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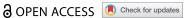
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Co-creating multifunctional landscapes – lessons from three case studies

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ABSTRACT

In the face of overlapping social and environmental challenges, multifunctionality has emerged as an important concept in ecosystem and landscape governance. To operationalize multifunctionality, the governance literature calls for collaborative approaches. Despite the abundant literature on collaborative approaches, there is a gap between rhetoric and practice and a need for more real-world examples. This paper explores the role and value of co-design as a co-creation approach to foster multifunctional landscapes. We analyze three different case studies that have deployed co-creation approaches to support multifunctionality by examining how these processes surfaced and shifted contextual conditions, how this influenced innovations and what the implications are for landscape multifunctionality. Rather than departing from landscape ideals, this paper suggests that supporting multifunctional landscapes through co-creation happens 1) from within the context, 2) over a long period of time, and 3) in 'opposition to' practices or dynamics that prohibit multifunctionality. We furthermore suggest that the role of co-creation in supporting multifunctionality can be understood as facilitating ongoing sense-making that 1) collaboratively identifies and defines the dynamics that hinder multifunctionality, 2) collaboratively identifies and explores implementation pathways to the 'next best possibility' by surfacing and influencing the contextual conditions that enable or hinder its implementation, and 3) reflects and adapts to continuously redefine the undesired and explore emerging possibilities. This paper can thus aid practitioners in implementing co-creation to enable multifunctional landscapes from a bottom-up approach.

1. Introduction

Multifunctionality as a concept has gained popularity in recent years as mounting evidence indicates the necessity of integrated approaches to land use in the face of overlapping environmental challenges (see, e.g. Termeer et al. 2015; Leventon et al. 2019, Reed et al. 2016; Galan et al. 2023). Generally, multifunctional landscapes are characterized by a complex spatial configuration with diversified management practices supporting multiple and occasionally competing interests of different actors in the landscape (Hölting et al. 2020). In contrast to a multifunctional landscape, many landscapes today focus on delivering a limited range of (ecosystem) services, often at the expense of others, such as biodiversity, resulting in benefits for some actors and negative consequences for others (Neyret et al. 2023).

Fostering multifunctional landscapes is a wicked problem with nonlinear feedback loops, the risk of unintended consequences, mismatches in spatial and temporal scales, power imbalances and contestation between diverse value systems (Termeer et al. 2015; DeFries and Nagendra 2017; Borgström et al. 2021).

DeFries and Nagendra (2017) argue that the two essential traps to avoid in ecosystem management are '[1] falsely assuming tame solutions and [2] inaction from overwhelming complexity'. Commonly, scholars advocate for collaborative, context-based, adaptive, and inclusive multisector approaches to navigate these wicked problems. Mastrangelo et al. (2014), for example, point to four guidelines to improve landscape planning for multifunctionality: i) landscape level assessments; ii) departing from ecological processes and maximizing socially relevant ecosystem services (ES); iii) involving stakeholders throughout processes and; iv) prioritizing the well-being of local people. While scholars stress different success factors, the active involvement stakeholders is a (almost) unanimous call. For example, Parrott et al. (2019) argue that multifunctionality at landscape scales requires 'ongoing and coordinated collaboration facilitated by a dedicated group of individuals and informed by science'. Different and often overlapping concepts have been adopted to describe these collaborative governance approaches, including participatory/collaborative landscape planning (Luz 2000; Kristensen et al. 2022),

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adaptive management (Folke et al. 2005; Schultz et al. 2015), and co-creation (Karrasch et al. 2017; Galan et al. 2023). However, the compelling notion of enabling multifunctionality through contextually grounded collaborative approaches is a demanding endeavour, and, as Conrad et al. (2011) note, there is a gap between 'rhetoric and practice'.

Co-creation provides a framework to navigate complex challenges, calling for more inclusive, democratic, and iterative 'problem-solving' approaches (Voorberg et al. 2015; Norström et al. 2020; Franklin 2022). The practical expression of co-creation manifests through facilitated interactions between different forms of knowledge, in theory, improving the understanding of complex situations and enabling the identification and implementation of innovations required in changing landscape management (Ansell and Torfing 2021).

While innovation is a contested term, Pel et al. (2020) provide conceptual clarity that captures the governance ambitioned through co-creation by integrating an array of dimensions, including cultural, economic, material, political, technological, spiritual, ecological and spatial, where innovation may emerge and alter ways of using, organizing, framing and knowing within the specific problem context. In other words, landscape governance through co-creation may involve collaboratively creating new management practices, new decision-making processes, applying new values, visions, concepts, stakeholder constellations, etc., that empower actors to navigate overlapping challenges and support multifunctional landscapes. As Eaton et al. (2021) point out, the conditions for the empowerment that enable environmental change are poorly understood and difficult to analyze.

This paper aims to contribute to concretizing the role and value of co-creation as a collaborative approach to promote multifunctionality by analyzing three case studies that have assumed a co-creation approach to foster landscape multifunctionality. The first case examines efforts to co-design the restoration of Pine Savannahs while promoting rural development in eastern Honduras. The second case examines an innovation process that promotes multifunctionality in production-dominated forests in central Sweden. The third case explores how a game co-design process can foster multifunctionality and reduce nutrient enrichment in three catchment areas in the Baltic Sea region. All three cases are characterized by a co-inquiry process that underpins the co-design of initiatives that lay the foundation for new livelihood opportunities, species maintenance, various ecosystem services, and cultural, aesthetic, and recreational values.

Below, we present our framework for analyzing the three case studies based on the work of Eaton et al. (2021), Patterson et al. (2013), and Pel et al. (2020).

2. Analytical framework and research process

To unpack the role of co-creation in supporting multifunctionality, we draw on the work of Eaton et al. (2021), Patterson et al. (2013), and Pel (2020) and examine relations and relational changes; resources and resourcing; norms, perceptions and perceptive shifts; and institutions and institutional change. As Patterson et al. (2013) note, innovations for landscape changes both emerge from and, in turn, shape these contextual conditions. To improve our understanding of the link between co-creation and multifunctionality, we examine how co-creation surfaced and influenced these contextual conditions, how this enabled or hindered innovations, and what this implied for multifunctionality in these contexts (see Figure 1). Below, we also present the conditions that constitute the analytical framework. Although distinguished for analytical purposes, the contextual conditions are overlapping and interdependent.

2.1. Relations and relational change

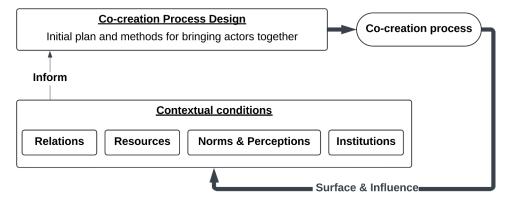West et al. (2019) conceptualize contexts as dynamic sets of relations altered by re-enacting social and

Figure 1. The framework illustrates how co-creation supports change toward multifunctionality and provides a theoretical basis for interpreting the three case studies presented in this study.

material relationships. Forming new relations can thus empower actors to take actions that influence the context in which they find themselves. Tangible expressions of new relations between actors may manifest through leveraging resources, maintaining the motivation to pursue goals, or challenging dominant norms and institutions, eventually leading to environmental change (Pel et al. 2020; Eaton et al. 2021). Relational change may happen within groups, between groups, within dominant institutions or socio-material contexts. Leveraging relational changes depends on actors' collaborative capacities, which in turn are entangled in existing resources, norms and institutions (Patterson et al. 2013). Forming new relationships is thus both an outcome and an intervention.

