Designing nature-building communities

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Abstract

Urban renaturing efforts increasingly emphasize the role of collaborative governance in managing nature-based solutions (NbS). However, existing frameworks often prioritize institutional perspectives and top-down participation, overlooking the early-stage design needs of grassroots initiatives. This study introduces the concept of Nature-Building Communities (NbCs)—voluntary, community-driven governance networks focused on creating and maintaining urban ecosystems. Using a design science research approach, we synthesize insights from socio-ecological systems, adaptive co-management, platform design, and energy communities to develop a practical design framework that supports the self-organization of NbCs. The framework identifies core design problems across five dimensions: scope, architecture, value logic, governance, and strategy. It is validated through a case study in Hungary, where a school-based NbC was initiated as part of an EU-funded greening intervention. Our findings provide actionable guidance for grassroots actors, intermediaries, and policymakers aiming to support autonomous community participation in the co-governance of urban NbS. This approach shifts the emphasis from institutional “reach down” to grassroots “reach up,” enabling more just and effective urban renaturing.

Disclaimers

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1 Introduction

1.1 Urban renaturing and co-governance

Urbanization worldwide has increased cities' vulnerability to climate change impacts, such as urban heat islands and flooding, while also distancing residents from nature. In response, renaturing cities – through the strategic restoration and integration of green spaces such as parks, green roofs, and natural waterways – has gained traction as a means to enhance climate resilience, quality of life, health, and well-being (Cissé et al., 2022; Egorov et al., 2016). In Europe, there is strong institutional support for renaturing cities through green infrastructure and nature-based solutions (NbS), with instruments such as the EU Green Infrastructure Strategy, the EU Biodiversity Strategy, and the EU Nature Restoration Law promoting these approaches to bolster resilience, manage water sustainably, and improve human well-being (European Commission, 2013; European Commission, 2020; European Parliament, 2024).

It is widely acknowledged that successful urban renaturing depends on collaborative governance, or co-governance, in which municipalities and local communities share decision-making and stewardship roles (Frantzeskaki, 2019; van der Jagt, 2017; Ostrom, 2009; Verschuuren et al., 2021). Co-governance enables cities to pool resources and capacities for systemic solutions and long-term maintenance, and enhances the legitimacy, resilience, and sustainability of NbS through public involvement (Lenhart, 2015; Seymour et al., 2011; Vasile 2024). It may also unlock outcomes observed more broadly in participatory processes, such as place attachment (Frantzeskaki et al., 2018; Murphy et al., 2019), social self-organization (Montgomery, 2013; Larson et al., 2016; Pauleit et al., 2021), reconnecting people with nature (Lenhart, 2015; Verschuuren et al., 2021; Basak et al., 2022; Franklin, 2017), and environmental justice (Remme & Haarstad, 2022).

However, collaborative governance also faces major challenges. It is often difficult to determine the appropriate scope, methods, and intensity of citizen involvement (Lenhart, 2015), while collaboration processes can be costly, time-consuming, and prone to conflicts between public authorities and grassroots actors (Barrutia & Echebarria, 2019). In some cases, grassroots groups view participatory tools as mechanisms for co-option into centralized planning, sparking resistance against top-down approaches (Kapsali, 2023). Both authorities and communities must navigate fears of losing control, handle conflicts constructively, learn how to co-govern effectively, justly, and sustainably.

1.2 From “reach down” to “reach up” co-governance

In response to these challenges, this study shifts the focus from conventional "reach-down" models—where institutions engage communities on their terms—to "reach-up" models that empower grassroots actors to initiate and sustain NbS governance. This shift, we argue, consists of four focus areas, that we will show in the following section to be underrepresented in the body of NbS co-governance literature:

(1) shifting from the institutional to a grassroots perspective, to provide missing insights for the free association of people on the grassroots level
(2) shifting from high levels of abstraction to actionable knowledge to design co-governance;

(3) focusing on the early stages of organizing collaborations and networks, which are often fraught with uncertainty and failure;
(4) focusing on the unique complexities of urban NbS, which involve fragmented land ownership, dense populations, and overlapping infrastructures.

Despite growing interest in participatory approaches, much of the literature continues to frame bottom-up initiatives as components to be integrated into pre-existing institutional strategies and values, rather than as autonomous, emergent forces capable of reshaping urban governance from the ground up (Pauleit et al., 2018; Buijs et al., 2016; Satterthwaite, 2014; Remme & Haarstad, 2022; Kuitert & Buuren, 2022; Diep et al., 2022; Cutts et al., 2022; Tippet et al., 2022; Jørgensen et al., 2022; Moretto et al., 2022; Faragher & Carden, 2022; Hölscher et al., 2024). This top-down emphasis leaves little room for exploring how grassroots initiatives might self-organize, expand, and coordinate with others at larger scales to create urban green infrastructures.

Furthermore, grassroots actors possess diverse, and sometimes conflicting, motivations for engaging in urban greening—ranging from environmental protection to social justice or simply improving public spaces—which may not align with institutional agendas (Campos et al., 2022; Oscilowicz et al., 2023; Kapsali, 2023; Tornhill et al., 2024; Herzog et al., 2022). Coupled with bureaucratic inertia, institutional rigidity, and trust deficits, these frequently lead to failed participation efforts (Kapsali, 2023). Instead of trying to force square pegs through a round hole, one could explore ways how institutional resistance could be bypassed through the emergence of consolidating grassroots initiatives.

Grassroots-led renaturing is more developed where resources are scarce, central institutions are weak, and planning capacities are low. As opposed to the capital-based approach in the global North (Gulsrud & Steiner, 2020), in the global South, mapping and amplifying social practices based on greening-related competences (Birtchnell & Sultana, 2019), and coupling already self-organizing agricultural practices with urban green space management (Contesse, 2017) have been demonstrated models of community governance of green spaces.

In Europe, despite the widespread promotion of NbS co-creation, participation remains shallow and instrumentalist, often reproducing existing power hierarchies and reinforcing environmental injustices like green gentrification (Kiss et al., 2022; Fainstein, 2000; Toxopeus et al., 2020; Gantioler, 2019). Failed participation risks not only disempowering citizens but also undermining trust in participation itself and renaturing efforts altogether (Collins & Ison, 2009). As an alternative, the concept of "commoning" emerged, emphasizing urban green commons – shared, collectively managed urban ecosystems – as vehicles for democratic governance and equitable resource distribution (Frantzeskaki, 2019; Remme & Haarstad, 2022; Colding et al., 2013).

The evolution of grassroots initiatives into commoning faces significant early-stage challenges, including knowledge gaps, political resistance, and social fragmentation, which often prevent projects from materializing (van der Jagt et al., 2019; Schmalzbauer, 2018; Pauleit et al., 2019). Even when projects succeed initially, sustaining them long-term remains difficult due to funding shortages, volunteer burnout, and limited formalization pathways (Schmalzbauer, 2018). To spark broader systemic change, bottom-up initiatives must first "show up" in sufficient numbers, demonstrating competence and readiness for collaboration.

While extensive research exists on community-based natural resource management in rural and Global South contexts, there is a notable lack of studies on urban green commons in the Global North (Colding et al., 2013; Kanosvamhira et al., 2024). In European cities, land scarcity, legal and regulatory constraints, technical complexity, and weak community capacity stemming from social transience and fragmentation discourage the public to self-organize and public institutions to take them seriously on an infrastructural scale (Alejo et al., 2022; Drake & Lawson, 2015; Dennis & James, 2016; Foster & Iaione, 2016; Buijs et al., 2019; Fors et al., 2021; Svendsen & Campbell, 2008; Mattijsen et al., 2017). An actionable knowledgebase is missing for grassroots organizations to develop in a way that they enter the co-governance arena with competence and agency, which could break the glass ceiling of urban green commoning.

