

Other typologies tend to encompass the variety of the citizen science concepts in their scientific and social contexts (Dillon et al., 2016; Wals, 2022). They distinguish the adaptive nature of the citizen science projects by identifying whether the goal is closed and pre-determined or open and co-determined. Next to these characteristics, they either analyse the level of participation (Dillon et al., 2016) or the drivers being more oriented to knowledge expansion or to social engagement (Wals, 2022). These typologies are featured in figure 2, which discerns science-, policy- and transition/concern- driven citizen science. In both models, science-driven citizen science very much coincides with Bonney's (1996) conception that underlines the importance of academic supervision in the scientific process and which implies specific, pre-determined scientific goals. This form of citizen science is often initiated by academics with a lower involvement of citizens. The policy- and transition/concern-driven citizen science approximate Irwin's (1995) idea where knowledge is produced to answer societal issues. These categories include academics as a group of stakeholders amongst many in a joint learning process leading towards fully engaged policies. As Wals (2022) points out, concern-driven citizen science is often initiated by citizens based on a common concern regarding their quality of life. Noticeably, both models regard "science-

driven" citizen science as having pre-determined goals, coordinated by recognized researchers. They thus tend to maintain the notion of "science" and "scientist" within a recognized academic institutional realm.

From the perspective of spatial planning, citizen science cannot be regarded independently from its potential social and political impact. As spatial planning aims at shaping and governing space to achieve economic, social and environmental goals (Van Assche et al. 2013), the concept of citizen science in spatial planning has to be placed in the frame of those goals. In this paper, citizen science is therefore delineated as the active participation of citizens in one or several steps of scientific inquiry that subsequently serves in the development of spatial plans or policies. Such active participation implies a cognitive engagement and understanding of citizens in the economic, social and environmental goals addressed by the scientific inquiry.

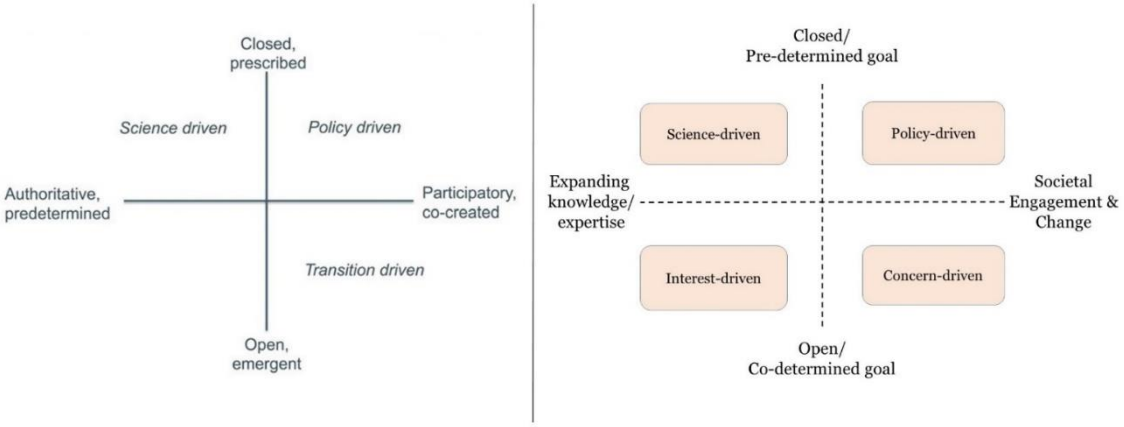

Figure 2.42 The citizen science typology developed by Dillon, Stevenson and Wals (2016) based on closed versus open goals and the level of participation (left) compared to the typology of Wals (2022) distinguishing closed versus open goals and scientific versus societal drivers (right).

2.3. Citizen *Social* Science

The growing interest amongst academics for the potential impact of citizen science on policy-making led to a further conceptualisation towards citizen social science. This concept of citizen social science centres around an involvement of citizens in the ensuing

policy-making, based on the citizen scientific inquiries (Kythreotis et al., 2019). On a different note, citizen science has predominantly addressed environmental issues (Schade et al., 2021). Hence, several academics from social disciplines started exploring the potential of citizen science to address social or sociological issues.

