Stakeholder Perspectives on Co-Creation of NBS in Rural Mountain Areas – Insights from PHUSICOS

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Abstract. Planners and engineers are increasingly interested in implementing Nature-Based Solutions (NBS) in rural mountain areas to adapt to hydrometeorological risks such as flooding, landslides, mudflows or rockfalls. While co-design and implementing NBS in urban areas has already been applied and is well documented, only little is documented in literature in rural mountain areas. In our case study analysis from PHUSICOS, we follow up on stakeholders and their perspective on NBS throughout the co-creation processes in Living Labs. Qualitative semi-structured interviews with key stakeholders were conducted for this purpose.

Despite the importance of NBS on political and research agendas, in both the literature and the interviews, the concept and ideas are less familiar to stakeholders. The main interest was to reduce risks and to find solutions that were attractive and interesting also from an economical point of view e.g. business models for farmers and landowners. Other ecological and social benefits were considered less important. The collaborative planning approach was seen as important for engaging stakeholders and creating knowledge about NBS, as well as bringing together stakeholders with decisive power to the table when competencies are overlapping, competing or scattered among different authorities and public bodies. Living Labs were regarded as very useful to bring together stakeholders, provide learning opportunities and move processes forward. Preliminary results show that even after several years with many Living Lab formats, skepticism and the need for more knowledge remain especially on the long-term proof of concept and for creating value chains or compensation mechanisms for the maintenance of NBS.

Keywords: Nature-Based Solutions (NBS), Stakeholders, Collaborative Planning, Co-Creation, Living Labs, Stakeholder Perspectives, Perception, Acceptance

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1 Introduction

Climate change increases extreme hydro-meteorological events triggering floods, landslides, mudflows, avalanches or rockfall in mountain areas [1]. Nature-Based Solutions (NBS) are a means to reduce exposure or vulnerability for such risks [2]. While NBS have received a lot of attention especially in urban areas in scientific literature, this is not the case for rural mountain areas [3]. In-depth engagement of different stakeholders, partnerships and collaborative approaches are seen crucial to overcome barriers and successfully implementing NBS, creating acceptance, sense of ownership and ultimately, the success of measures and their implementation (e.g. [4-7]). Formalized procedures or approaches for systematic collaboration and participation are important for a successful implementation and increasingly are becoming more common [8]. One concept to stimulate and systematize collaboration is the use of "Living Labs". In Europe, the application of Living Labs in real-life settings and 'real' experimentation emerged around 2005, when the concept started to receive strong attention from the European Union (EU) and it was recognized as a progressive form of experimental and inclusive mode of planning, project design, and implementation that fosters innovation [9]. A common idea of many Living Labs is to form partnerships between public organizations, private companies, academia, and people for co-creating solutions [9-10]. For co-creation processes, it is important to understand the stakeholders' perspectives. Venkataramanan et al. [11] highlight the willingness of stakeholders to support NBS depending on a variety of factors such as awareness of the problem, knowledge, attitudes, interests and intentions. Thus, understanding stakeholders and how to motivate them to act are important to orchestrate collaborative planning for NBS [12].

Looking at literature for collaborative planning of NBS and neighboring concepts in early 2021, stakeholder involvement and their perceptions mostly were only examined from a theoretical point of view or in urban settings. Actual stakeholder views on NBS and planning processes were far less explored [13].
Thus, the objective of this paper is to present stakeholder views, perceptions and perspectives of NBS and co-creation with a focus following up on the evolution of stakeholder views throughout the project. Guiding questions were:

- How do stakeholders perceive NBS, their benefits and concerns about NBS throughout the co-creation process of PHUSICOS? How do perspectives change during an NBS project? What barriers for NBS implementation have been experienced and how are they overcome?
- What are the roles, benefits and barriers of Living Labs for co-creating NBS for stakeholders?

The paper builds upon first work of [13] and presents stakeholder perspectives when they started to work in Living Labs established in the three demonstrator regions to co-create NBS at different sites (Figure 1), at an advanced state and from a retrospective perspective.