We address this research gap by synthesizing existing knowledge to create a design framework to guide the early-stage development of grassroots-driven NbS projects in the context of European cities that allows them to enter the co-governance arena autonomously. We also introduce the concept of *Nature-Building Communities* (NbC)—grassroots, community-driven governance networks focused on creating and managing urban nature-based solutions as collective actions—as the design object. Specifically, we answer the question: **Which early-stage design choices enable grassroots communities to act as autonomous partners in co-governing urban nature-based solutions?**

There are several studies and toolkits that attempted to create design frameworks for NbS co-governance, but leave three notable gaps. First, they tend to focus on specific NbS types, such as community gardens (e.g., Replay Network, 2020), rather than diverse urban greening initiatives. Second, they assume an institutional perspective, or a „reach-down" model, where municipalities initiate projects (e.g., Van der Jagt et al., 2019; Malekpour et al., 2021). Third, many frameworks are often deeply rooted in specific legal and institutional settings, and rarely address long-term governance challenges or integration into larger green infrastructure strategies, such as guidelines from Brussels (Le Début des Haricots, 2014), Geneva (République et Canton de Genéve, 2018), Bergen (Statsforvaltaren i Vestland, 2022) and the UK (Plymouth City Council, 2021).

Our contribution is threefold. First, we offer a practical framework that enables grassroots actors and mediators to overcome entry barriers and build self-sufficiency. Second, this would strengthen the grassroots movement to shift away power from an instrumentalist towards a commoning approach to urban renaturing. Third, we show how more self-sufficient grassroots initiatives can ease burdens on public authorities by engaging in co-governance with greater competence and readiness.

1.3 A new concept: nature-building communities

To have an appropriate object for the study, we introduce the nature-building community concept. Formally, we define nature-building communities (NbC) as open and voluntary governance networks performing collective actions to create, restore, maintain urban ecosystems as nature-based solutions, primarialy for the benefit of the community rather than for profits. The three main elements of this definition correspond to the gaps identified in the literature. First, the „governance network" element refers to associations of interdependent, autonomous actors, who exhibit some degree of formalization, self-regulation, typically operating autonomously in the shadow of public authorities (Torfing & Sørensen, 2014, built

on Rhodes, 2007 and Klijn & Koppenjan, 2000). This fulfils the increasing need for communities to present as (semi-)formal, competent partners in the co-governance of urban green spaces. Second, the „collective action" element refers to individuals intentionally organize around a shared goal of managing and provisioning public goods or common pool resources, as a joint commitment (Olson, 1965; Ostrom, 1990; Gilbert, 2010, Gantioler et al., 2023). This fulfils the need to shift from an instrumentalist approach of co-governance, where public authorities „reach down", to a commoning approach, where the grassroots level „reaches up", and planning objectives and urban-scale co-benefits are emergent rather than prescribed. Finally, the definition includes the main activity of communities, reflecting the focus on the urban context and on renaturing.

2 Materials and methods

2.1 Overall methodology

To identify early-stage NbC design choices of interest, we follow a design science research methodology (DSR) approach – creating knowledge through creative configuration of elements that solve a practical problem (Hevner et al., 2004; Peffers et al., 2007; Hevner, 2007). Our design object is the NbC and the design framework to create one is the main result that answers the research question. Adopting DSR recommendations (Hevner, 2007), the research includes a:

- rigor cycle, linking the design framework to academic knowledge;
- design cycle, the creation of the design object;
- relevance cycle, linking the design framework to practice (figure 1).

This section explains how literature and case data were selected and analyzed to generate the design framework and to test it in practice.

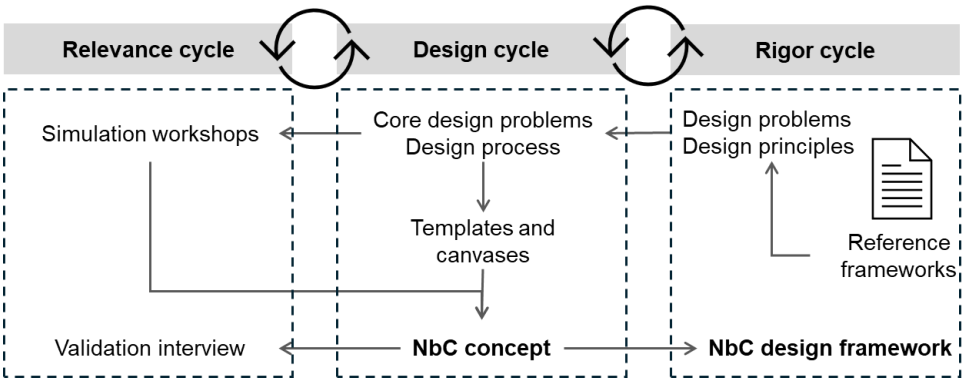

Figure 1: Research methodology overview, based on Hevner (2007)

2.2 Rigor cycle: creating the design framework

We define the design framework as a conceptual framework where the concepts are core design problems. By core design problems, we refer to the most burning issues common to NbCs at their early stage, which need to be specified to be able to articulate how the NbC works. Thus, during the rigor cycle, we follow the phases of conceptual framework development (Jabareen, 2009).

Phases 1-2 include mapping, reading, cataloguing data sources. We derive core design problems from an interpretation of concepts of existing frameworks relevant for NbC, which we obtain from a selective review of literature. We ensure NbC relevance with two levels of inclusion criteria, which also serves as a logic to categorize data sources. First, we define sibling frameworks, which thematically match the core characteristics of the NbC:

- free (open and voluntary) association of people
- interpedent and autonomous actors in the context of the object of governance
- collective action

Second, we define precursor frameworks, which also fit the domain of natural resource and ecosystems. The role of including siblings in the review is to overcome potential blindspots by relying exclusively on a single discourse. Finally, both precursors and siblings must be a sufficient model to understand, compare, and design the object they describe to be included.

From the theoretical background in which this paper is positioned, the socio-ecological systems (SES) framework and adaptive co-management (ACM) fit the criteria for precursors. SES provides a structured language for analysing the interplay between natural resource systems and the social arrangements governing them (Ostrom, 2009; Ostrom & Cox, 2010), which was also used as a design tool (see Ramaswami et al., 2012; Krafft & Frey, 2019; Dunlop et al., 2022). The ACM complements SES with an operational framework for managing complex ecosystems by iterative learning, adaptation under uncertainty, and the distribution of responsibilities between governmental and non-governmental actors (Berkes, Colding & Folke, 2000).

Authors 1 and 2 included 1 sibling frameworks each, after an initial reading of the precursors to respond to potential blindspots. First, the platform design framework – a collection of core design problems and a design process for technological platforms that facilitates interactions between actors (Tura, Kutvonen & Ritala, 2016) – was select. While generally discussed in management literature as tools for economic value creation (McIntyre and Srinivasan, 2017), platforms are more widely recognized as a driving force that shape any social arrangement (van Dijck, Poell & de Waal, 2018; Gillespie, 2010; Martin & Zysman, 2016; Alaimo et al., 2017), and can facilitate self-organizing entities and collective actions (e.g., Bennett & Segerberg, 2012; Howard & Hussain, 2013). Both SES and ACM have a higher level perspective for NbCs, informing governance arrangements and capacities, while platform design introduces a lower level focus of interactions among actors.