Table 1. The concept of citizen social science proposed by Kythreotis et al. (2019) based on the typology of Haklay (2013)

Increasing levels of citizen participation and engagement ↑			
	(Level 5)	"Citizen Social Science"	• Citizens as key agents of research, action AND policy change at ALL levels of engagement and scales of the decision-making process
	Level 4	"Extreme Citizen Science"	• Collaborative science–problem definition, data collection and analysis
	Level 3	"Participatory Science"	• Participation in problem definition and data collection
	Level 2	"Distributed Intelligence"	• Citizens as basic interpreters • Volunteered thinking
	Level 1	"Crowdsourcing"	• Citizens as sensors • Volunteered computing

The first form of citizen social science, proposed by Kythreotis et al. (2019), is a continuation of the typology proposed by Haklay (2013), based on a vertical notion of participation, proposing a step beyond extreme citizen science (Kythreotis et al., 2019; see table 1). This concept builds upon the argument that citizen science, to date, merely uses citizens as policy passive objects for research. Kythreotis et al. (2019) propose to involve citizens not only in the different steps of scientific inquiry, but also in the ensuing policy-making. Citizens as key-agents would ensure the input of heterogeneous forms of social knowing, values and cultures both in the knowledge production and policy-making. This citizen social science framework sees all participating stakeholders as co-learners within a research process by actively exploring the possibility of transforming institutionalised research methods and policy systems towards more socially grounded policy decisions. It implies the effective integration of different forms of knowledge via the recognition of multiple social practices and experiences (Campos et al., 2021).The second form of citizen social science evolved from exploring the practicality of citizen science in social sciences. This concept of citizen social science does not necessarily imply the involvement of citizens at every step of the research process (Heiss et al., 2021; Pykett et al., 2020) A significant part of the studies discussing that form of citizen social science emphasize on the empowerment of citizens in the scientific process through the input of citizen-based knowledge and collective actions (Amirrudin et al., 2021; Campos et al., 2021; Perelló, 2021). Such objective could therefore only be attained through the engagement of citizens in all steps of the research process (Albert et al., 2021).

These two forms of citizen social science take fundamentally different starting points. The first form initially aims at addressing issues by empowering citizens at every step of

scientific research to make policy-making more relevant in the social lifeworld of citizens. The second form can be seen as the active participation of citizens in social scientific research (Thomas et al., 2021). While there are differences, these forms share a significant amount of attributes and can sometimes be confused with one another. For instance, addressing environmental issues through the input of citizen's knowledge based on their social lifeworld inherently brings a social dimension to the topic, which transforms the environmental issue into a social issue. Both interpretations entail an empowerment of citizen, the recognition of citizen-based knowledge and research based on multiple forms of knowledge. Both interpretations also imply an enduring on policy-making by increasing its social relevance. In this paper, citizen social science is defined as a form of citizen science that addresses social issues to enhance the relevance of policies in the social life-world of citizens.

3. Citizen Social Science and Spatial Planning

3.1. Introduction

The description in the previous section about the different definitions and typologies of citizen science shed light to its potential practicalities in the context of policy-making and enhanced participation. Consequently, this paper explores its links with conceptual spatial planning thoughts. The paper centres around three attention points that relate to complexity thinking: the technical versus communicative rationalities dichotomy, complex adaptive planning and evolutionary resilience. These three perspectives regard the spatial planning practice from different angles. The first focuses on how spatial planning reality is perceived, analysed and how the consequent course of actions is defined. The second tends to broaden the understanding of societies' complexity through a system-based analysis. The third centres its attention on The combination of those three perspectives allow to identify different notions and challenges spatial planning is facing and how it could benefit from citizen social science.

3.2. Rationalities

One approach is to regard planning practice from the perspective of the adopted rationality. Rationality can here be defined as the logical frame of intentional behaviour adopted by planners to define a course of action in a given situation, based on existing knowledge, information and experience (de Roo and Perrone, 2020). A dominant categorization of rationalities in spatial planning distinguishes technical from communicative rationality. The prior relies on objective reasoning and technical expertise to analyse the world, predict its potential future and act upon it rationally.

