PHUSICOS

According to nature

Deliverable D3.7

Lessons learned with the Living Labs Experience – Final Version

Work Package 3 – Service Innovation: Stakeholder Participation through Living Labs

Deliverable Work Package Leader:
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Project information

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Summary

This deliverable, D3.7 *Lessons learned with the Living Labs experience*, is a follow up on previous deliverables, namely D3.5 presenting preliminary draft version, updating and following the processes until the end of the project lifetime to draw final lessons learned. It includes additional stakeholder perspectives on Nature-Based solutions (NBSs) throughout the project lifetime and the experiences made with Living Labs, and the different co-creation processes and stages of co-designing, co-implementing and co-evaluating NBSs.

This deliverable starts with a literature review on stakeholder perceptions reported to NBS and neighbouring concepts in collaborative disaster risk reduction projects as a point of departure. The report then describes the perception of stakeholders engaged in the Living Lab processes at the demonstrator case study sites, starting with assessing the initial NBS knowledge of the stakeholders. It follows up the changing perception of such solutions with perceived benefits, remaining concerns and barriers while being engaged in the project. Second, the report presents the experiences made with and within the Living Labs, examine the expectations and satisfaction with the Living Lab experiences. The report is based on in-depth stakeholder interviews conducted during several points of time during the project lifetime, standardized surveys to capture participant perspectives in the Living Lab sessions.

This deliverable follows the main guiding questions: What are the overall stakeholder perceptions of NBSs or neighbouring concepts? How do they evolve during PHUSICOS? What are the overall main interests, barriers and concerns of stakeholders considering such solutions? What expectations and experiences actors have with collaborative planning of NBSs using Living Labs? What are the lessons learned that can be drawn from PHUSICOS experience?

Summarising the findings in literature, applying a broad scope in the literature search including neighbouring concepts to NBSs and disaster risk reduction, not much work on stakeholder perceptions on strategies to reduce risk with NBSs or similar concepts could be found at the time of the literature review. Interestingly, disaster risk reduction, similar concepts and stakeholder perspectives mainly relate to understanding their perception of natural hazards, risks, vulnerability and preparedness to react to an occurring disaster, e.g. evacuation rather than on solutions.

Comparing literature and findings from PHUSICOS, despite the importance of NBSs on political and research agenda, in both the literature and the interviews, the concept and ideas were less familiar to stakeholders at the beginning of PHUSICOS. NBSs are mainly encountered within river restoration measures. Main key stakeholders expected PHUSICOS to raise awareness and create knowledge, not only about NBS, but also linked to a more fundamental understanding of risks related to hydrometeorological events.

PHUSICOS was seen as a starting point with hands-on cases to reduce risks and to find solutions that are attractive and interesting also from an economical point of view (e.g., a new business model for farmers and landowners). The rather strong interest in the economic aspect and creating value chains or business models is quite different from findings in the literature. Most of the work published is on urban areas, and in these areas, multiple benefits are much more important for most stakeholders. With the pan-European perspective of the project including a retrospective learning case, upscaling and replication of good NBSs were perceived to be an attractive opportunity provided by the project.

At the beginning of the Living Lab process, NBSs were mainly seen as beneficial for nature and providing interesting opportunities for local businesses. Acceptance and risk reduction became more important during the project. Multiple benefits were of less explicit importance throughout the project lifetime. Looking at the expectations raised, the main remaining challenges were creating local value added by NBSs as well as the long-term proof of concept based on monitoring data. Almost all interviewed key stakeholders experienced learning for themselves but need for even more activities as several other stakeholders still have varying knowledge of NBS and awareness for natural hazards. Recommendations were given for a variety of different communication and information offers, parts of them outside Living Labs.

Stakeholders experienced a number of challenges to implement NBSs. Barriers were related to legal challenges, tendering, lacking norms or standardization and a lack of skilled companies to carry out the work to implement NBSs. Outside a project like PHUSICOS, this could have led to abort the idea of implementation such solutions, shift to a grey solution or not addressing the risks and hazards at all. This outcome highlights the importance of such projects and Research and Innovation formats like PHUSICOS to overcome such hurdles.