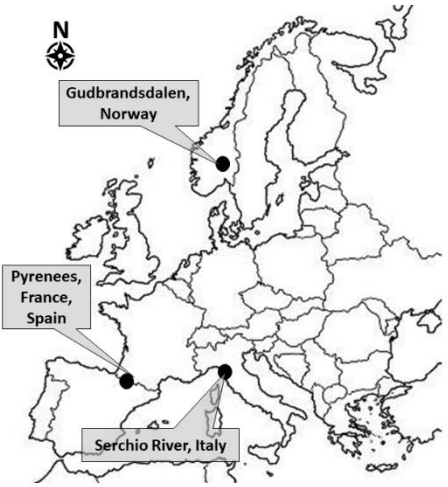

Fig. 1. Location of the demonstrator regions with implementation sites in PHUSICOS

2 Material and Methods

2.1 2.1 Demonstrator Case Study Regions

The 140 km long **Valley of Gudbrandsdalen** in Norway is located north of Lillehammer in the Innlandet Fylke (NUTS3). Many settlements in this valley are exposed to flooding. NBS at four different sites (LAU-2) in the river watershed were discussed. Discussion focused on the reestablishment of floodplains, river restoration and enhancement of the water storage capacity in the catchment areas. For one site at a municipality, an intensive Living Lab process was set up working on NBS from scratch.

In the **Pyrenees** mountain range between France and Spain, reforestation and afforestation in the release areas can reduce the risk of avalanches. For reducing rockfall and debris flows, among others, creating or revitalizing forests, terracing instable slopes using wood and local site sourced materials such as soil and rocks as well as wooden barriers were seen options to stabilize slopes to reduce hazards to infrastructures such as roads and support the establishment of trees or other stabilizing vegetation. Measures were discussed and implemented in four different Living Lab processes at four different sites; Artouste (LAU-2) (France, Département Pyrénées-Atlantiques), Capet Forest in Barèges (LAU-2) (France, Département Hautes-Pyrénées), Sta. Elena (LAU-2) (Spain, Aragon – NUTS 3) and Erill-la-Val (LAU-2) (Spain, Lleida – NUTS3).

For the **Serchio River Basin and Lake Massaciuccoli** near Lucca in Tuscany (NUTS3), Italy, main challenges are extreme drought and flooding, water pollution by runoff of sediment and nutrients from farmland. NBS such as re-vegetation efforts and

adapted farming practices were discussed and implemented close to the lake at different local sites (LAU-2) close to the lake to reduce the runoff from the agricultural fields into the water bodies using one Living Lab process.

2.2 Qualitative in-depth Interviews

To assess the stakeholder perspectives on NBS and the Living Labs processes initiated in the different demonstrator case study regions, we opted for a qualitative approach using semi-structured in-depth protocol interviews [14] and developed them in a way to have the flexibility to be conducted in-person, outside in the field, online or by phone to adapt to different situations reflecting the COVID-19 outbreak and restrictions in place to travel or meet in-person. To cover different perspectives, attitudes and opinions, a systematic approach to select interview partners was chosen based on the grounded theory [15, 16] to cover a wide range of perspectives within a small group of interviewees. Based on systematic stakeholder identification [17], interview partners were selected together with site owners and facilitators. A least one key representative from the commercial sector, academia, authorities, political representatives and from civil society representing the different groups collaborating in Living Labs was included and reflecting a more detailed differentiation of participating groups to cover different perspectives, especially of decision makers such as political representatives [17]. Starting in spring 2020, not all of the initially identified persons (around 20) could be reached or agreed to be interviewed during the COVID-19 outbreak. For this reason, for some groups, we could only obtain one perspective (research perspective outside the project team, NGO perspective as a representative for the civil society as well as having interview partners other than businesses in agriculture).

A final set of initial 13 participants agreed on participating, dropping to 11 in the following round due to longer sick leave, shift in responsibilities and occupational changes (Table 1). For some cases, a replacement for the initial key stakeholder was interviewed instead. Three interview rounds with the same key stakeholders (or their replacement) were conducted: One at the beginning of the Living Lab work in spring 2020, a second after mid-term in 2022 when persons had collected some experiences and a third, retrospective round at the end of the Living Labs in 2023. The final interview round 3 was ongoing at the time of writing this paper in early 2023 with some responses missing. Interview transcripts or notes were made anonymous (names or hits that could potentially identify persons were blinded or deleted in the materials), analyzed, shortened and structured to highlight the key statements and relative frequencies following the qualitative content analysis method described in Mayring [18]. To put the responses of the selected interviewees into a broader context, in several Living Lab sessions, all participants were asked to fill in standardized surveys developed and based on the first interview round outcome. The data collection of surveys was still ongoing until the final events and are not part of this paper for this reason.