The second sibling is the energy community. Energy communities are open, voluntary associations of people and organizations in the field of energy, typically to jointly produce renewable energy, share energy, jointly invest in energy efficiency (Bauwens et al., 2022). It is selected due to its maturity as a concept concept, defined in EU and member state legislation (European Parliament & Council of the European Union, 2018 and 2019), political support (Busch et al., 2021), and an ever growing numbers of energy communities across the EU (Wierling et al., 2023).

For each framework, we identified key literature by snowballing from seminal publications on SES, ACM, and platform design (table 1). In the case of energy communities, technical support manuals for early energy community design were judged as more appropriate sources given the research question. Snowballing ran parallel to the coding process until a saturation of concepts was reached.

Table 1: Reference analysis sources

Reference	Key literature	Type
Socio-ecological systems analytic framework	Ostrom, 2009; Ostrom & Cox, 2010; Cole et al., 2019; Ostrom, 2007; Ostrom, 2002; Ostrom et al., 1994; Ostrom, 1990	Precursor
Adaptive co-management	Berkes, 2009; Berkes, Colding, & Folke, 2000; Berkes & Folke, 1998; Armitage et al., 2009; Olsson, Folke & Berkes, 2004; Plummer & Armitage, 2007	Precursor
Platform design framework	Tura, Kutvonen & Ritala, 2018; Gawer & Cusumano, 2014; Gawer & Cusumano, 2008; McIntyre & Srinivasan, 2017; Boudreau & Hagiu, 2009; Katz & Shapiro, 1985; Martin & Zysman, 2016; Tiwana, 2014; van Alstyne, Parker, & Choudary, 2016	Sibling
Energy community design frameworks	Rijpens, Riutort & Huybrechts, 2014; de Vries et al., 2016; Goiener, 2022; SEAI, 2023;	Sibling

Phases 3-6 of conceptual framework development is an inductive process of identifying, deconstructing, integrating concepts (core design problems) into the new framework. Authors 1 and 2 were involved in the open coding of the publications, starting with precursors before moving on to siblings. Each code had to fit the following criteria to be considered a core design problem:

- Actionability at an early stage
- Context of an issue or requirement
- Multiple choices to resolve them

The integration into themes consisted of formulating the design problems and grouping them into sequential categories, retaining and reformulating the codes as guiding questions for design. This happened parallel to the analysis and addition of new data sources, iteratively refining the framework. Phases 7-8 apply to the relevance cycle, described in seciton 2.4. The resulting set of core design problems is presented in section 3.1.

2.3 Design cycle: creating a nature-building community

An NbC in the context of the of greening interventions in a primary school (figure 2) in Szombathely, Hungary was selected as a case study to test the design framework. Two after-school clubs, one for cooking and one for crafting, supported by the parents of the children, were envisioned to become the NbC, with the scope of volunteering in the partial maintenance of the schoolyard, utilizing outdoor spaces for club, and other activities, and learning about and setting and example for nature-positive behavior. The case was selected, because it matches each element of the NbC definition: it maintains urban NbS in the schoolyard, the children, parents, teachers do so in the form of collective action, for the benefit of the whole school, and the relationships among teachers, the school, the municipality, the parents are not hierarchical, but network-based.

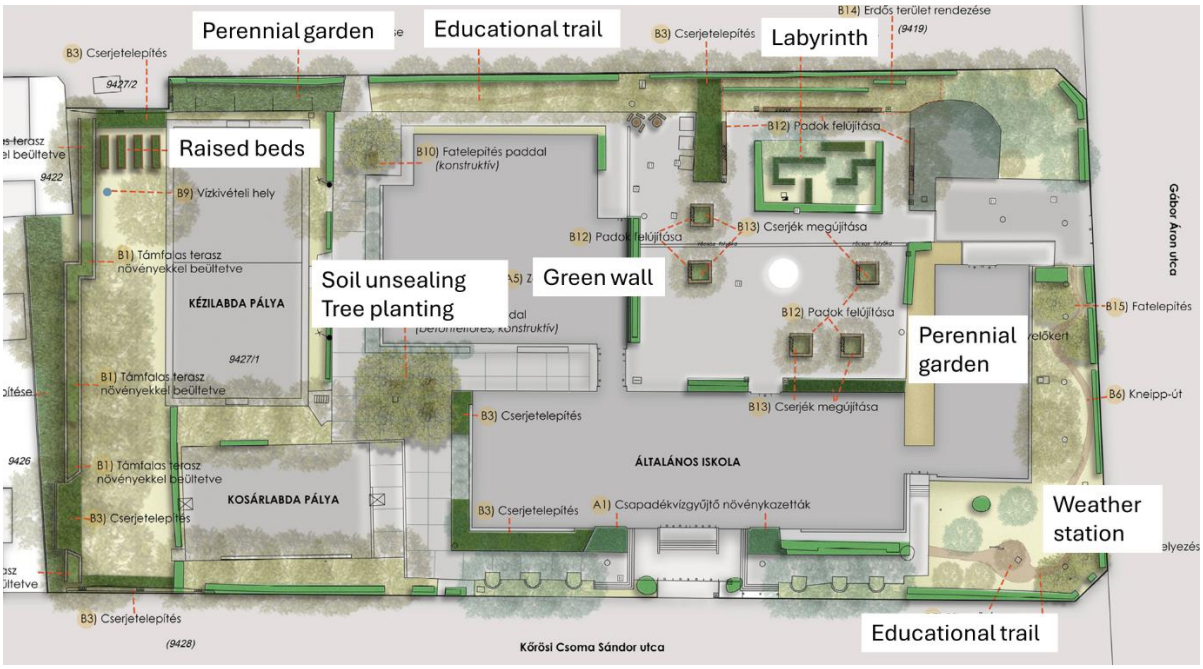

Figure 2: plan of greening interventions of the case study. Credit: Szily Adrienn tájépítész

The NbC was created prior this research as a part of a larger project with the involvement of authors 1 and 2. Data was gathered from multiple reports on engagement activities within the larger project (table 2). In each case, these are observations and summaries by researchers, rather than primary data. Author 1 was moderating all engagements.

Table 2: list of data sources used in the design and relevance cycles

Engagegement purpose	Methodology and outputs	Participants
Formulating objectives for co-governance	Review of municipal strategic documents, structured interview, formulating objectives using the SMART framework (sitation).	1 city hall department lead 1 politicial representative
Describing a pathway to improve co-governance capacities	Workshop, using backcasting to develop theory of change from the objectives.	1 city hall department lead 1 politicial representative
Preliminary visioning and municipal expectations for an NbC at the school	Workshop, ideating on the questions of NbC purpose, key actors, their roles, and resources needed to perform these roles.	1 city hall department lead 1 politicial representative
Scope of volunteering, utilization of space, and preferences for rules and organization by the pupils and their teachers	Simulation workshop, participants simulating a functioning NbC, addressing preselected challenges, observed by two researchers. The data source is the observation report.	2 teachers 14 pupils
Reflections and fine-tuning the outcome of the pupil workshop with their parents	Guided reflection on the previous results, redressing the same challenges. The	2 teachers 8 parents

	data source is the minutes of the session.	
Validation of the NbC constructed from the inputs of the pupil and parent engagement	Debrief meeting. The data source is the minutes of the session.	1 city hall department lead 1 politicial representative
Follow-up on NbC operation	Site visit and presentation	2 teachers 1 city hall department lead 1 politicial representative

The design framework was used as coding logic for a deductive analysis on the engagement outputs. Authors 1 and 2 identified observations and notes that could indicate a response to either of the design problems to reconstruct an NbC concept. Only explicit design choices that clearly, and according to both researchers respond to a design problem were considered. The observation reports and minutes of the pupil and parent workshops were the primary sources, supplemented by the preceding engagement reports with the municipality. The results are presented in section 3.2.