In summary, Living Labs were seen a very useful tool and approach to engage a broad range of stakeholders and creating knowledge regarding NBSs. Stakeholders very much appreciated to work on hands-on cases, co-creating and working collaborate on the different phases co-creating NBSs. Challenges were experienced when dealing with different levels of knowledge. This was an issue also at later stages and interviewees perceived this to slow down processes. It was not easy bringing together the right stakeholders with respective power at the table to reach a decision. This was especially apparent when the competencies were scattered among stakeholders or when there was overlapping responsibilities. A systematic stakeholder mapping was seen useful to identify and mobilize such relevant stakeholders at the very beginning. Field trips or site visits to discuss the risks and potential solutions on-site together were seen most interesting Living Labs activities pushing the processes. An important aspect and factor for success was seen in participating experts and research in the Living Labs, as well as students to discuss, share and develop new ideas. With very positive experiences, remaining topics were related to economic aspects of NBSs and creating value chains for maintenance and management as well as to upscale and disseminate solutions.

Glossary

KEY CONCEPTS, ABBREVIATIONS AND DEFINITIONS

CO-DESIGN, CO-CREATION, CO-PRODUCTION:

Co-design, co-creation or knowledge co-production can be defined as an innovation process that involves end-users as "actors" instead of solely "factors" in all phases of the design process, unlike traditional top-down linear design thinking where end-users may only be responsible for reviewing or giving feedback on the design process (Voorberg et al., 2014; Evans et al., 2017).

CONCEPT CASE SITE (CC):

Small-scale case study site which serves to test specific challenging aspects of NBS, and to study transferability of lessons learned. In PHUSICOS, the Kaunertal Valley of Austria and the Isar River watershed of Germany are designated as concept cases.

DEMONSTRATOR CASE SITE (DS):

Large-scale demonstrator case study site for the implementation of nature-based solutions (NBS). In PHUSICOS, these are situated in Gudbrandsdalen, Norway; the Pyrenees, France-Spain-Andorra; and the Serchio River Basin, Italy.

EFFECTIVENESS:

Extent to which a project attains, or is expected to attain, its objectives efficiently and in a sustainable way (Gujit and Woodhill, 2002).

EFFICIENCY:

Measure of how economically the inputs of a project intervention (funds, expertice, time, etc.) are converted into outputs (Gujit and Woodhill, 2002).

EVALUATION:

Systematic examination of a planned, ongoing or completed project, which aims to judge the overall value of a project intervention and provide lessons learned for corrective action, planning and decision-making. Commonly, an evaluation intends to determine the efficiency, effectiveness, impact, sustainability and relevance of the project intervention (Gujit and Woodhill, 2002; European Commission, 2004).

IMPACT:

Effect of a project intervention on its wider environment, and its contribution to the project's purpose or overall goal (Gujit and Woodhill, 2002; European Commission, 2004). Often, the impact is expressed by the changes the target groups of a project intervention perceive.

INDICATOR:

Quantitative or qualitative variable that provides a simple and reliable basis for assessing achievement, change or performance. Indicators can be formulated on various levels, such as output, outcome or impact level (Gujit and Woodhill, 2002; European Commission, 2004).

KEY CONCEPTS, ABBREVIATIONS AND DEFINITIONS (continued)

LIVING LAB (LL):

A Living Lab is a physical area and interaction space, in which stakeholders form an innovation network including companies, public agencies, universities, users, and other stakeholders in the pursuit of collaboration for the creation, prototyping, validating and testing of new technologies, services, products, and systems in real-life contexts (based on Leminen, 2013).

LIVING LAB FACILITATOR:

A person who is in charge of facilitating and steering the local Living Lab process, which involves identifying, engaging, coordinating and monitoring stakeholders as well as pro-actively guiding the iterative knowledge exchange with a project's work packages and implementation of process outcomes (based on Van der Jagt et al., 2017).

MONITORING / M&E:

"The regular collection and analysis of information to assist timely decision-making, ensure accountability and provide the basis for evaluation and learning. M&E is the combination of monitoring and evaluation, which together provide the knowledge required for i) effective project management and ii) reporting responsibilities" (Gujit and Woodhill, 2002: A-7).

NATURE-BASED SOLUTIONS (NBSs):

"Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions. Nature-based solutions must therefore benefit biodiversity and support the delivery of a range of ecosystem services " (European Commission, 2020).

STAKEHOLDER:

All persons, groups and organisations with an interest or "stake" in an issue, either because they will be affected or because they may have some influence on its outcome. This includes individual citizens, companies, economic and public interest groups, government bodies and experts. (Ridder et al., 2005: 2).

STAKEHOLDER INVOLVEMENT / STAKEHOLDER PARTICIPATION:

Process of involving those who are affected by and thus have an interest in a defined issue. This involvement of interest groups may refer to different contents, such as planning, decision-making or monitoring and evaluation of an issue (after Hauck et al., 2016 and FAO, 1995), and happen on different levels, ranging from information and consultation to active collaboration and transferring decision-making into the hands of the public (IAP2, 2018).