Table 1. Identified and interviewed stakeholders (anonymized).

Initial Stakeholders	Stakeholder group	Round 1	Round 2	Round 3
Agriculture 1 (Business)	Commercial Sector	✓	✓	✓
Agriculture 2 (Family)	Commercial Sector	✓	✓	
Research, Agronomist	Academia	✓	✓	✓
Water Authority Region (NUTS3)	Authority	✓	✓	✓
Water Authority Region (NUTS3)	Authority	✓	✓	✓
Authority Region (NUTS3)	Authority	✓		
Authority Infrastructure 1 Region (NUTS3)	Authority	✓	✓	
Authority Infrastructure 2 Region (NUTS3)	Authority	✓	✓	
Nature Manager Community (LAU-2)	Speaking for Political Representative (LAU-2)	✓	✓	✓
Decision Maker, Forest Administration Community (LAU-2)	Political Representative	✓	✓	
Decision Maker Region (NUTS3)	Political Representative	✓	✓	✓
Decision Maker Community (LAU-2)	Political Representative	✓		
Representative of interest group for Nature and Outdoor Recreation (LAU-2)	Civil Society	✓		✓

3 Preliminary Results

3.1 NBS Perceptions

Around one third of the 13 interviewees had not heard about NBS before and discovered it with the project activities, e.g. project preparation or the initial Living Lab session. Many of the interviewed key stakeholders expressed they learned a lot about natural hazards and gained knowledge around NBS. Some mentioned the specifics and ways natural materials could work in terms of reducing the risk of natural hazards and getting engaged with other stakeholders. Others referred to connect to historic land uses, assessment of other successful NBS cases, co-creating an NBS solution as well as verifying the effectiveness of NBS by science and collecting monitoring data. The in-depth interviews showed that at the beginning of the Living Lab process, key stakeholders perceived NBS as beneficial for nature and providing interesting opportunities for local

businesses. During the project, the perspective shifted towards “working with nature”, use of local materials and NBS being more aesthetical. With a big emphasis on co-benefits in both theoretical discussions and policies, multiple benefits were of a lesser explicit importance to interviewed stakeholders in rural mountain areas throughout the interview rounds.

Main concerns formulated by the interviewed key stakeholders were the high expenses needed for NBS implementation, the costs of regular maintenance, or no local value-added. Furthermore, the lack of business models to support NBS implementation were mentioned. During the engagement in the project, many of the concerns got smaller but some main points remained such as business models for management materials resulting from maintenance of NBS. Linked to skepticism, in the mid-term interviews, the lacking proof of concept frequently brought up and from a retrospective perspective in round three, despite availability of numerous modeling results for the demonstrator cases, still the long-term proof of concept based on monitoring was seen a major concern.

Interviewees described a lack of knowledge by those with power to make decisions remained an obstacle until the project end despite numerous activities and learning opportunities. Other human factors were, as stated, the fear of taking “new pathways traveling to the unknown”. During the project, the lack of available land or space to implement NBS became more prominent. One aspect emerging in the round two interviews when implementing NBS was the aspect of suitable local materials that could be extracted next to the place where a measure was intended to be implemented to keep carbon-footprints and need for transportation as low as possible. Linked to knowledge, during the project, a lack of skilled local companies was seen as a barrier such as how to apply natural materials in the construction of protective infrastructures. Legal challenges, complicated tendering processes and no standardizations or norms linked to NBS were perceived to be high hurdles to overcome. An emerging concern in interview rounds two and three were business models around NBS to attract more landowners or farmers willing to manage or implement such solutions.