2.4 Relevance cycle: revisiting the NbC

The role of the relevance cycle is to validate the results by demonstrating the practical utility of the design object. To do so, we conducted an unstructured interview with municipal representatives shortly after the pupil and parent workshops to reflect on the process and outcomes, as well as a site visit with the teachers 6 months after the workshop. The teachers received compensation from the municipality to organize their NbC based on the workshops for the period. During the site visit, we assessed the state and utilization of the physical interventions, the teachers presented the activities of the NbC thus far, with initial feedback and plans for the future. To assess relevance we sought answers to two questions:

- Would the municipality repeat the project and welcome other NbCs?
- Will the members of the NbC continue to operate after the financial compensation stopped?

The former tests whether the NbC is seen as a competent partner in co-governance, while the latter gives an indication about its sustainability. The results for these engagements are built into section 3.2.

3 Results

3.1 Nature-building communities design framework

The design framework is a structured representation of the core design problems for NbCs at the early conceptual stage (table 3). By considering all and answering as many questions in the framework as possible, the idea of the NbC becomes specific enough to mobilize local actors, communicate the project to a wider audience, gather support from key external actors, make cost estimates, and begin detailed planning. Subsequent chapters describe the framework by module.

Table 3: Overview of the NbC design framework

Design problem	Guiding questions
Scope	
Resource system	Which ecosystem services by which NbS does the NbC provide and safeguard? What systemic, particularly ecological processes underpin the NbS? What are the boundaries of this system?
Degrees of affectedness	Who is affected and to what degree by the NbS? Who has a stake in the NbS? Which stakeholders are more, which are less powerful, are there vulnerable social groups to consider?
Purpose	What does the NbC aim to do? What values guide NbC actions?
Architecture	
Roles	Who does what? What different rights and responsibilities are assigned?
Actors	Who needs to be brought to the table? What skills and capacities are required? To what extent are they already available? What are their preexisting relationships?
Structure	What are the different levels of participation? Who are the key peripheral and who are the core actors and roles? How are they engaged? How are different actor groups connected within and into the core?
Value logic	
Incentive system	What motivates each actor? How can they be incentivized to do the right thing, and deterred from doing the wrong thing?
Value capture	Which ecosystem services are traded? Under what business model? What other sources of funding are attainable?
Governance	
Leadership model	Who is/are driving, leading the process in the beginning? Is there a core group of reliable figures?
Institutional space	What are the core interactions the NbC should make easier? How can these be grouped into different arenas? What do these arenas need to provide to make core interactions easier?
Operational rules	How are benefits shared? How are responsibilities allocated?
Collective choice rules	How are decisions made? How are they challenged?
Strategy	
Core information pool	What information needs to be monitored to effectively enforce rules? What others to effectively capture value and sustain outcomes? What others to diagnose problems, learn, and adapt? How can all that be obtained?
Incubation	How to grow and retain membership in the beginning? Who are potential and necessary partners, and how to engage them? How to engage with the local public? What are the early learning goals, and how to fulfill them?
Network effects	What are the risks and benefits of growing? What will be easier, what will be harder? What are the key milestones of growth, and what changes at these milestones?

3.1.1 Scope

The scope refers to both the NbS and NbC scopes. In the case of the NbS, it includes gathering information about the resource system in which the NbS functions and the people affected, while for the NbC, it includes high-level questions about purpose and core activities.

The shared resource is pivotal information both in the SES and energy community spheres. The SES and ACM models define *resource systems* that generate resource units or livelihoods (Ostrom, 2007; Plummer & Armitage, 2007). Learning from energy communities, resources need to be itemized as a pairing of a technology (the NbS) and a(n ecosystem) service (Goeiner, 2023) – see figure 3 for an example. On the system level, the design must provide clarity on the boundaries of the system that delivers these services (Ostrom, 2002; Ostrom, 2009), and knowledge on ecological processes that underpin, maintain, and enhance service delivery (Berkes, Colding, & Folke, 2000). These, for an NbC are more complex questions than for an energy community, where the resource is clear, and the siting is determined by technology selection (SEAI, 2023), whereas ecosystem service systems stretch beyond the boundaries of the properties of the resource itself and can be public, private, toll, or common-pool based on excludability and subtractability (Ostrom et al., 1994).

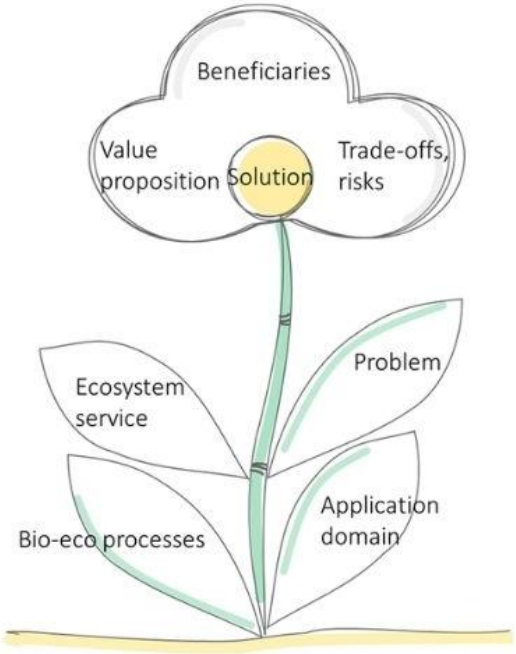

Figure 3: The NbS canvas is one possible tool to define the resources of the NbC. Credit: ABUD

A heterogeneous local public is inevitably affected by an NbC through contributing to, benefiting from, utilizing, supporting, or living near an NbS. Identifying who they are is crucial for several reasons: to enable consultation (Colfer, 2005), to tap into local knowledge, skills, and resources (Olsson, Folke, & Berkes, 2004), to prepare for the challenges of inclusion (Merril-Sands et al., 2000), and to align benefit and cost distribution rules (Ostrom, 2002). This does not just apply to people, but different properties need to contribute in nuanced and dynamic ways for NbS to function reliably – e.g., not blocking ventilation corridors – which would be the basis of different property rights (Schlager & Ostrom, 1992). The core design challenge lies in identifying who is affected, to what extent, and with what specific needs (Goeiner, 2022). Mapping local needs in relation to an NbS can promote fairer distribution of environmental resources, provided no group is marginalized (Gantioler, 2022). The *degree of affectedness* varies by ecosystem service – e.g., cooling effects are smaller than amenity catchments – and by social group, given their differing needs, values, and vulnerabilities (Ostrom, 2007; Thomas et al., 2019).