Acknowledging the fundamental importance of existing relations in forming actions and innovations, we explore how the co-creation processes in the case studies surfaced existing networks and empowered actors to enhance their collaborative capacity to form new relations.

2.2. Resources and resource mobilization

Ensuring resource availability in the problem context is vital for local action (Patterson et al. 2013). While financial mobilization, i.e. ensuring adequate and sustained financial investments over time, is often acknowledged as a key factor, resourcing has more dimensions. These include the physical dimension, i.e. empowerment through changes to infrastructure and technology; the human dimension, referring to necessary skills and knowledge underpinning changes to practices; the natural dimension, i.e. the regeneration of natural capital that provides resource flows and services; and lastly, the social dimension referring to changes in collaborative capacities, including trust, equity and justice. Fostering the capacity to make sense of necessary resources and identifying possible pathways to generate them is thus crucial in navigating complex landscape management contexts (Patterson et al. 2013; Pel et al. 2020; Eaton et al. 2021).

Acknowledging resource mobilization is critical in empowering actions, we explore how the co-creation processes surfaced existing and untapped resources and empowered actors to mobilize resources in their contexts.

2.3. Norms, perception and perceptive shifts

Abandoning undesirable norms or establishing new positive norms requires changes in empirical and normative expectations (Bicchieri and Mercier 2014). As Eaton et al. (2021) note, this can happen in three dimensions: 'subjective norms (expectations of what ought to be done), injunctive norms (approved of behaviors), and descriptive norms (what is being done)'. Deliberative spaces where actors can reflect on challenges and practices can support the emergence of new norms within existing actor constellations or newly formed coalitions of actors (McGuire et al. 2013; Bicchieri and Mercier 2014; West et al. 2019). While normative shifts are bound to be gradual and emergent (Pahl-Wostl 2009), they can manifest through differences in the ordinary ways of doing things within or between actor constellations, through an increased sense of responsibility (e.g. land care), collective efficacy, or a sense of group solidarity (Eaton et al. 2021). The disruption of established knowledge and critical reflection of existing assumptions and delineation of system boundaries is crucial. This can be achieved by promoting systemic inquiry and negotiation, rather than technical inquiry, and by avoiding the pursuit of an elusive 'right' (Ison 2010). This process is often referred to as social learning, a collective learning process that enables sensemaking by sharing knowledge, and enabling a space to learn about 'others' epistemology, their grounds for knowing and doing (Ernst 2019). This may foster collective visions and strategies and thus contributes to generating action in contexts where joint responses are difficult to foster (Patterson et al. 2013; Eaton et al. 2021).

Acknowledging norms and perception as critical to change efforts, we explore if and how the co-creation processes empowered collective visions and what responses emerged from these communicative spaces.

2.4. Institutions and institutional change

Institutional arrangements, including formal (regulations, policies, plans), informal (e.g. relationships, multi-actor platforms and bridging organizations), and market mechanisms, shape what practices are possible in landscape management (Pahl-Wostl 2009; Patterson et al. 2013). Pel et al. (2020) point out that these institutions are not 'unmovable, monolithic blocks' but emergent and constantly negotiated. To effectively empower actors to steer and adapt to 'more desirable' relations to the landscape, the institutional arrangements must enable new ways of doing, organizing, framing and knowing. Pahl-Wostl (2009) notes that resilient and adaptive governance regimes require contextual adaptability, balance between formal and informal institutions, balance between top-down and bottom-up initiatives, ability to navigate uncertainty, emergent leadership and capable knowledge brokering. While this invites various possible responses and strategies, Patterson et al. (2013) point out it might occasionally be more important to 'understand how multi-level institutional arrangements and their interactions collectively enable or constrain management action at and beyond the local level' rather than 'seeking a single integrative institutional level or governance mode'.

Acknowledging institutions as constraining or enabling, we explore if and how the co-creation processes surfaced an understanding of existing institutions and a collective cognizance of their influence on landscape management opportunities. Figure 2 outlines key steps in this research process.

3. Case studies

In this section, we summarize the co-creation process in the case contexts and briefly present how these surfaced and shaped the conditions presented above. Subsequently, we present what this meant for landscape multifunctionality in the different contexts. Table 1 provides an overview of key indicators for each case.
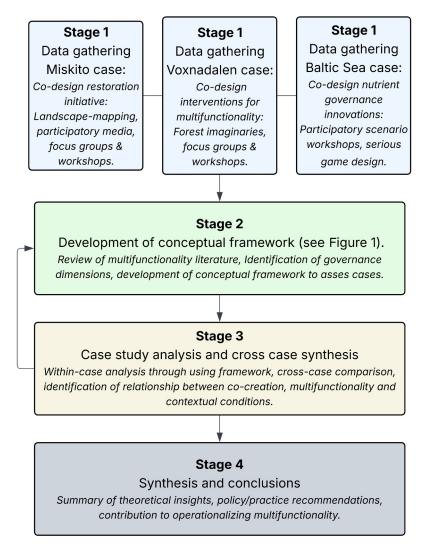
Stage 1 Data gathering Miskito case: *Co-design restoration initiative: Landscape-mapping, participatory media, focus groups & workshops.*	**Stage 1** Data gathering Voxnadalen case: *Co-design interventions for multifunctionality: Forest imaginaries, focus groups & workshops.*	**Stage 1** Data gathering Baltic Sea case: *Co-design nutrient governance innovations: Participatory scenario workshops, serious game design.*

Stage 2
Development of conceptual framework (see Figure 1).
Review of multifunctionality literature, Identification of governance dimensions, development of conceptual framework to asses cases.

Stage 3
Case study analysis and cross case synthesis
Within-case analysis through using framework, cross-case comparison, identification of relationship between co-creation, multifunctionality and contextual conditions.

Stage 4
Synthesis and conclusions
Summary of theoretical insights, policy/practice recommendations, contribution to operationalizing multifunctionality.

Figure 2. Overview of the main stages of the research process, from data collection and stakeholder engagement in each case study to cross-case synthesis and comparative analysis, illustrating how the empirical insights presented in the paper were generated.

Table 1. Comparison of indicators between three case studies.

Indicator	Honduras (La Mosquitia)	Sweden (Voxnadalen)	Baltic Sea Region Catchments
Geographic context	Eastern Honduras, Miskito territory; degraded pine savannahs	Mid-Sweden coniferous forest belt; UNESCO biosphere reserve	Catchments in Sweden (Fyrisån), Poland (Słupia), Finland (Vantaanjoki)
Socio-economic	Subsistence economy, widespread poverty	Forestry-based rural economy, small industries and family businesses	Mixed rural – urban economies; intensive agriculture and forestry alongside growing urban centers
Main land-use	Subsistence farming, low intensity forestry, hunting and foraging	Clear-cut forestry, agriculture	Agriculture, urban areas, mixed forestry
Key multifunctionality challenges	Current fire regime.	Declining biodiversity.	Nutrient enrichment → eutrophication

3.1. Fire management and savannah restoration in LA Mosquitia, Honduras

3.1.1. Contextual overview

In 2013, the Honduran government granted 7% of Honduran territory to MASTA, a political organization representing the Miskito people in the Honduran part of La Mosquitia (eastern Honduras, see Figure 3). La Mosquitia contains diverse habitats with large swaths of degraded land following decades of colonization, plantations and ranching that drove forest clearance (Herlihy and Leake 1992). Beyond a degraded landscape, Gracia Dios (the Honduran department where La Mosquitia is situated) has rampant poverty, slow development and the highest vulnerability of all 18 regions in Honduras, with one in five people in rural areas surviving on less than US$1.90 per day (Confederation 2022). In 2019, in Truksinasta territorial council, an initative began with the aim to co-create the design of a restoration project, using the voluntary carbon market (VCM) as a primary funding source.