Contrarily, the latter builds upon Habermas' communicative paradigm underlining the existence of multiple perceptions to this world. Communicative planning tends towards an agreed reality and subsequent course of action based on intersubjective reasoning (Boelens and Devos, 2022; de Roo and Perrone, 2020). While technical rationality can be useful in situations with a limited number of influential actors and thus few planning objectives, communicative rationality seems more reasonable in complex situations with a high number of influential actors and several planning objectives to take into considerations (de Roo et al., 2020). Technical rationality is based on the assumption that issues can be understood and solutions can be developed through rational technical or strategic expertises from an objective approach. It traditionally implies top-down perspective of decision-making based on a central guiding position. Communicative rationality in spatial planning focuses on often called bottom-up approaches, which tends to develop decisions based on multiple perspectives from key-stakeholders and citizens or communities. Such rationality emphasizes intersubjectivity and horizontality in decision-making (de Roo and Perrone, 2020).

A similar dichotomy can be noticed in the initial definitions and interpretations of citizen science (see figure 3). Bonney's (1996) interpretation believed in the necessity of central guidance and a methodology-making by recognized academic actors to build research processes and produce scientific knowledge. In such design of citizen science, citizens tend to maintain a limited role in their participation along the scientific process. This role generally includes data collection and sometimes basic analysis of the data. The other steps of the scientific process are designed and performed by recognized academic actors (Haklay, 2013). In that sense, the knowledge that is produced is strongly academic-based. Much contrarily, Irwin's (1995) concept of citizen science underlined the importance and added-value of considering new forms of knowledge (Campos et al., 2021; Perelló, 2021). His concept is based upon the notion that academic knowledge is produced to serve the interests of recognized academics who act and work within their specific institutional settings. He therefore advocates for the acknowledgement of citizen-based knowledge, which would serve the interests of citizens, and an empowerment of citizens in the scientific process. The models adopted by Haklay (2013) and Kythreotis et al. (2019) speculates that this empowerment could entail an increase of citizen's participation in several steps of the scientific process. An increase of citizen's participation and cognitive engagement could thus go along with an increasing acknowledgement of their role in integrated knowledge and policy-making (Kythreotis et al., 2019).

Much like Arnstein's ladder (1969), this hierarchical approach does not reflect the diversity of contemporary practices. Several citizen science cases have shown that the reality is more nuanced in practice (Dillon et al., 2016; Strasser et al., 2018; Wiggins and

Crowston, 2011). Citizen's participation often presents a dynamic and diverse character and consequently cannot be categorized based on a static form of citizen's participation in distinct steps of the scientific inquiry. For instance, citizens can sometimes initiate a citizen science project based on their societal concerns, thus formulating the problem statement, but rely on an academic team to collect the data and conduct the analysis. The initiating citizens then use the academic-based results to outline policy recommendations to serve their interest or answer their concerns (Shirk et al., 2012). In that example, while citizens have a limited participation in the scientific inquiry, their cognitive engagement and empowerment in its societal and political relevance is nevertheless significantly high. Yet, one could question the relevance of these policy recommendations in the social life-world of these citizens as this life-world was not fully integrated in scientific inquiry.

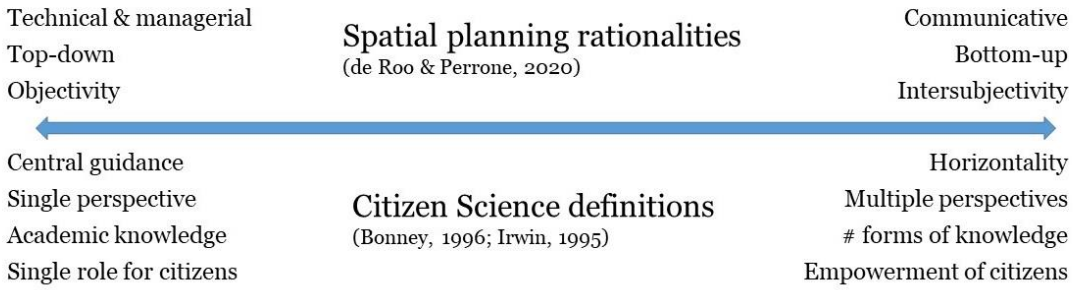

Figure 3. The similarities between the spatial planning rationalities as described by de Roo & Perrone (2020), the original interpretations of citizen science
Source: Bonney, 1996; Irwin, 1995.