Finally, parallel to understanding the NbS scope, the other foundational step is to define the NbC purpose. Agreeing on a statement of purpose, including basic expectations, values, goals, the reason for having an NbC (following a canvas such as figure 4) both serves to project clarity and avoid conflict, as well as a stepping stone to formalize the NbC later, if needed (Olsson, Folke & Berkes, 2004; SEAI, 2023; Goeiner, 2022).

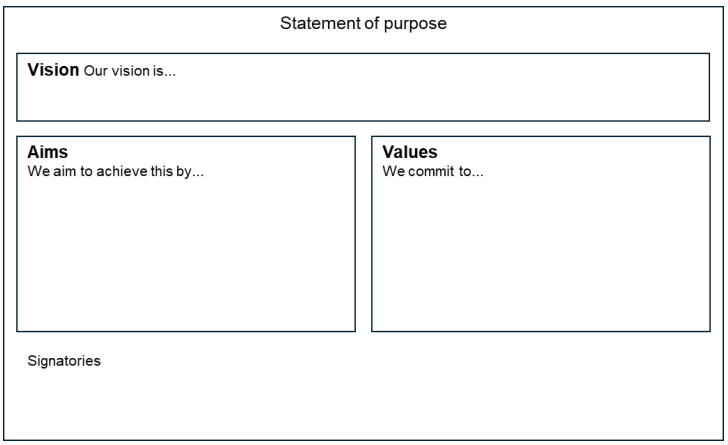

Figure 4: A template statement of purpose can be used to define the NbC scope. Credit: SEAI

3.1.2 Organizational structure

Design problems of NbC architecture include specification of the key actor roles, the layers of involvedness, and the network structure.

The first step in designing the structure is identifying the components, which, for an organization means identifying the roles. The platform literature defines an actor role in terms of the value they create (Gawer & Cusumano, 2014; Hein et al., 2019), energy community guidelines focus on what they do (SEAI, 2023), while the SES model includes variables listing the kind of governmental and non-governmental organizations interact in focal action situations (Ostrom, 2007; Cole et al., 2019). In the NbC context, it is appropriate to think of roles in terms of (1) activities and responsibilities, and (2) rights, access, and permissions[1].

However, it is also important to consider actors not just in terms of their role, but also of what we need them to bring to the table. As in both platforms and energy communities, an NbC also has a minimum viable stakeholder base, those capacities that the NbC must insource to function (Tura, Kutvonen, & Ritala, 2017; SEAI, 2023; Rijpens, Riutort, & Huybrechts, 2014; Plummer & Armitage, 2007). Designers need to create an inventory of actors, mark what is critical, and check how it maps to the NbC stakeholders. From an ACM perspective, this inventory should include knowledge needs – both technical and tacit – and the power dynamics of the expected community and the people affected (Armitage et al., 2009). This ensures that various NbC arenas (see Governance section) can be designed to mitigate preexisting marginalization and power asymmetries.

The third design problem is bringing the pieces together into a *structure* of involvement. An NbS is inherently a bundled package, inseparable from its spatial context, often delivering multiple ecosystem services to diverse stakeholders. Depending on their interests, stakeholders engage with the NbC at varying levels – from mere consent to active operational

[1] For reference, key roles for an energy community include: chairing, administration, fundraising, finance, community engagement, communication, legal, and technical (SEAI, 2023).

participation. Platform literature addresses this through access control, defining different degrees of platform openness (Parker & van Alstyne, 2017). The SES and ACM literatures emphasize nested governance structures, highlighting that actors external to a local project may hold divergent perspectives, interests, and powers to enable or obstruct local activities (Ostrom, 2002; Olsson, Folke, & Berkes, 2004; Plummer & Armitage, 2007). For an energy community, grid operators, municipalities, and regulators act as gatekeepers, whose ongoing support is essential (SEAI, 2023; Goeiner, 2022). This logic generalizes to NbCs as partnerships with overlapping infrastructure operators, democratic institutions, and regulatory bodies. It is thus important during the design process to specify different layers (figure 5), where a layer is specified by the level of access, participation depth, and approaches to communication.

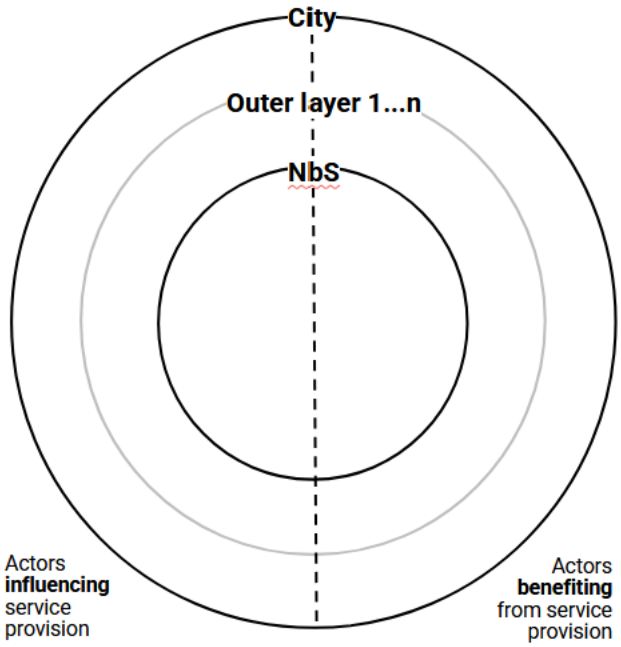

Figure 5.: A simple canvas can be used to visualize both connections and layers of the organization. The nodes can refer to roles, actors as single organizations, or actors as social groups. Key stewards can be represented on the edges. Credit: the authors

Finally, designers must specify the connections between roles to illustrate the NbC's actor network structure (Ostrom, 2007). These connections may involve information flows, relationships, or value exchanges (Cicero, 2017). Given the platform-like nature of NbCs, such links are responsible for mobilizing resources. For instance, losing a university partner may mean losing equipment and expertise, while alienating local pensioners can reduce inclusivity. Designers should therefore identify key stewards who link core actors with peripheral members and partners, as well as bridge clusters within local social networks, where feasible (Olsson, Folke, & Berkes, 2004).

3.1.3 Value logic

The value logic illuminates the architecture by mapping internal and external value flows, explaining why actors collaborate and why the co-created NbS can succeed. This involves two key design tasks: creating incentive systems and identifying value capture methods.

Incentivization becomes a design challenge in contexts lacking institutional or social norms to support NbS co-management (Berkes, Colding, & Folke, 2000), as is often the case in

European cities, where space management typically falls to property owners or managers. Designers must therefore assess actor motivations and identify incentives – or disincentives – to ensure accountability (Armitage et al., 2009; Ostrom, 2002).

Second, demonstrating the NbC's financial viability requires outlining a revenue model (Tura, Kutvonen, & Ritala, 2017) or available funding sources (Olsson, Folke, & Berkes, 2004). Revenues may stem partly from the NbS itself—through traded ecosystem services—or from conventional funding, such as grants. Services that can be monetized and how value is captured is thus a design problem. Common models include provisions, infrastructure risk reduction, tourism, pollution mitigation, green building certifications, and energy savings (European Commission, 2022). However, many ecosystem services provide non-tradeable social value (e.g., recreational spaces), which should be considered to attract investment.

3.1.4 Governance

NbC governance refers to practical tools and strategies for the members to take responsibility for their collective project. It includes the design problems: leadership, institutional space, and rules.