3.2 Co-Creation of NBS using Living Labs

Interviewed key stakeholders often expressed interests that relate to economic aspects of NBS already in the first interview round and for this reason, expected that these topics should be an important aspect to be worked on in the Living Labs. With the perceived skepticism, in the first interview round, interviewees expressed their expectation that Living Labs would contribute to demonstrate that NBS could be a good and effective solution for their region and throughout the process, this aspect was considered an important element of the Living Lab outcomes with academia providing evidence-based data and modelling, and at later stages, the co-creation, implementation and first monitoring of NBS.

During the Living Lab processes, interests shifted towards a broad range of implementation-oriented topics such as positive effects of NBS on landscape with simulation of NBS and how they evolve during the different phases with a state before, during and after the intervention. Interviewees regretted not having opportunities for intense knowledge exchange and transfer of experiences made between the different PHUSICOS demonstrator case regions located in different countries because of the COVID-19 restrictions. Videos and documentations were not seen as useful as having on-site visits and sharing experiences during field trips or in-person exchanges.

Interviewed stakeholders experienced a multitude of benefits linked to Living Labs, increasing knowledge being the most important one and integrating a broad range of stakeholders. Other frequently mentioned positive aspects were working on a specific solution and dissemination of NBS. With an intermediate and retrospective look taken in the interview rounds 2 and 3, Living Labs were seen to showcase positive effects of NBS, creating or collecting data to contribute to a proof of concept, supported the exchange between different stakeholders breaking silos. While the overall experience with LLs was explicitly described as positive, some, some negative aspects were mentioned by the interviewees. More Living Lab activities should have taken place and more knowledge about NBS and addressing natural hazards should have been provided to the different stakeholders and different levels of knowledge. Interviewees found that scattered responsibilities of stakeholders made it difficult to come to decisions. To mobilize persons influencing or needed to make decisions, it was suggested to make the participation in Living Labs more “mandatory” but it was not explained in more details, how this might be achieved. COVID-19 was seen a negative factor as digital formats reduced the enthusiasm of participants.

4 Discussion

Comparing the outcomes of the in-depth interviews conducted at different stages of PHUSICOS and a first preliminary look at the collected surveys reaching out to all participants of selected Living Lab sessions at the time writing this paper, a number of distinct perspectives and issues can be detected for co-implementing NBS in rural mountain settings (Table 2). Comparing them with literature and outcomes of other projects on implementing NBS or neighboring concepts, existing literature suggests that stakeholders perceive the effectiveness of NBS to address hydrometeorological risks critically even at later stages of such projects (see literature cited in Table 2).

The interviewed PHUSICOS key stakeholders had a more positive perspective. Nonetheless, a major concern was the long-term proof-of-concept of NBS despite the involvement of research and modelling. Despite their importance on political and research agendas, the knowledge of on-the-ground stakeholders on NBS still seems to be limited and was stated also in literature.

Table 2. Comparison literature and interviews, based on Lupp *et al.,* (2022), added and evolved

Description	Findings in literature (systematic review)	PHUSICOS key stakeholders' answers	
Stakeholder familiarity with NBS and related concepts	Lack of knowledge. Most literature underlines the importance of NBS projects for learning and raising awareness/knowledge (e.g. [19, 20])	About one third have not encountered the concept of NBS before the start of the project.	Confirmed
NBS benefits perceived by stakeholders	Mainly urban NBS in the literature, mainly co-benefits for society are valued [21] managerial views relate to easier maintenance [22]	Interviewees mainly refer to benefits for nature and working with nature, while expressing potential economic opportunities. Less emphasis was laid on co-benefits.	Not confirmed
Concerns of stake-holders on NBS	Less effective especially in severe events [23], high maintenance costs [24], little acceptance for solutions that are not aesthetically pleasing [25]	Lack of long-term proof of concept, evidence of durability or functionality is largely missing, effectiveness is perceived to be lower, long-term maintenance might be challenging	Partially confirmed
Perceived barriers to NBS by stakeholders	Often, a lack of knowledge and awareness but evolve during projects, importance of participation in co-creation processes [11], [26].	Lack of knowledge, project contributed to overcome or address this issue. More fundamental barriers experienced during project: tendering processes, lack of skilled companies, business models and value chains or compensation for farmers	Confirmed, experienced other barriers linked to implementation
Collaborative processes	Mixed experiences, critical reflections (e.g. [27]) as well as positive reports (e.g. [26])	Living Labs raised awareness, provided learning, experiencing and working on hands-on cases, engaging research and collecting data to evaluate NBS; scattered responsibilities slowed the processes, wish for even more communication and learning activities (separate formats or independent from Living Labs) are seen useful to overcome skepticism	Largely positive experiences