Such framework coincides with Arnstein's hierarchical approach (1969) to participation which co-relates higher levels of participation to a greater empowerment. However, several citizen science cases indicate that the reality is more nuanced in practice (Dillon et al., 2016; Strasser et al., 2018; Wiggins and Crowston, 2011). Citizen's participation often presents a dynamic and diverse character and consequently cannot be categorized based on a static form of citizen's participation in distinct steps of the scientific inquiry. For instance, citizens can sometimes initiate a citizen science project based on their societal concerns, thus formulating the problem statement, but rely on an academic team to collect the data and conduct the analysis. The initiating citizens then use the academic-based results to outline policy recommendations to serve their interest or answer their concerns (Shirk et al., 2012). In that example, while citizens have a limited

participation in the scientific inquiry, their cognitive engagement and empowerment in its societal and political relevance is nevertheless significantly high.

3.3. Complex Adaptive Planning

The emphasis towards the integration of multiple perspectives and intersubjectivity in citizen social science is consistent with the advocacy of highly communicative approaches in spatial planning when facing significantly complex issues. In his earlier works in environmental planning, de Roo (2003) presented a framework depicting the level of complexity in function of the number of planning objectives and the number of actors related to these objectives (figure 4). This framework first describes the number of objectives and actors as being directly correlated. In other words, the more goals are included in spatial plans the higher the amount of actors are related and will interact with these goals. Secondly, the level of complexity of the issues are directly proportionate with the amount of objectives and interacting actors (de Roo, 2003). In such depiction, where complexity is defined by the amount of actors and objectives influencing the spatial plans, the appropriate rationality can be adopted depending on the level of complexity of the issue. In case of simple and relatively static situations with few actors involved, a technical rationality could be the most appropriate. The best rationality becomes progressively communicative with increasing complexity, which implies an acknowledgement of multiple perspectives and forms of knowledge to address those issues.