First, the *leadership model* is central. Different frameworks emphasize various leadership aspects. SES and ACM literatures stress the role of local leaders and entrepreneurial capacity in fostering successful self-organization (Baland & Platteau, 1996; Berkes, Colding, & Folke, 2000). Energy community manuals highlight core groups of leaders (SEAI, 2023; Rijpens, Riutort, & Huybrechts, 2014). Platform ecosystems focus on the distribution of leadership between platform owners and complementors (Tiwana, 2014). In NbCs, it is crucial to identify from the outset who drives the process and inspire trust and demonstrate stability, especially during early, volatile phases, and whether they operate hierarchically (e.g., for urban park co-management) or distributed (e.g., for community gardens).

Second is the question of *institutional spaces*, that the NbC provides for collaboration. Various frameworks describe such collaborative arenas as governance infrastructures for self-organization. ACM emphasizes learning arenas for knowledge sharing, community learning, and innovation (Olsson, Folke, & Berkes, 2004; Armitage et al., 2009; Cook et al., 2004). SES, refers to conflict resolution mechanisms (Ostrom, 2002). In the energy domain, arenas feature as instruments of systemic transition. In the energy literature, we find arenas for systemic change (Joergensen, 2012; Loorbach, 2010), and deliberative arenas, working groups, recommended by practical guides (SEAI, 2023; Goeiner, 2022; Rijpens, Riutort, & Huybrechts, 2014). These arenas – whether for learning, conflict resolution, experimentation, or coordination – are essentially platforms designed to enable interactions (van Alstyne, Parker, & Choudary, 2016; Boudreau & Hagiu, 2009). Thus, designers must identify the core interactions the NbC should support, structure them into distinct arenas (or sub-platforms), and describe the features of individual arenas need that facilitate their core interaction (Tura, Kutvonen, & Ritala, 2017, Olsson, Folke, & Berkes, 2004).

The final design problem concerns rules. On the conceptual level *operational rules*, and *collective choice rules* or collective decision procedures need to be considered (Ostrom, 2007; Berkes, Colding, & Folke, 2000; Plummer & Armitage, 2007). The main operational are those of appopriation and provision, which needs to be in balance to ensure fairness (Ostrom, 2002). Designers need to develop a logic to assign responsbilities and allocate benefits among the membership that is proportional, just, and legitimate. Everyone affected by operational rules,

need to be provided channels and a process to participate in creating and challenging them as collective decisions (Ostrom, 2002).

3.1.5 Strategy

The strategy module addresses operational design challenges in the NbC, focusing on the core information pool, lifecycle management, and network effects.

Given the complexity of SES, a critical design task is defining the information required for daily NbC operations. Predictability is a key constraint in natural resource management, and specifying data needs indicates the feasibility of achieving it (Ostrom, 2009). Monitoring supports rule enforcement (Ostrom, 2002), tracks NbC outcomes (Ostrom, 2007), and provides additional data for system diagnosis and adaptation (Berkes & Folke, 1998). Designers must thus select information types for enforcement, outcome evaluation, and diagnosis – the *core information pool*. This requires balancing costs and enforcement effectiveness, quantifying measurable, actionable objectives and value capture, and identifying key system variables beyond outcomes. Co-monitoring options should be preferred, for it allows day-to-day observations by locals, who in turn will learn gradually more about how the NbS operates (Olsson, Folke, & Berkes, 2004).

The NbC *lifecycle* mirrors platform development, with an incubation and a mature phase, marked by membership and commitment benchmarks (Evans & Schmalensee, 2010). The incubation phase is characterized by intense networking to identify leaders, start public consultation, acquire skills and capacities, and secure partnership with gatekeeper actors (SEAI, 2023). Designers must therefore devise engagement strategies across social networks, local areas, and partner organizations (SEAI, 2023), while setting early learning goals and identifying learning resources (Berkes & Folke, 1998). Additionally, designers need to explore whether to formalize to gain access to external support, and under which legal structure (SEAI, 2023).

Finally, strategies for managing growth are also relevant. In platform literature, the defining dynamic of platforms are *network effects* or network externalities – benefits or detriments due to the size of the membership (Katz & Shapiro, 1985). Not all NbCs grow to invoke network effects, but for those with a larger green infrastructural perspective, they are relevant. Designers can draw inspirations from the platform literature, e.g., the network effect of complementarity goods availability (McIntyre & Srinivasan, 2016) or from the SES literature, e.g., the effect of group size on transaction costs (Ostrom, 2009). Positive network effects should be then considered as milestones, interim goals to reach, while negative network effects as risks to prepare for.

3.2 Demonstration: nature-building community in Hungary

This section shows how a completed NbC concept design looks like, applying the design framework on the school NbC in Szombathely. We provide a summary of design choices in table 4, with a more detailed description in the following chapters.

4. Table: Overview of design choices for the Szombathely school NbC

Design problem	**Guiding questions**
Scope	
Resource system	School grounds 1. Raised beds: crops provision

	2. Soil unsealing, trees, perennial gardens, green wall: cooling effect 3. Trees, green wall: air purification 4. Raised beds, information stones, plant litter: education, recreation 5. All interventions: biodiversity 6. All interventions: beautiful environments
Degrees of affectedness	1. School students 2. School teachers 3. Parents
Vision	Create and sustain long-term engagement with the NbS, relying on an alliance of teachers, students, and parents, by building the NbS into the activities of the extracurricular clubs.
Architecture	
Roles	1. Club students: maintenance, awareness raising and club activities 2. Club teachers: developing and executing an educational program in the club 3. Municipality: initial financial support 4. Parents: material and other support of the club activities
Actors	All capacities present in the current stakeholder base.
Structure	1. Core group: club teachers and students 2. Shared activities with: other clubs, parents 3. Regulatory oversight and support: municipality, school management
Value logic	
Incentive system	1. Teachers, students, parents are motivated by engaging activities. 2. Municipality is motivated by decreasing maintenance needed for newly installed green interventions.
Value capture	No new operational costs are incurred, future developments and material needs of the clubs will be raised by parents, the school, or the municipality. No ecosystem services traded. The NbC becomes self-sustaining on the basis of strong engagement, reciprocity and social capital.
Governance	
Leadership model	The club teachers lead the process.
Institutional space	The NbC occupies the existing arenas provided by the clubs, the school, and the parent association.
Operational rules	Each club adopts green elements that are relevant for their activities, and maintains them, whereas they exploit the benefits themselves.
Collective choice rules	Educational content is developed by the teachers by default, proposals can come from parents or students through direct communication.
Strategy	
Core information pool	Indicators were not defined, but degree of engagement, and topical relevance to nature and environment are monitored by the teachers and the municipality, respectively. Data sources: internal reflections among teachers and parents, reporting to the municipality, and a sensor for some environmental data provide information.

Incubation	Simulation workshops and one-year incubation period, during which teachers receive financial compensation and report to the municipality.
Network effects	Growth opportunities are expanding to other clubs, deeper involvement of parents, developing more educational facilities outdoor.