3.1.2. Process description

Restoring the savannah provided an initial point of interaction between previously disconnected actors.

In collaboration with project initiators, local authorities facilitated meetings across the region to discuss and agree on a broad framework for the restoration. Once the initiative had been anchored in the communities and relevant actors had been identified, attention turned to co-creating the design of the restoration initiative. As existing literature and initial field research revealed, the current fire regime in Truksinasta undermines the regeneration of *Pinus caribaea* (Myers 2006), drastically impacting the landscape. Consequently, the fire and the socio-ecological dynamics underpinning the fire regime became a focal point for continued co-inquiry. Various methods such as participatory media, landscape imaginaries, household interviews and formal meetings were used to include multiple perspectives and ensure meaningful dialogues informing the design and implementation of restoration activities.

Informed by the insights from the co-inquiry, the process shifted toward crafting plans, strategies, and innovations that could enable an implementable approach to managing the fire regime in large swaths of the Savannah. The process thus sought to explore questions of how to organize fire management, how payments for the sequestered carbon should function,
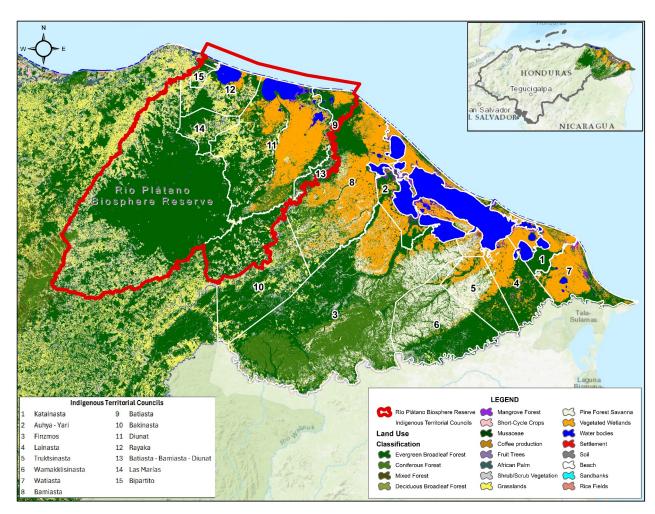

Figure 3. Map from showing different habitats in La Mosquitia as well as the local council councils.

who would get to work in the fire brigade, and what areas should be prioritized for restoration. Addressing these questions required different actor configurations to tackle varied conditions, necessitating a shift toward specialized knowledge at certain times while being informed by the perspectives generated throughout the co-inquiry. (See Appendix A for a more detailed process description.)

3.1.3. Conditional shifts

The co-inquiry provided opportunities for different actors to deliberate on their divergent and collective relationships to fires. The process showed that most people in the region saw the fires as deeply problematic. While excluding fire from the landscape was believed to lead to undesirable consequences, possibly tipping the savannah into a tropical hardwood forest, there was a large consensus that the fire regime had to be managed. Figure 4 illustrates the perceived benefits of a managed fire regime.

As Figure 2 shows, the co-inquiry revealed that managing the fire regime could deliver an array of ecosystem services while supporting livelihoods and improving food security. Community groups had, however, previously attempted to coordinate working groups to control the fires but failed. Looking at the contextual conditions hindering successful fire management interventions, we found that 1) There was

little or no collaboration between families and villages, indicating a low collaborative capacity, 2) No funding existed to organize landscape actions at scale (on both collective and private land), 3) There was a prevailing belief that caring for trees was hard and restoring the savannah was impossible with no coherent vision for managing the fire regime, and 4) There was only a small fire brigade without diverse representation from different communities and thus lacked real agency to influence.

In the sites where the restoration initiative is piloted, the fire management has thus far proven successful, with pine trees germinating in areas where grass previously dominated. While causality cannot be identified in wicked problem contexts, shifts in the contextual conditions can be seen and include 1) Increased collaboration between villages facilitated through fire management activities, 2) Access to funds through the VCM, and an increased number of paid job opportunities 3) Belief that regeneration at scale is possible due to observing successful germination in pilot sites as well as plans and ideas of where and how to manage the fire regime, and what is needed to succeed, and 4) Growing fire brigade from a diverse cross section of various communities, providing paid jobs, fire education and fire protection across large swaths of the savannah. These shifts have proved pivotal in moving away from a yearly fire regime in the pilot areas.
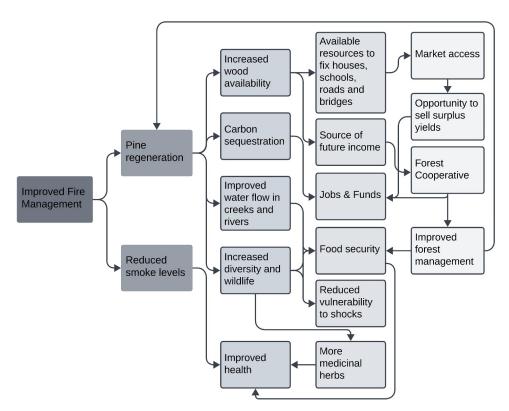

Figure 4. Summary of community perspectives from La Mosquitia on the ecological, social, and economic outcomes of coordinated fire management efforts, derived from participatory mapping and workshops.
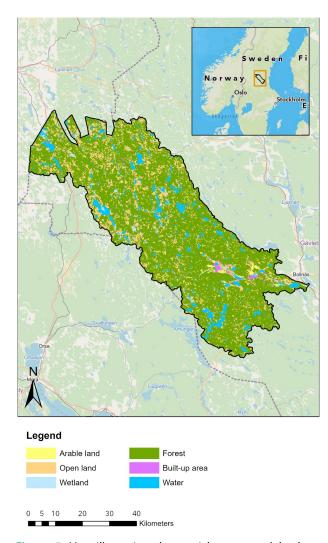
Figure 5. Map illustrating the spatial extent and land-use distribution of the Voxnadalen Biosphere Reserve, including key land-cover types such as forest, agricultural, and settlement areas.