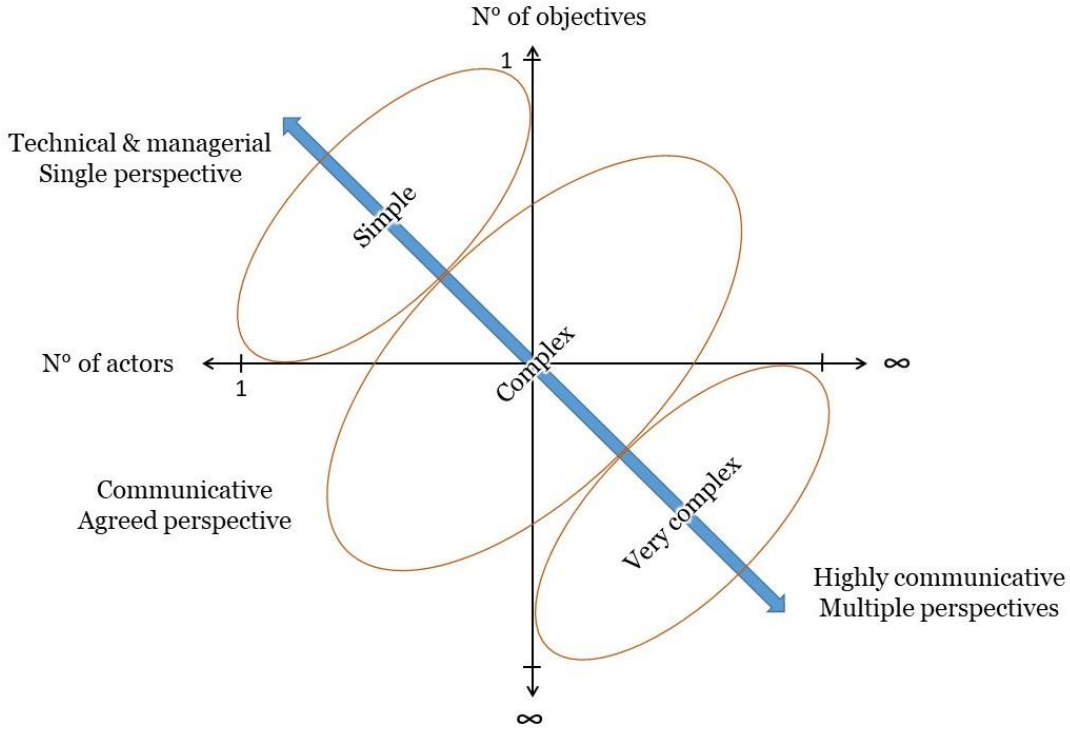

Figure 4.43 Transposing the citizen science dichotomy on the framework proposed by de Roo (2003) depicting the relationship between number of planning goals and interactions based on level of complexity.

However, more recent planning reflections brought the concept of co-evolution to consider, which adds a layer of complexity to such analysis. Co-evolution concretely implies a dynamic feature of the number of actors and objectives in such model. Actors and factors of importance in a certain situation co-evolve continuously in time bringing new circumstances, for better or worse (Boelens, 2020a). This dynamism in time has led to the development of the complex adaptive planning concept. The concept still implies the possibility of addressing issues from a traditional technical and single perspective if the situation allows it. However, circumstances can change requiring a highly adaptive capacity from the planner and the participating actors. When a certain level of complexity and unpredictability is reached, spatial planning practices then change from a position of leadership and control to a position of observation and adaptation. In these situations, the level of complexity and unknown necessitates an adaptive learning behaviour to grasp the new situation (de Roo et al., 2020; Rauws et al., 2019). The dynamic complexity explained above would also imply an adaptive capacity when conducting a particular form of citizen social science in spatial planning. In case of new

circumstances a new form of citizen social science might be adopted entailing an adaptive learning behaviour from the actors involved in citizen science.

3.4. Evolutionary Resilience

The challenge of dealing with unexpected change also introduced the concept of resilience in spatial planning. The resilience thinking originally emerged from the 1970s to study how ecological systems deal with stresses and shocks by external factors. Resilience was thus primarily used in relation to environmental hazards and risk mitigation for environmental management. Gradually, spatial planners started exploring its application in the context of complexity and in the face of important demographic, economic and social change (Bertolini, 2010; Davoudi et al., 2012). The initial conception of resilience defined as the persistence and ability of a system to resist or absorb disturbances and maintain the relationships between its population or its state variables. The resilience concept thus identified two different ways to deal with change: stability, resist and return to equilibrium after the shock or absorb the change and get to a new equilibrium (Folke, 2006). The application of resilience thinking in social systems however, led to the conceptualisation of a third form: socio-ecological resilience. The socio-ecological resilience is regarded as the capacity to adapt through behavioural change and ecological transformation (Tempels, 2016). In the context of spatial planning, some commentators highlight its similarities with the co-evolutionary perspective and thus prefer to call it evolutionary resilience (Davoudi et al., 2012). The concept of evolutionary resilience relates more directly with complexity and co-evolutionary thinking where systems are identified as being complex, uncertain, non-linear and self-organising (Davoudi et al., 2012).

This latter concept of co-evolutionary resilience in spatial planning instigates a continuous search for robust measures and options that should be left open. It requires an ongoing societal dialogue covering different views on the means and goals of planning and experimental attitude towards policies and the appropriate interventions (Bertolini, 2010). While the resilient concept encourages a continuous dialogue between key actors to consider technical, ecological and social measures to address change, public institutional and administrative structures still tend to manage societal issues from a fragmented expertise-based approach (Boelens, 2020b). Furthermore, public institutions are traditionally inclined to apply engineering-based measures by focusing primarily on infrastructural change (Tempels, 2016). Such assessment instigates the advocacy for nurturing diversity and combining knowledge systems into institutions. It includes logics of conflict resolution, negotiation, and participation to maintain a process of learning and adaptation in the face of uncertainty (Folke, 2017). Citizen social science,

by producing knowledge from a citizen's perspective, helps in understanding the co-evolution of behavioural change and communities' perceptions regarding complex spatial issues. The application of citizen social science in the process of spatial policy-making would therefore intrinsically induce spatial policies that do take into account the real-life world of citizens.