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1 Introduction

1.1 Lessons Learned from Living Labs in PHUSICOS – Positioning of the Report in Service Innovation

From an overall perspective, one of the barriers hampering the implementation of nature-based solutions (NBSs) at larger scales is a lack of inter-sectorial cooperation and in-depth stakeholder involvement in planning processes. One example is stakeholder involvement in identifying the necessary solution (Zingraff-Hamed et al., 2020a). While various governance models enable NBS implementation, partnerships and collaborative approaches are crucial factors for success when implementing solutions (e.g. Zingraff-Hamed et al., 2020b). The advantage of collaborative planning is well known but its use requires social competence to avoid congestion in the process. Therefore, identifying, understanding and addressing stakeholder values, interests, and knowledge are crucial steps in successful in-depth participatory processes (Burgers and Farida, 2017). NBSs often require integrated measures which implies collaboration and the willingness of stakeholders to act (Heitz et al., 2009). Especially for facilitators, understanding scepticism and motivation to act is important to orchestrate collaborative planning processes (Lupp et al., 2016). According to Heitz et al. (2009), risk perception and striving to implement solutions are based on own experiences, beliefs, and psychological, social, economic, temporal or institutional factors. Venkataramanan et al. (2020) highlight the willingness to make changes depending on a variety of factors such as awareness of the problem, knowledge, attitudes, or intentions that lead adopting and implementing solutions. Consequently, the stakeholders´ willingness to act is also related to their perception of hazards, risks, and exposure, and, their estimation of their own ability to contribute to a solution and the receiving benefits. For collaborative planning, facilitator knowledge about stakeholder perceptions will support the processes and elaboration of outcomes.

To ensure a successful implementation of NBSs in this context, in PHUSICOS, various stakeholders are actively involved throughout the project using Living Labs in order to incorporate their knowledge, preferences, views, values, scepticisms, and attitudes. The project aims to involve and motivate stakeholders to co-design, co-implement, and co-monitor NBSs. In PHUSICOS, Work Package 3 which is on “service innovation” is dedicated to the collaborative planning process within Living Labs and related tasks with a number of products and activities providing a framework, tools for collaborative planning and monitoring and evaluation procedures.

This deliverable report D3.7 provides insights on lessons learned from the Living Labs. This deliverable builds upon the previous reports and findings elaborated by Work Package 3. It provides a comprehensive perspective and views collected at the end of the lifetime of PHUSICOS and completes elaborations with first insights presented in Deliverable D3.5. The deliverable report is based on the theoretical foundation and framework, criteria and monitoring and evaluation processes to assess the performance

of the Living Labs and of user satisfaction at the case study sites. It builds on previous materials and follows up on D3.3 and D3.4, Monitoring & Evaluation (M&E) scheme version 1 and 2:

- D3.1 *Guiding Framework for Tailored Living Lab Establishment at Demonstrator and Concept Case Study Sites* provides the theoretical background and project terminologies for the Living Lab processes, as well as a practical guidance for the main steps to be taken to establish the Living Labs.
- D3.2 *Starter Toolbox for Stakeholder Knowledge Mapping to Co-Design Nature-Based Solutions at Case Study Sites* presents a comprehensive toolbox for fostering stakeholder involvement at the case study sites. It is a steppingstone from Living Lab preparation towards implementation by assembling a comprehensive Toolbox for fostering stakeholder involvement at the case study sites.
- D3.3, D3.4 and D3.6 *Monitoring & Evaluation Scheme to Assess Stakeholder Participation and User Satisfaction with Living Lab Experience - Version 1, 2 and 3* present the theoretical framework of the Monitoring & Evaluation (M&E) scheme for Living Labs within the PHUSICOS project. M&E serves various purposes and is intended to accompany the achievement of goals and targets set for a project.
- D3.5 *Lessons learned with the Living Labs Experience - Draft* provides first insights and results from stakeholder perspectives on co-creating NBSs and experiences made with Living Labs.

Following D3.3, D.4 and D3.6 (Fohlmeister et al.; 2019a, 2020, 2022) and, based on Eckart et al. (2018), Living Labs have different types of interconnected targets. These include: practice-related targets, research targets and learning targets, namely fostering learning processes, knowledge generation, definition and co-design of research and practice-related targets, empowerment of innovators and fostering local innovation capacity.