3.2. Forest futures in Voxnadalen biosphere reserve, Sweden

3.2.1. Contextual overview

The Voxnadalen biosphere reserve was endorsed by UNESCO in 2019. It is located in the mid-Sweden coniferous forest belt and is characterized by forests, mountains, and UNESCO World Heritage-decorated farmhouses (see Figure 5). A key focus area for the Voxnadalen biosphere is sustainable forest management, a contested issue across Sweden characterized by a continued prioritization of the short-term economic dimension of sustainability and increasing polarization (Lindahl et al. 2017; Jakobsson et al. 2021). The Voxnadalen biosphere, through collaboration with other regional actors, aims to provide a neutral arena that supports dialogue, learning, and innovation for sustainable forest management (Ovanåker n.d.)). Since 2019, the work has resulted in 1) an economic association (Voxkedjan) that purchases and distributes quality timber and lobbies for management practices that ensure quality timber for the future, and 2) excursions and education materials focused on spreading forest management methods favouring quality timber. In collaboration with the Voxnadalen biosphere, we facilitated a co-creation process during 2022–2023 with the initial aims of 1) creating a safe space to discuss forest issues and the future of forests and the forest sector, 2) promoting social learning among diverse actors, and 3) exploring pathways to sustainable use and management of forests.

3.2.2. Process description

The Management Board of the Voxnadalen biosphere acted as a key informant to help identify relevant stakeholders, drawing on their existing networks. A total of 10 interviews and focus groups were carried out with different actors in the region. Using imaginaries (conceptualized as visions of desirable futures) to mediate conversations, actors gathered in their respective groups to explore seeds of change (promising ideas and practices), perspectives on current forestry practices, expectations and desires of future forest management, as well as ideas of how to bridge the expected and the desired. The interviews and focus groups, in turn, informed the design of the first workshop, which combined rich picturing and imaginaries to explore pressing challenges and ways of navigating these in relation to the Voxnadalen biosphere. The workshop ultimately resulted in the establishment of a goal to make the biosphere into a model area for sustainable forestry in Sweden. This goal was explored in depth in the second workshop, with discussions revolving around emerging seeds of change and how they might be implemented or scaled in the Voxnadalen biosphere. Three topics were highlighted and brought into a third workshop where attention turned toward the practicalities of empowering these emerging seeds of change. The three ideas were: 1) compensation schemes for promoting continuous cover forestry (CCF), 2) land-ownership structures and land inheritance, and 3) work procedures to promote increased collaboration amongst forest owners. (See Appendix B for a more detailed process description.)

3.2.3. Conditional shifts

The initial interviews and focus groups together with the first workshop showed that despite differences and tensions between various perspectives, actors agreed on an overarching aim of working towards making the Voxnadalen a model area for sustainable forestry, including strengthening biodiversity, storing carbon, enabling diverse forest-based livelihoods, and preserving cultural heritage. At first glance, this could be understood as broad support for multifunctionality. However, as
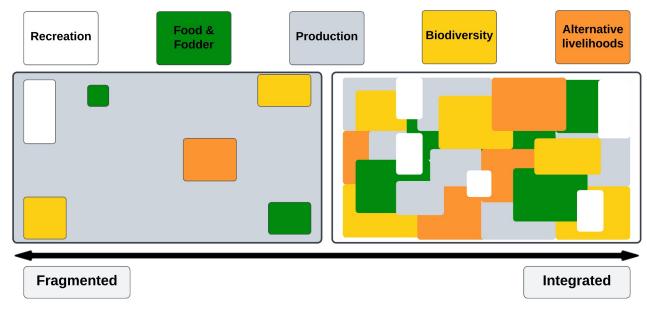
Figure 6. Different conceptualizations of a multifunctional landscape with integrated approaches representing one side of the spectrum and fragmented approaches the other.

deliberations in the various focus groups showed, differences crystallized in the relationships between the various landscape functions. Figure 6 illustrates a spectrum based on ideas of multifunctional landscapes. On the one side of the spectrum is an integrated approach where multiple values are generated across the landscape. On the other side of the spectrum is a fragmented approach where the landscape generates the same values but at different locations.

Despite these differences, actors managed to identify a few key ideas that they agreed would support the Voxnadalen biosphere in becoming a model area for sustainable forest management. Continuous cover forestry (CCF) emerged as one of the pivotal ideas, considered by most actors to deliver multiple benefits, including long-term access to quality timber, increased carbon storage, biodiversity and sustained incomes for forest owners. As the discussions in the second workshop highlighted, making this transition is a wicked problem with embedded cultural, financial, structural, technological and capacity dimensions. The lack of short-term financial incentives for CCF and the promotion of ecosystem services stood out as particularly perverse, not least since the first workshop highlighted the importance of forestry for supporting local livelihoods. While the financial aspect of CCF was discussed further with varying opinions on the profitability, actors agreed that a compensation scheme that could compensate for the potential loss of short-term incomes in a CCF transition with payment for the promotion of various ecosystem services and ensuring quality timber for the future could be beneficial. Since influencing national politics for payments was perceived as very difficult, voluntary carbon credits emerged as a potential financial innovation in the region to promote capacity building for a long-term transition to CCF. In the second workshop, it became evident that a majority of the actors in the co-creation process believed carbon credits could promote biodiversity and carbon sequestration and support a wide range of livelihoods from the forest landscape, warranting further research into what could realistically be implemented. In exploring timeframes, responsibilities, activities, resource boundaries and conditions in the third workshop, several insights emerged. Figure 7 summarizes one of these insights, providing an overview of the conditions considered essential for a VCM model adapted to the Voxnadalen.

The third workshop not only addressed the emerging seeds of change and the challenges in scaling them but also provided space for reflection on the contextual conditions and their influence on the ability to sustain the efforts required to scale these changes. Knowledge gaps and funding hurdles emerged as tangible and significant obstacles, and it became evident that the co-creation process needed to embrace new processes and actor constellations capable of leveraging necessary financial and human resources. While these processes are still unfolding, the effects are discernible through collective funding applications for enhancing CCF-related capacities, implementing deliberative mini-publics connected to forest futures and the desire to develop a VCM-funded CCF-capacity building project. The co-creation process can be understood as surfacing and facilitating reflection on the contextual conditions in connection to various innovations. As the process enters new phases, the observable shifts in contextual conditions include 1) New collaborations enabling successful funding applications for continued capacity building for CCF, 2) Identification of missing
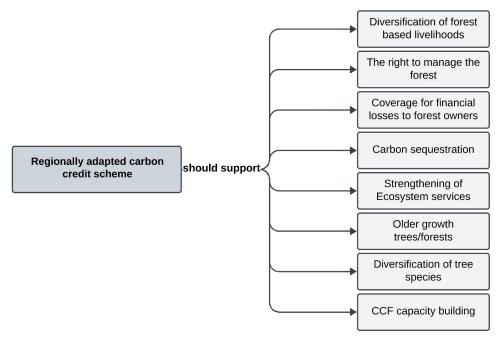
Figure 7. Conditions identified as important for implementing a carbon credit scheme adapted to the Voxnadalen Biosphere Reserve.

financial and human resources to enable desired interventions, 3) Increased and shared understanding of the challenges behind transitions in forest management, and 4) Increasing responsibility and ownership of future visions across local stakeholders.