In addition to demonstrating durability of NBS in the context of addressing natural hazards, literature with a focus on urban areas emphasize the importance of co-benefits for society. Looking at the NBS and the importance of co-benefits, in PHUSICOS, for the key stakeholders, this was seen to some extent more an academic discussion and were of less explicit importance. Linked to the specific technical, environmental and socio-economic features of NBS and land ownership [28, 29], the most important aspects for the interviewed key stakeholders originating from rural mountain areas were working with nature and solutions fitting into farming and land use practices and linking NBS to existing or unveiling old knowledge. While it might be of lesser explicit importance in PHUSICOS, in the long run, co-benefits may gain importance as long-term "mutual" benefits (e.g. establishing protective forest in remote high mountain areas in the Pyrenees) or might materialize quickly after the implementation of NBS (e.g. opportunities for recreation and bird-watching at Serchio River basin measures close to Lake Massaciuccoli).

A key element in literature and outcome from PHUSICOS was the importance of learning opportunities and the importance of research addressing knowledge gaps creating data and monitoring approaches. A useful tool in PHUSICOS was learning from co-creating "hands-on" case and exchange or learning from other successfully implemented cases ideally having a multitude of monitoring data available supporting a proof-of-concept for NBS.

The Innovation Action Type of projects to establish demonstrators was seen useful in both literature and from the experiences made in PHUSICOS. Such projects provide additional resources for actors to work in more depth on NBS and to reflect on natural hazards, resulting risks and potential of different options including "grey" solutions.

For stakeholders, it was attractive to work and co-create an NBS for their region for NBS and being at the top of political agendas, supportive governance at various levels from the European to local levels are lacking. Some of the barriers can be addressed and overcome at the local or regional level in the Living Labs. Besides activities and advocacy for NBS, ways to address these barriers might be related to local policy approaches of providing funding to support implementation or follow-up activities. Some aspects and topics remained open and could not be solved in the Living Labs and on local level. They linked to financing mechanisms for maintenance and compensations or suggested "Payment for Ecosystem Services" making NBS more attractive for land owners to opt for NBS.

5 Conclusions

Drawing conclusions from the stakeholder experiences made with Living Labs in PHUSICOS and taking a broader perspective from literature, the following aspects can be highlighted:

- The importance of creating and disseminating knowledge including the participation of research and knowledge institutions to provide and translate scientific and evidence-based data to overcome skepticism towards NBS
- Broad Stakeholder involvement, co-creation and Living Lab approaches proved useful dealing with different perspectives

- Stakeholder motivation to participate was working with real cases and the implementation of the co-designed NBS. Living Labs with site visits to discuss the challenges and potential solutions in person exchange were key success elements breaking silos and creating momentum, willingness to collaborate and overcome barriers.

- Creating and showcase NBS and the involved stakeholders can act as advocates and knowledge vectors for NBS. It will be worthwhile to follow up on implemented NBS

- over time with monitoring to provide evidence-based data when solutions mature and co-benefits become more tangible.

6 Ethics Statement

The study involves statements from humans. Conducting and handling of the interviews, collected data and maintaining privacy of persons follows the legal basis of the EU, REGULATION (EU) 2016/679 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing GDPA Directive 95/46/EC (General Data Protection Regulation) and corresponding country-specific regulations for the Federal Republic of Germany reflecting – BDSG (new) from 2018 for the lead institution in charge and leading the survey as well as their adoptions in the participating EU and EEA countries. In line with the Research Ethics Procedures of the Technical University of Munich and project partner institutions based on the mentioned EU, EEA and respective country regulations, the participants received written information on how the data would be used and were asked to give their consent to participate in the interviews according to these guidelines. We obtained consent from all research participants prior to the interviews and handled their confidentiality and interview data according to this consent.

7 Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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