3.2.1 Scope

The NbS was selected from the interventions on the school property based on the priorities of the two extracurricular clubs, the municipality, and the teaching staff. Cooling effect, recreation, biodiversity enhancement and crop provision are the main ecosystem services utilized by the two clubs, whereas the municipality and the teaching staff also added air purification and education. Recreation, education, and – owing to its small size – cooling effect can be considered club goods, and crops private goods, as they are tied to the school property. Air purification and biodviersity enhancements on the other hand are public goods. However, when thinking on a systemic scale, air quality improvement does not manifest in the absence of an obvious nearby source of pollution, and lack of a larger green infrastructure for ventillation. The social dimension of the system is more relevant, as crop cultivation, education, protection of biodiversity depend on the engagement and actions of people involved. Thus the main purpose of the NbC is to create and sustain long-term engagement with the interventions, relying on an alliance of teachers, students, and parents. The community aims to build the NbS into the activities of the extracurricular clubs. The cooking club takes on cultivation of herbs and vegetables, the crafting club working with natural materials and building for animals, into their portfolio of activities.

Figure 6: Pictures from the first year activities of the NbC. Left: planting herbs in the cooking club. Right: preparing bird feed in the crafting club. Credit: Dési Huber Általános Iskola

3.2.2 Architecture

The core group of the NbC consists of the two clubs, with a rotating pool of students, and one teacher running each club. Each club „adopts" a green element, and students in the club are responsible to carry out maintenance, guided by the teachers. The cooking club takes over the raised beds, the crafting club takes any animal-oriented infrastructure. A third club, responsible for after-school sports, with access to equipment and the sports fields is to be mobilized to similarly adopt the sports area. Students also assume a role of awareness raising, setting an example and engaging with other students to keep the outdoor areas clean. The two teachers, besides coordinating maintenance, plan and carry out the outdoor-oriented education programs in the extracurricular group, liaise with parents, the school management, and report on activities to the municipality.

Parents constitute the middle layer of engagement (figure 7), They provide materials, ad-hoc help with the activities of the club, and organize fundraising to get new equipment, plants, or other small-scale developments. Access to them is possible on a needs basis, either through their children or through the teachers.

The outermost layer includes the school management and the municipality. The school management has operational oversight on the club activities, while the municipality audits the level of engagement with the green interventions and the nature-positive content of the educational program. Both peripheral roles include financial support for larger developments.

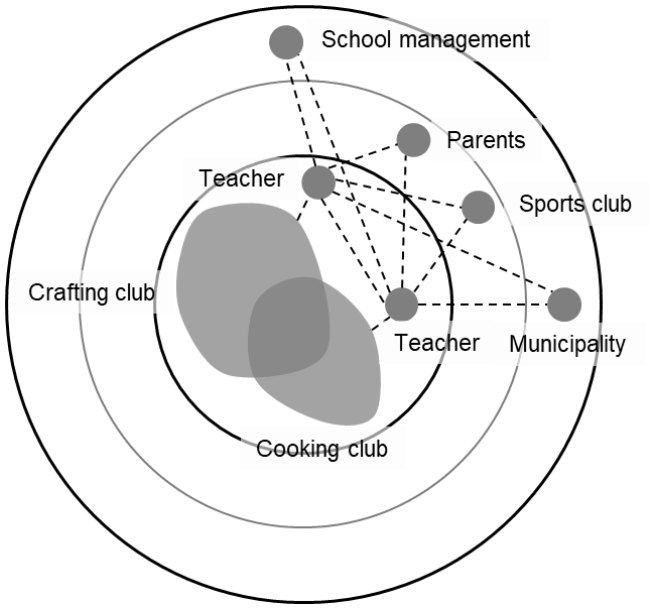

Figure 7: Architecture of the Szombathely school NbC

3.2.3 Value logic

In the Szombathely case, there is no traded ecosystem service, as toll goods belong to a public institution, and public goods do not manifest measurably and reliably. The long-term sustainability of the community depends on volunteer work on the side of teachers and parents and the engagement of the students, and any future development depends on availability of public sector funding. The municipality decided to provide some compensation for the two teachers to develop and test their new educational program for one year. To ensure that these activities survive beyond that period, the teachers were given freedom in selecting the

activities, with the only requirement being the use of the new outdoor facilities, and a nature-positive framing. This fulfils the motivation of the municipality, which has a pro-environmental policy agenda, and seeks to re-green public institutions within the city. As the success of such interventions rely on care and maintenance, the NbC is a tool for the municipality to devolve maintenance as close as possible to the users. The parents, children, and the teachers are motivated by keeping the new environment clean and functional, but the true motor of the NbC is engagement in the club activities. More interesting activities, leading to more engaged students, leading to more engaged parents, leading to more resources committed to new activities is the reinforcing feedback loop, which, as long as it runs, will keep the NbC afloat.

3.2.4 Governance

The two teachers take the leadership role, driving the success of the NbC. This partnership gives some redundancy in case one of them no longer performs their role. However, the support of parents is necessary to avoid burnout. At the time of writing, there is no need to adjust or develop the existing institutional space provided by the two clubs, the school, and the parent association. It is reported by some parents that their involvement is not properly facilitated, they often do not know how they could support the school and if they need to. Operational rules ensure that benefit sharing is congruent with the allocation of work: students are responsible mainly for the NbS they benefit from directly. The cooking club uses the crops, while the crafting club students take home when their work is no longer in rotation at the school. Decisions about the educational program ultimately rests on the teachers, but since the club activities are not part of the national curriculum, it is open to any proposals from students and parents alike. Larger activites, events, developments must be approved by the school district, the authority employing the teaching staff (which is not an NbC member), and the municipality, in their capacity as asset managers.

3.2.5 Strategy

Core information is rather disconnected from the value of the ecosystem services. A sensor to measure air pressure, wind speed/direction, precipitation, radiation temperature, pyranometer and soil humidity have been installed, with a data dashboard made public. This monitors the air quality and cooling effect ecosystem services. The municipality identified the learning goal of facilitating successful participatory projects, and setting an example for co-maintenance by local communities. However, the only instrument to enable this is a report that the two teachers give at the end of their kickstart year.

In terms of lifecycle, the NbC starts already with critical mass membership, thus the goal of the incubation period is not to mobilize more members, but to internalize the new activities. The most important incubation activities were the two simulation workshops, which gave a foundation for the teachers to develop the NbC. The municipality offered financial compensation for the first year, both to support, and through reporting, to steer the NbC. Good experiences from this first year is then expected to bring about sufficient momentum for the following years. Growth opportunites are limited, but not insignificant. The sports club has been identified as a potential future member, but other extracurricular clubs could be approached as well. Due to the rigidity of school curricula in Hungary, expanding to the classes are more difficult, but the homeroom class might provide some space for limited participation. Deeper involvement of parents, the organization of events and fundraising came up as an option to elicit growth. This particular NbC concept hinges on the interactivity of NbS: the more

interactivity it offers, the more it can be used as an educational device. The members did not identify network effects on their own.

4 Discussion

4.1 Reflection on the methodology

What was the result of using sibling concepts? Looking at the design framework, there are three kinds of core design problems: (1) ones that were present in only one framework, (2) ones that were present in all but one framework, (3) ones that were present in all frameworks (table 5).

Each design problem that exist in only one framework highlights the unique value of considering that framework. For example, only the platform design framework explores deeply network effects. Thinking about them forces us to acknowledge that the NbC is a dynamic entity, it will not be the same next year as it was the last year, and network effects offers one useful perspective to make sense of it. In the Szombathely case, no network effect was identified, but it is easy to see how the participation of more clubs would eventually lead to eliminating most outdoor day-to-day maintenance needs, effectively occupying the whole schoolyard, or how deeper parental involvement can diversify the range of activities possible, given how diverse resources they could bring to the table. If an NbC does not have such a limiting spatial scope, such as an urban river renaturalization project, an NbC can also run into a scalability limit, where new arenas have to be installed for changing needs to facilitate more and more members shared work.