3.3. Eutrophication – governance for multifunctionality in the Baltic Sea region

3.3.1. Contextual overview

The systemic nature of nutrient enrichment in the Baltic Sea region creates intricate connections between the biophysical and socio-economic realms, magnifying and exporting issues across various dimensions. Acknowledging that wicked situations involve numerous conflicting interests that transcend discrete sectors and stakeholders, the European science and policy community are turning to participatory and systemic approaches to knowledge production and governance for inspiration. The change in governance focus is evident in the EU Water Framework Directive (WFD), which promotes integrated and participatory methods for formulating a program of measures to attain optimal ecosystem health in local catchments (Jager et al. 2016). Despite these intentions, existing power imbalances enable stakeholders in influential positions to disproportionately influence outcomes during consensus-building processes related to defining good ecosystem health and in trade-off processes associated with developing a program of measures (Westberg and Powell 2015; Knight et al. 2019). This can be exemplified by the preexisting policy environment emphasis on addressing nutrient emissions from specific point sources,

particularly the wastewater sector (Thodsen et al. 2017). In doing so, diffuse sources of nutrients are neglected, primarily stemming from the agriculture sector, which significantly contributes to the Baltic Sea's nutrient loads. Consequently, there has been a pronounced concentration on expensive, one-dimensional technical measures, overshadowing the potential for more holistic and multifunctional practices. This instance underscores the distorting role of power imbalances evident at the intersection where knowledge is transformed into governance actions.

As a response, the 'Innovative Methods for Stakeholder Engagement' work package in the Bonus Return project (www.bonusreturn.eu/) initiated a co-creation process to create a safe and inclusive learning environment. The aim was to bridge between knowledge and action by creating an inconsequential setting for testing assessing various eco-technologies (measures and actions) that could address nutrient enrichment and enhance local practices. Stakeholders and researchers from three catchments (See Figure 8) – Fyrisån in Sweden, Slupia in Poland, and Vatanaanjoki, Poland – participated in the process of co-designing a serious game to support this aim.

3.3.2. Process description

A serious game is a game with a purpose beyond entertainment where actors can test and evaluate the impacts of various actions within a playful and safe environment that represents real-world situations. The co-design process began with actors gathered for a rich picture workshop to map and deliberate over socio-ecological dynamics and issues within
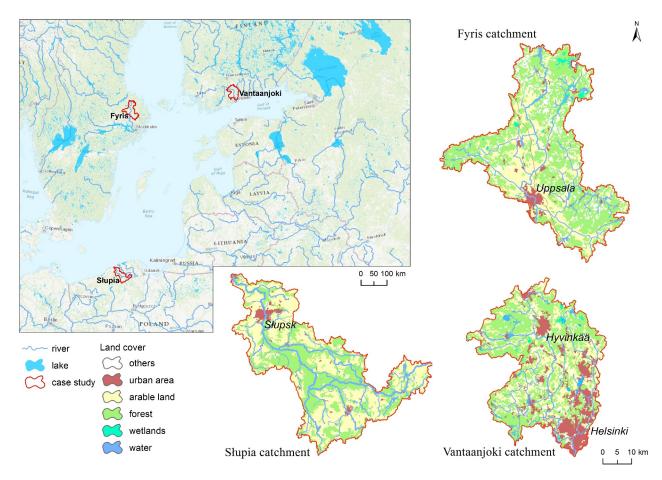
Figure 8. Map showing the three catchments and the landuse within them. Source: Piniewski et al. (2021).

their respective catchments, mediating a systemic cognizance of the catchment. Building on the insights from the first workshop, the co-inquiry continued through a second workshop focusing on the feasibility and impacts of eco-technological constellations in agricultural, forestry, urban, and marine settings. Drawing on the insights from the workshops, a first game prototype was developed and playtested through focus groups to mediate dialogue and learning about eco-technology preferences and their systemic consequences. Through two additional rounds of co-designing the game, various policies and socio-ecological shocks were further incorporated into the game prototype. This allowed actors to playtest and explore how different constellations of measures and actions performed in an uncertain non-equilibrium system. The prototype supported further cross-cutting workshops, mediating conversations on the barriers and possibilities posed by the existing socio-political environment to the implementation of eco-technologies and development interventions in their respective catchments (Powell et al. 2021). (See Appendix C for table with more detailed description of process.)

3.3.3. Conditional shifts

Building agility and adaptive capacity was a key aim and outcome of the process, not least evidenced by the final game prototype where adaptation was pivotal to fulfil the primary aims of the game, namely to 1) *reduce emissions from respective land use systems (urban areas, forestry, and agriculture)*, and 2) *increase the productivity of these systems*. As the game prototype evolved through iterations of co-designing and playtesting, ideas for addressing the wicked issue in local catchments began to shift. While the need for agility and adaptive capacities were very much part of the perceptive shift, treating nutrients as a resource and not a problem also gained importance amongst actors, effectively reframing the initial problem definitions. Multiple iterations of playing, evaluating and re-designing the game prototype, helped foster systemic awareness of the biophysical, cultural and socio-economic challenges of navigating diffuse sources of nutrient emissions in the Baltic Sea region. While this was an important contribution to the process, the game's strength was primarily found in co-designing it as the co-design process mediated un-scripted dialogues in a playful and safe space, supporting futures

literacy and emergent responses. The co-design of the game thus provided a safe space to surface and deliberate over opportunities and barriers to contextual conditions across the different catchments, arguably building the adaptive capacities among participants to address and navigate challenges in a self-organized manner. Observable shifts in contextual conditions include 1) Learning networks across different catchments in the Baltic Sea region, 2) Reframing of nutrients as a potential resource, 3) Increased futures literacy and understanding of the complexity of nutrient enrichment, and 4) Enhanced understanding of socio-political barriers and possibilities to innovations in the catchments.

3.4. Synthesis

All three co-creation processes revolved around wicked issues and corresponding innovations. Moreover, the processes all strived to surface and influence the contextual conditions that enabled or hindered the innovations from taking hold or being scaled. The importance of surfacing and influencing contextual conditions can thus be seen in all three contexts but nevertheless manifests differently across them. In La Mosquitia, for example, the increased collaboration between villages enabled improved fire management, which in turn, further improved the collaboration, creating a positive feedback loop in the project area and indicating a relational change. In Voxnadalen, changes in the landscape have not materialized in the same concrete way as La Mosquitia. However, becoming specific about the resources required to scale CCF in Voxnadalen indicates a shared awareness of existing constraining conditions, which empowered a group of actors to submit joint project applications for capacity building in alternative forest management, pursuing to influence both financial and human resources in order to scale CCF in the region. In the Baltic Sea region case, reframing nutrients from a problem to a resource offers another example of how the processes influenced the contextual condition, indicating a perceptive shift enabling innovative practices or actions that can address nutrient enrichment at the Baltic Sea region level but also provide local benefits in the various catchments. Differences across the contexts are expected, but attempts to influence contextual conditions to promote emergent innovations proved to be a key part of all three co-creation processes to support multifunctional landscapes.

3.4.1. Implications for multifunctionality

Although multifunctional landscapes were the aspiration in all three cases, the term was not explicitly defined. Rather, the catalyst was identifying what is currently hindering a multifunctional landscape, specifically the dynamics and practices that prevent multiple practices and services from co-existing in the landscape. The attempts in La Mosquitia to foster co-existence between various landscape functions offer a good example. Rather than starting from the landscape ideals, the process was guided by the collective identification of pathways away from an undesired state (annual fires). The identified pathways furthermore had to support both the interest of funders to sequester carbon and the interest of local communities to ensure food security, health and livelihoods. Innovations to deliver multiple landscape functions thus grew from a shared perception of annual fires as a force undermining various landscape functions. The implementation of innovations, however, stemmed from multiple shifts in the contextual conditions, including the leveraging of flexible and long-term funding through the VCM, the formation of new actor constellations with different capabilities, the cultivation of collaborative capacities, and the development of shared visions. The practice of co-creation in supporting these shifts can thus be understood as deliberating on the innovations as well as surfacing and influencing the contextual conditions in ways that empowered actors to take actions to move the landscape away from what is collectively identified as undermining multifunctionality. It is worth noticing that this is an iterative process where shifting the baseline conditions requires a continuous process of collectively identifying the dynamics that prevent the co-existence of multiple practices.