4. Discussion

In this paper, three theoretical concepts were used to explore the potential of citizen social science in spatial planning: the technical versus communicative rationality, complex adaptive planning and evolutionary resilience. All three of these theoretical reflections emphasize on the importance of multi-stakeholders' involvement, space for self-organisation, a recognition of multiple perspectives and an open-mindedness for new potential situations. To put it more bluntly, societies need to open-up beyond their institutional realms and learn to observe from different perspectives, learn and adapt.

Originally, learning is the basic objective of any form of scientific research. The ensuing knowledge production is performed to develop a better understanding of this world and the processes that shape it (Cambridge, 2023). The primary conceptions of the scientific method to conduct scientific research takes its grounds in the 17th century, during the so-called Enlightment. The scientific method was regarded as a guarantee of a certain objectivity to study processes and to produce knowledge. Nowadays, the scientific method is predominantly used by recognized actors with a specific academic background and following a specific institutional-related framework. The objectivity of recognized scientifically produced knowledge is therefore subject to an epistemological debate (Irwin, 1995). In that sense, citizen social science proposes alternative models of knowledge production in accordance with the scientific method and based on dialogue between multiple members of communities and by fostering commitment (Campos et al., 2021). Its approach inherently implies a learning process that goes beyond in the traditional institutional approaches of knowledge production and a subsequent understanding of socio-ecological systems. Citizen social science hence motivates to look beyond traditional engineering approaches to address societal issues. As a form of scientific research, it aims at a greater understanding of societal situations. Traditional actors however cannot apply citizen social science on their own. Citizen social science can be applied both through the collaboration between academic actors and lay-citizens or by a group of self-organising citizens. Ultimately, citizen social science can be thought of as a highly potential planning tool to continuously explore and deal with complex adaptive systems and possible socio-ecological interventions for an enhanced resilience.

Through this paper's literature review, several advantages are identified to apply it in

spatial planning. These advantages can be formulated in the frame of the three main issues presented in the introduction: (1) the lack of recognition of citizen's role for active participatory planning, (2) the difficult search for instruments or approaches in the face of unpredictable complexity and (3) the translation of spatial policies coherent in the concrete life-world of citizens. Firstly, citizen social science can theoretically be initiated by any societal actor and subsequently serve "to develop a better understanding of the world (Cambridge, 2023)" from the perspective of the real life-world of citizens. Its conception intrinsically implies an essential active role for citizen to develop this new understanding. Secondly, it offers a wide array of possible modus operandi where any actor can actively participate in any step of the scientific process, as long as citizen's play a key-role. Depending on the level of the citizen's role, citizen social science presents various degrees of divergence to the traditionally recognized knowledge production. The role of each actor can be determined in function of situational factors of importance and different institutional settings. It thus has the potential to take any form and be carry out in function of situational circumstances. In the end, citizen social science can serve as useful socio-political learning tool in spatial planning to understand complex adaptive systems.

These conclusions are based on a comparison of theoretical reflections around citizen science and spatial planning and on an effort of joining them coherently. While this exercise led to the formulation of promising benefits of citizen social science in spatial planning, these potentialities were only theoretically conceptualised and thus remain hypothetical. Further investigation through practical case-studies could shed light to what extent these benefits are achieved and what situational factors influence those benefits.

Acknowledgments. This paper was written under the frame of the joint PhD conducted by Tom Goosse between the Centre of Mobility and Spatial Planning of the UGent (Belgium) and the Department of Spatial Planning of the RUGroningen (The Netherlands). The PhD research is promoted by prof. Luuk Boelens (UGent) and Gert de Roo (RUGroningen) and supervised by Dr. Tim Devos (UGent) and Dr. Christian Lamker (RUGroningen).

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