Some design problems are present in multiple frameworks, but one. This signals an opportunity to reflect on that one framework to see whether it has blindspot that is worthwhile to address. Here, we can make a couple of recommendations. The platform design framework (Tura, Kutvonen, & Ritala, 2017) would benefit from including „core information" as a design problem, to ensure adaptive capacity, rule enforcement, outcome measurement. The SES and adaptive comanagement frameworks typically have a static lens of mature governance arrangements, granted they are analytic framework. However, some concept of lifecycle stage would allow both to capture the changing challenges, requirements, characteristics of these governance arrangements. It could be an insteresting avenue of research to look for inflection points similar to the critical mass in platform literature, and adjust e.g., the second and third-order variables in an SES analysis accordingly.

In cases where all frameworks had an input to a design problem, they still focused on different aspects of it, offering some learning opportunities. For example, we have identified that the platform concept is a useful tool to both standardize and operationalize the various arenas explored by other frameworks. People on the grassroots level may not know whether they need a transition arena, or a learning arena, or what that entails, but they can articulate facilitation needs for some core interactions to occur. In the Szombathely case, teachers had bad experiences with parent inertia in the past, while parents appeared proactive, and missing channels where they can contribute. This refers to a facilitation need, namely a platform to coordinate parent contributions, corresponding to a task group. Similarly, teachers did raise an issue that any physical intervention must go through too many actors, the school board, the school district, and the municipality, where they are bound to run into resistance. This signals

the need for space for experimentations, well captured in the transition arena concept (Loorbach, 2010).

Table 5: Reference frameworks with significant (***) or tangential (*) contributions to a design problem

	Platform design framework	Socio-ecological sytems model	Adaptive comanagement	Energy communities
Scope				
Resource system		***	***	*
Degree of affectedness	*	***	***	***
Vision				***
Architecture				
Roles	***			
Actors	***		***	*
Structure	*	***	***	***
Value logic				
Incentives	***	***	***	
Value capture	***		*	
Governance				
Leadership model	*	***	***	***
Institutional space	***	*	***	***
Rules	***	***	*	***
Strategy				
Core information		***	***	*
Incubation	***			***
Network effects	***	*		

4.2 Reflection on the research objectives

The presented design framework answers the question how to self-organize the creation of urban NbS. It can be used by mediating actors to consult with grassroot actors, and can be used as a blueprint by the grassroot actors themselves. Of the reported barriers of urban green commoning, the results can support targeted capacity building in communities, and define the topics where enabling policies need to be instated. According to our reading of the literature, if grassroots movements can resolve more of the design problems, they will be better at mobilizing support, and demonstrating a degree of competence. On the one hand, this positions them better to obtain land for their projects, on the other hand, it reduces the risk the public sector perceives in power sharing.

The design framework does not steer the user towards complete self-sufficiency, but towards an autonomous operation involving public institutions. This is reinforced by the layered „structure", the „actors", and the „role" design problems, which encourages users to acknowledge their capacity gaps, and not to draw a hard boundary around a core group, but imagine it more like a gradient of participation. While both SES and ACM refer to a nested governance structure, the NbC is not merely the last level closest to the NbS. As a governance

network, the NbC spans across multiple governance levels, where some are more engaged than others.

The gradient of participation is also a key difference between NbCs and energy communities and community-based natural resource management. This logically follows the differences in their resource systems: NbC operations will always overlap with larger green infrastructures and ecosystem services affecting large populations. In particular, regulatory and cultural ecosystem services in the urban context will create more intricate, fuzzy, multiple overlapping areas of effect, and system boundaries are less clear than in a rural context. This gives high importance to the degrees of affectedness design problem, which pushes designers to tackle the urban complexity and level the playing field for marginalized voices.

4.3 Limitations and further research

Key research choices with a risk of bias in this study were selections of (1) frameworks, (2) specific sources, (3) items to include in the new framework.

The eligibility criteria allowed to determine which framework to include, but do not explain why these particular frameworks made the cut and others did not. SES and adaptive comanagement are easily defensible as the two defining and often intertwined concepts in the literature concerned with self-organization in ecosystem governance. However, the any of the sibling frameworks could have been replaced by a suitable alternative that meets the eligibility criteria, .e.g., frameworks of open innovation (Huizingh, 2010) or digital peer production (Kostakis, Vragoteris, & Acharja, 2021). It was not the intent of this study to be comprehensive in that regard, but merely to learn from other fields, where synergies are obvious. The production of the design framework should not stop here, it should be adjusted, adapted, expanded, by bringing in more outside experience in a cross-disciplinary effort. Should a comprehensive approach be attempted, the research team should insource relevant expertise from a variety of fields where topics listed in the eligibility criteria are in focus.

Potential source of bias lies in the selection of items from each framework. In case of sibling references, sources were mainly design manuals and frameworks, where the risk of error is lower. When selecting from analytic frameworks on the other hand, we had to judge whether each item can be realistically influenced by design, whether it is influenced by early-stage design choices, and whether it is relevant for urban contexts in Europe.

The design research methodology limits generalizability. The selected case study is situated in very particular conditions set by a large EU research project. External funding was acquired for the actual NbS interventions, the interventions occured prior the formation of the NbC, and members have been engaged before in co-design, and were familiar with co-governance as one of the focal points of the project. Grassroots initiatives do not usually have access to this level of technical know-how and funding, nor can we call this a case of urban green commoning, given that the project was initiated by the municipality. Further testing in operational environments and under different conditions will increase confidence in the framework.

Finally, the design framework was not given directly to NbC members, meaning we do not have information on whether it promotes self-sufficiency. While the research question focused narrowly on what design questions should be answered by prospective NbCs at an early stage, for practical purposes, follow-up research should explore what competences are needed to

answer these. This would allow us to understand what constellation of actors are more likely to become NbCs, but could also help developing governmental services to support grassroots self-organization.

5 Conclusion

We set out in this study to turn attention from instrumentalist co-governance of urban NbS to urban green commoning. We showcased a gap in the literature that focuses more on building knowledge on how public institutions can „reach down" to communities, and less on how the grassroots can „reach up", and shape institutions through an emergence of their actions.

We introduced the concept of nature-building communities (NbC) as open and voluntary governance networks performing collective actions to create, restore, maintain urban ecosystems as nature-based solutions, primarialy for the benefit of the community rather than for profits. We formalized the lack of knowledge on grassroots „reaching up" as a lack of a clear, actionable framework for the early-stage design of NbCs, and developed and tested such framework, following a design science research method, relying on existing frameworks for socio-ecological systems, adaptive comanagement, platforms, and energy communities. The main contributions of the study:

1. Nature-building community as an umbrella concept like energy communities for urban contexts in the global North that captures various grassroots, community-based, self-organizing models aimed at urban green commoning.
2. The design framework supports consultants and municipalities work with grassroots organizations, neighbourhood associations, informal groups, individuals in the early stage of co-creating urban NbS. If they are able to guide local actors through the points of the template, they are capable of incubating NbCs.
3. The design framework supports the aforementioned groups to articulate their concept, mobilize support, and demonstrate competence in the arenas of co-governance.

Ultimately, if clarity in the early stages allow NbCs to appear, connect, and influence urban institutions in numbers, it will reduce the burden of the public sector, hopefully leading to a more effective and just renaturing of cities.

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