What is not enabling a multifunctional landscape also proved to be a starting point in Voxnadalen. Actors participating in the process had diverging views on what a desirable multifunctional forest landscape in Voxnadalen would look like (see Figure 3). They could nevertheless largely agree that the status quo did not represent multifunctionality and that scaling certain practices and introducing new ones was important to move towards a more multifunctional landscape. Similar to La Mosquitia, deliberations on the actual innovations were complemented by actors unpacking how the contextual conditions shape the opportunities to engage with and work on the innovations considered essential for a turn towards more multifunctional landscapes. Through this process actors collectively expressed how the Voxnadalen biosphere endorsement was itself an enabling opportunity to foster the collaborative capacity required for transformations. While actors saw the Voxnadalen biosphere as an institution supporting transformative endeavours, the lack of resources, relationships, and norms to promote emerging ideas and disrupt the status quo in the region highlighted that much work lies ahead to influence these conditions and scale the desired innovations. The

usefulness of co-creation moving forward thus depends on the collective ability to navigate these identified constraints and influence the contextual conditions by building relevant actor constellations, acquiring additional resources and sustaining interaction between various actors. This movement between exploring pathways away from what is not considered multifunctional and reflecting on possibilities to influence the contextual conditions has been a fundamental part of working towards multifunctionality through co-creation in Voxnadalen.

Multifunctionality was neither explicitly defined throughout the game co-design process in the Baltic Sea region case. Instead, it was left to be interpreted when needed as an emergent strategy rooted in site-specific needs to adapt to or anticipate uncertain futures, including bio-physical shocks or social-political changes. Cultivating an ability to navigate shocks adaptively and creatively thus emerged from the process as a critical intervention to enable multifunctionality. The safe space provided by the co-design of the game enabled actors to reflect on the viability of various innovations under different shock regimes in a non-scripted and emergent way. As Ison et al. (2011) point out, this form of social learning can be seen as a 'governance mechanism' to improve participants' capacities to navigate emergent challenges and opportunities in their respective catchments. The game co-design indicated that multifunctionality is defined through iterations of the 'next best possibility' that emerges in relation to challenges or opportunities manifest at the local level. In the case of the Baltic Sea region, co-creation thus offered approaches to develop an adaptive and anticipatory capability to empower actors to navigate risks and unexpected events. As such, multifunctionality is constructed over time through actors redesigning, re-imagining and putting together different practices in contextually novel ways.

To summarize, the three cases show that multifunctionality through co-creation is defined: 1) from within the context, 2) over time, and 3) in 'opposition to' practices or dynamics that prevent multiple practices and services from co-existing. This understanding of operationalizing multifunctionality from a local level aligns with the calls in the literature for processes such as co-creation. While the findings suggest that co-creation is needed, they also indicate the importance of avoiding predefined and narrow definitions of multifunctionality that prevent actors from entering into dialogue and deliberation without a landscape ideal framed from the outset. In departing from the 'undesired', the role of co-creation in supporting multifunctionality can be understood as facilitating sense-making that 1) collaboratively identifies and defines the practices or dynamics that prevent multiple practices and services from co-existing

and 2) collaboratively explores the possibilities and pathways to realize multifunctionality by identifying the 'next best possibility' and by surfacing and influencing the contextual conditions that enable or hinder its implementation, and 3) reflects and adapts to continuously redefine the undesired and explore emerging possibilities. In the coming section, we draw on the insights from the processes to reflect on key premises in designing co-creation processes that can contribute to enabling multifunctionality in local contexts.

4. Discussion

In this paper, we reflect on the co-creation processes implemented in three different cases to support multifunctional landscapes by looking at how these processes surfaced and shifted contextual conditions. Specifically, we looked at relations, resources, perceptions, and institutions as these influence actors' ability to identify and implement innovations that may support transitions toward multifunctional landscapes. Below, we discuss how multifunctionality as a concept was defined in the local context, evolving over time, and in opposition to practices or dynamics that hinder the co-existence of multiple values. In addition, we discuss how this understanding informs the design of co-creation processes. These reflections have emerged from the three case studies and further concretize the role and value of co-creation in promoting multifunctionality from a bottom-up perspective.

4.1. Designing for emergence

The exact nature of a multifunctional landscape in the three case studies is unclear and contested. However, actors generally expressed that multifunctionality is not promoted through yearly fires, widespread clear-cut forestry, or over-reliance on expensive, one-dimensional technical measures to combat nutrient emissions. The challenge of defining multifunctionality in these contexts and the literature (see for, e.g. Stürck and Verburg 2017; Garland 2021; Fors et al. 2024) illustrates the inherent complexity of transforming landscapes, suggesting a prescriptive approach that works backwards from a landscape ideal is likely going to fail (Snowden and Boone 2007). Instead, the cases encourage the pursuit of a systemic cognizance of the context as an appropriate starting point rather than a landscape ideal. Reaching a comprehensive understanding of a wicked problem is, however, impossible, and so both the cases and existing literature call for processes that, in parallel, draw on multiple ways of knowing to continually probe actionable possibilities (O'Farrell and Anderson 2010; Ros-Tonen et al. 2018;

Björneborn 2023). Making sense of what is hindering multifunctionality while also identifying the actionable possibilities positions co-creation as a bottom-up socio-ecological innovation approach for wicked problems which supports the emergence of perspectives and responses (Alstyne and Logan 2007; Faulconbridge 2017; Pel et al. 2020). In the three cases, designing processes that support emergence meant avoiding predefined, narrow and de-contextual definitions of multifunctionality or pre-conceived innovations/solutions. Rather, the cases focused on the premises of interactions, attempting to foster safe communication spaces where multiple forms of knowledge could explore actionable possibilities away from the practices or dynamics that were perceived to undermine multifunctionality.

The ambition to probe actionable possibilities shown in the three cases expands the role of co-creation in promoting multifunctionality beyond the commonly called-for co-production of knowledge (see for e.g. Schneider et al. 2019; Miller and Wyborn 2020; Norström et al. 2020). This is not to suggest the production of new knowledge was insignificant or absent in these cases. Rather, it highlights the importance of avoiding an overemphasis on knowledge production which could marginalise opportunities to influence the contextual conditions. The role of knowledge then, as West et al. (2019) argue, is to be drawn upon and used within the contexts to probe actionable possibilities and influence the contextual conditions rather than extracted from the contexts. Positioning co-creation as such addresses the separation of knowledge and governance that commonly happens in knowledge co-production processes (Latulippe and Klenk 2020). In the process of drawing upon existing knowledge, stakeholders may however realize that recognising gaps in knowledge is itself a necessary intervention. Such proved to be the case in Voxnadalen as the processes concluded that currently unrepresented perspectives were required to implement the emergent innovations. In La Mosquitia, on the other hand, factors beyond knowledge proved more crucial in probing the actionable possibilities, illustrating that a lack of knowledge is not always the primary barrier in bringing about change.

In other words, enacting multifunctionality requires a practice-based approach to co-creation, extending beyond expert knowledge applied 'to' action, an argument echoed in other papers as well (see for e.g. Ruhl et al. 2014; West et al. 2019; Hölscher et al. 2024). Identifying and probing actionable possibilities represents a co-creative way of defining and operationalizing multifunctionality. Success nevertheless rests on the ability to make sense of the probing, i.e. how the context 'speaks back' when probed (Snowden and Boone 2007; West et al. 2019). In La Mosquitia, several probes were piloted, creating learning loops that, through collective sense-making, improved the practices and informed adaptations toward multifunctionality. In the case of the Baltic Sea region, actions were piloted in an inconsequential setting through the game, allowing actors to reflect and bring their own real-world experience into constructing the game and pre-experience alternative futures in the game setting. These practice-based approaches shift co-creation away from being a series of workshops toward an approach aiming to navigate the multiple feedback mechanisms that characterize wicked problem contexts. This is, however, challenging and, as the three cases indicate, requires longer and deeper commitments capable of iterative action-learning cycles built upon relations. To make such learning cycles viable, the co-creation process must navigate the contextual challenges for multifunctionality and the internal challenges of sustaining efforts (Hölscher et al. 2024; Whitman et al. 2024). In La Mosquitia, the VCM has provided time and flexibility to build meaningful relations and ensure long-term commitments. Contrary to the La Mosquitia case, the Baltic Sea region case, while meaningful for its duration, would have benefitted from continuing to explore and innovate beyond the game setting, utilizing the networks established and insights that emerged throughout the co-design process. The Voxnadalen case finds itself at a crossroads where the innovation processes rely on sustaining engagement and overcoming internal barriers. Until that is sorted, the benefits of the process will remain limited.
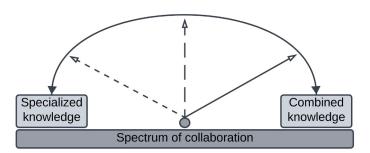

Figure 9. Spectrum of stakeholder engagement throughout the co-creation processes, emphasizing the dynamic and iterative nature of collaboration across the three case studies.

4.2. Oscillating on the spectrum of collaboration

While a key principle of co-creation is incorporating multiple perspectives and ways of knowing (Norström et al. 2020; Caniglia et al. 2021), the cases show that all perspectives do not need to interact constantly. Instead, the cases highlight the importance of moving along the spectrum of collaboration illustrated in Figure 9. On one side of the spectrum is combined knowledge, and on the other is specialized knowledge. In La Mosquitia, moving between these two proved imperative, not least during the process of deciding where and how to control the fires. The fire management plans were crafted in a collaborative effort between forest engineers, project coordinators, the regional council and a community group that had received training in fire management. Together, the group had the necessary knowledge to identify what areas to begin protecting to maximize useful ecosystem services identified in the co-inquiry process. Accordingly, pilot sites were launched, and people began creating fire breaks and firefighting. As actions were implemented, the process again shifted more towards combined knowledge, aiding sense-making and adaptation of these actions. The specialized knowledge, in this case, thus refers to basic generalizable knowledge of fire management principles. Combined knowledge, on the other hand, refers to the mosaic of knowledge called upon to navigate contextual uncertainties.

All forms of knowledge must, in other words, not constantly be engaged. Nor is it sufficient to gather different forms of knowledge in the same space to surface and influence contextual conditions. As the literature on co-creation and participatory research highlights, methods and tools are essential to engaging stakeholders meaningfully (see for e.g. Reed 2008; Vaughn and Jacquez 2020). The cases in this paper suggest that a co-creation approach attempting to influence the contextual conditions hindering or enabling multifunctional landscapes may involve various methods to mediate sense-making, learning, decision-making and capacity-building. For example, the game was never the aim in the Baltic Sea region. Instead, the co-design of the game provided a structure to mediate conversations safely, non-scripted and playfully. La Mosquitia presented different challenges requiring various methods and tools to mediate interactions. While context largely determines the usefulness of a method, the three cases further point to the importance of methods supporting non-scripted interactions by adopting participant-appropriate methods that ensure all actors can contribute to sense-making, learning, and decision-making. Drawing on the literature and cases, we thus suggest that designing for emergence through co-creation resides an open-ended process to achieve a systemic cognizance of context while probing the actionable possibilities. However, the quality of this approach in having a positive impact is contingent on the premise of interactions between stakeholders determined by the methods and their ability to facilitate non-scripted interactions that contribute to sense-making, learning and decision-making.

5. Conclusion

Operationalizing multifunctionality in landscape governance is a wicked problem. Our analysis of three case studies that implemented co-creation processes to promote multifunctional landscapes revealed that multifunctionality is best conceptualised as those practices that, paradoxically, undermine a multifunctional landscape. Shifts are thus always rooted in the contextual challenges manifesting in the moment rather than ideals. Here, co-creation fills an imperative role by facilitating the interaction of actors to systemically explore the context and probe the actionable possibilities. As the introduction points out, surfacing and shifting contextual conditions is essential to understanding and challenging the manifested problems that undermine multifunctionality. By looking at the practice of co-creation for multifunctional landscapes in three case contexts, we see that shifting these conditions requires a co-creation approach that 1) supports emergence, 2) probes the actionable possibilities, 3) takes a practice-based approach, 4) sustains long-term engagement, 5) oscillates across the spectrum of collaboration, and 6) uses participant appropriate methods to mediate interactions.

These points can be helpful to practitioners facilitating co-creation processes. They indicate the significant challenge of deploying co-creation to support multifunctionality and point to the fact that the appropriateness and success are contingent on the quality of the process design, demonstrated through its ability to support emergent ideas and responses, navigate trade-offs and power asymmetries, and facilitate some form of concerted action. Creating such processes is challenging even in the most favourable contexts. However, co-creation processes are often shaped by structural constraints, not least the availability of time and other critical resources, making it even more challenging.

Despite the challenge of making co-creation processes highly meaningful, we echo existing literature suggesting that local co-creation processes are essential to surface and shift the contextual conditions that underpin a multifunctional landscape. Realizing multifunctional landscapes thus requires a shift from static forms of knowledge production aimed to pin down multifunctionality as a universal ideal towards a practice-based approach where knowledge gets produced and used within the context and multifunctionality gets contextually defined over time. Co-creation approaches to operationalise multifunctionality will likely be important to such efforts. The insights presented here can provide

inspiration for designing these processes, but further (action) research is necessary. Based on the insights from this paper, we encourage researchers to further: 1) Develop and test methods to mediate safe and unscripted dialogue and deliberation (including quantitative tools) within different problem contexts, 2) Explore and develop business and funding models conducive to the need for long-term projects and engagements supportive of emergence, and 3) Provide continued critical reflections on the role and value of co-creation in governing for multifunctionality.

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Appendices
Appendix A. Methods mediating co-creation approach in La Mosquitia

The co-creation process in La Mosquitia can be perceived as a two-folded overlapping process leaning on a co-inquiry process and a co-design process, both mediating the design of a savannah restoration initiative. While the following methods have provided key insights into both the open exploration of life in the savannah and fires as well as the design of particular interventions, it is worth stressing the importance of the formal and informal meetings that bound these methods together into a coherent process capable of delivering transformations. Co-creation in La Mosquitia is thus best understood as a dance between the planned and the emergent interactions between stakeholders, aiding the navigation of the complex socio-ecological context and supporting both sense-making and decision-making to enable an equitable savannah restoration. With that said, the following methods have been essential to the insights presented in this article.

Futures workshops

Initially, a series of facilitated workshops were carried out with groups of mixed ages and genders tasked to develop imaginaries together with other stakeholders from the projects. These workshops were carried out in different communities and served as a first deep dive (previous engagements had been larger and more formal meetings) into community ideas and attitudes toward restoration. The groups were tasked to collectively draw a map of the village, the immediate surroundings, and the features necessary for their livelihoods. They then deliberated on desired futures related to livelihoods and discussed both barriers and opportunities. The groups then presented the maps and visions to each other, initiating a deeper dive into community engagement and ideas on the restoration initiative.

Participatory media

The use of media included both photovoice in different communities eventually also feeding into the making of a film. The purpose of using media was twofold, firstly to unpack challenges and opportunities in the region, their relationship to the savannah and fires, and secondly to use the photos and film to stimulate continued dialogue between different actors.

The photovoice included 50 participants, including marginalized voices such as women and youth. They spent an hour learning how to use the camera. Then, participants spent two days photographing challenges and opportunities in their daily lives and envisioned co-benefits or constraints growing out of the project implementation. In groups of 4–6, the participants then engaged in focus groups, delving into what the photos they had taken showed and why they had taken them. 5–10 key photos were collectively chosen to show at a public screening through a projector where over 50 people showed up to listen to the stories and share their thoughts on what emerged.

Based on emerging key themes, including health, infrastructure, food security and education, we facilitated 2 workshops with over 50 participants/workshop to dive deeper into the connections between fire and these emerging themes, including how changing the current fire regime might influence health, infrastructure, education, food security etc.

Following up on the emerging insights, we saw a need to delve deeper into these connections through film. Consequently, a film was made and eventually shown in several contexts, including among business communities and policymakers, effectively supporting further dialogue and deliberation while cultivating new relations and insights to enable the restoration of the savannah.

Landscape imaginaries

The landscape was mapped with individual family small holdings (roughly 5–20 hectares) and community leaders for the larger common lands. The process nevertheless followed similar patterns, starting with a visit to the place or places in the landscape to map the current land and land use using drone and/or satellite images as support while also inquiring about the history and current livelihoods. The details of the process varied between families and communities but generally involved a group of 2–8 people drawing on the ground or paper. Whether walking or drawing (on paper or on the ground), participants mapped out desired changes in the coming 1, 5, 10, and, if possible, 20 years. The inquiry then explored existing capital to make these changes happen before exploring what might aid such ambitions and what capacity the savannah restoration project could contribute. In the discussion of pathways, critical information emerged that informed the project's design and also laid a foundation for a trusting and transparent relationship as both parties had to clarify their capacities regarding the imaginaries.

Household interviews

To deepen the understanding of everyday life, household interviews based on the sustainable livelihoods framework were carried out with families in the project region. These semi-structured interviews especially looked to deepen an understanding of the role the savannah and fire play in daily lives. Additionally, the interviews served as a method to identify missing perspectives and new families who were willing to be part of the project.

Appendix B. Methods mediating co-creation approach in Voxnadalen

With initial stakeholders identified by the Voxnadalen biosphere reserve, the co-creation process started with ten focus groups. These focus groups, ranging between 2-8 participants per focus group, were designed to provide a safe space for stakeholders to express their experiences and views on the polarizing issue of forest management. The focus groups were loosely based on the three-horizon model (Sharpe et al. 2016), facilitating the group to deliberate on the present forest management, risks facing the status quo, expectations and desires of future forest management, emerging seeds of change and opportunities as well as challenges of scaling these.

The first full-day workshop followed a similar pattern, aiming to facilitate a safe space for the assortment of stakeholders to meet and explore forest futures in relation to the Voxnadalen biosphere. Rich picturing (Lewis 1992), combined with a causal layered analysis (Inayatullah 2019), mediated the interactions, enabling social learning while forming shared visions of undesired but possible forest futures and probable yet desirable futures in Voxnadalen. Central to discussions was the specific role of the biosphere in enabling certain futures.

The second workshop explored the emerging seeds of change and their role in making Voxnadalen a model area for sustainable forest management, a goal commonly defined in the first workshop. Guests with particular knowledge of certain seeds of change were invited to present and participate in the discussions. The futures triangle (Milojević 2023) was used to mediate conversations between participants (4 groups of 6-8 participants), supporting deliberation on the barriers and opportunities to scaling the respective seeds of change in Voxnadalen. The workshop thus created openings for actions that could be implemented in the region and support transformations based on an understanding of current barriers and opportunities within the Voxnadalen biosphere.

In the third workshop, the emerging insights from workshops 1 and 2 were taken further, with a day dedicated to exploring the practicalities required to empower initiatives that could contribute to scaling the seeds of change deemed desirable and feasible in Voxnadalen. Specific competencies were invited again to give presentations and participate in the discussions. To mediate this discussion, a process built on collective storytelling in 3 groups of 6-8/group using 'what if' scenarios to co-design drafts of project proposals. The proposals were then presented and reflected upon in a plenary session. Beyond actionable proposals, the workshop increased the understanding of constraining or enabling contextual conditions for desired interventions while also identifying missing forms of knowledge and actors to work on the ideas that had emerged through the process.

Appendix C. Methods mediating co-creation approach in BSR

To create a safe learning space while bridging the gap between knowledge and action, a co-creation process spanning across three catchments in the Baltic Sea Region (BSR) engaged diverse stakeholders in co-designing and prototyping a serious game. The game served as a mediating object that allowed participants to test and evaluate the impacts of various actions within a playful and inconsequential environment that represents real-world situations.

The co-design process began with actors from agriculture, wastewater treatment, forestry, aquaculture, energy and environmental protection participating in a rich picture workshop to map and elicit socio-ecological dynamics and challenges within their respective catchments, supporting a systemic cognizance of nutrient-related issues.

The co-inquiry process continued with a series of focus groups designed to explore the feasibility and impacts of eco-technological constellations in agricultural, forestry, urban, and marine settings. Drawing on the emergent insights, an initial game prototype was developed and playtested to facilitate dialogue and learning about how different constellations of eco-technologies can address nutrient enrichment at the BSR level while providing co-benefits to local communities at the catchment level. Through additional rounds of game co-design, numerous policy changes and socio-ecological shocks suggested by the stakeholders were further incorporated into the game prototype. This allowed them to explore how different constellations of actions and measures might perform in an uncertain, non-equilibrium system.

The game prototype supported two cross-case workshops with actors from all the three BSR catchments, stimulating deliberations on the barriers and possibilities posed by existing socio-economic, political environments to the implementation of eco-technologies in their respective catchments. Further details about the game co-design process can be found in Powell et al. (2021).