Key elements of Living Labs within PHUSICOS are stakeholder involvement from the beginning, integration of identified stakeholders' priority demands, capacity building, innovation as well as learning, participants' power and influence, participants' impact on outcomes and resource accessibility and availability (Fohlmeister et al., 2018). To assess learning processes, evaluation criteria also need to relate to provision of learning opportunities, and raising the awareness of local stakeholders regarding natural hazards and the potential of NBSs. Serving this purpose based on the M&E scheme elaborated by Fohlmeister et al. (2019a, 2020, 2022), the aim is to track these Living Lab goals outlined by Eckart et al. (2018).

The Living Labs at the demonstrator case study sites in PHUSICOS go through different phases of stakeholder co-design stages and strategies with a variety of targets for practice, implementation, research and learning. The M&E scheme therefore intends to balance between individual needs, local contexts, and site demands on the one hand and

cross-case comparison for ensuring a common ground for all case sites within PHUSICOS on a project level on the other hand.

Based on D3.6, a comprehensive pool of evaluation criteria reflecting stakeholder participation was collected. The reflections on lessons learned makes use of these criteria as a starting point (Table 1).

Table 1: Criteria for monitoring and evaluation given in D3.6 (based on Fohlmeister et al. 2019a)

Objectives listed in PHUSICOS' Document of Action (DoA)	Proposed Indicators (D3.6)	Evaluation Criteria covered
Living Labs enhance **local innovation capacity** at case study sites	Degree of achievement of learning goals	Learning, innovation, capacity building
	Perception of innovation capacity enhancement by LL participants and other stakeholders	Learning, innovation, capacity building, empowerment of innovators
Living Labs **contribute to decision-making on NBSs**	Degree of uptake of LL inputs in relevant decisions on NBSs (selection; design; implementation; assessment)	Participants' power to influence, participants' impact on outcomes
	Perception of degree of uptake in relevant decisions by Living Lab participants	Participants' power to influence, participants' impact on outcomes
Living Labs enhance **NBS awareness & acceptance** and change **perception of health and safety**	Extent of NBSs awareness/acceptance/ health & safety perception change	Learning, capacity building, social capital, institutional capital
Living Labs have **functioning information exchange**, also with external stakeholders	Number of new stakeholder networks/relations	Social capital, institutional capital
	Perception of network quality	Social capital, institutional capital
Living Labs **co-design NBS** projects and other PHUSICOS products (WP2/4/5/6/7)	Degree of consideration of LL participant demands/inputs in research agendas of WPs and practice-related goals (e.g. NBSs)	Participants' power to influence, participants' impact on outcomes, integration of local and scientific knowledge
	Number and type of stakeholders involved in co-design per session	Representativeness, legitimacy, participants' power to influence
Living Labs **capture and leverage stakeholder knowledge** in an iterative manner according to identified priority demands	Perception of stakeholders of LL process as iterative knowledge exchange (incl. adequacy of participatory methods; accessibility of language; knowledge co-creation)	Integration of local and scientific knowledge, suitable methods, continuous and active involvement, provision of learning opportunities
	Ratio local/external experts per session	Integration of local and scientific knowledge, learning
Living Labs are **enabled to co-design** NBSs	Perception of stakeholders on quality of facilitation and accessibility of Living Lab process	Highly-skilled facilitation of process, transparency, resource accessibility and availability
Living Labs are **capable intermediaries between multiple actors** (public & private sector, enviro. & social NGOs, citizens)	Number and type of core stakeholders being actively and continuously engaged in Living Lab process	Representativeness, transparency, legitimacy, highly-skilled facilitation of process, suitable methods, continuous and active involvement
Living Labs are **established and work according to plan**	Frequency of Living Lab sessions	Continuous and active involvement
	Degree of conformity with work plan and PHUSICOS standard	Transparency, legitimacy, cost-benefit ratio, structured participatory process

To identify and weight their relevance, the indicators from Table 1, each indicator was evaluated on a 1-5 Lickert scale (1=not important at all; 5=very important) and ranked using a sorting approach according their perceived importance. During the virtual consortium meeting on February 2021, participating PHUISCOS stakeholders and external experts were asked to conduct these two tasks (Table 2 and 3) and discuss the outcomes to help identify and focus on the most important indicators.

Table 2: Evaluating indicator importance with Lickert Scale (1=completely irrelevant, 5=very important; n=20, 9 valid cases completing the task)

Indicator	Average Value (Lickert Scale)
Uptake of participant inputs in relevant decisions	4,25
Achievement of learning goals	4,22
Innovation capacity enhancement	4,13
Rising NBS awareness, acceptance and perception change	4,11
Perception of iterative knowledge exchange	4,00
Uptake of participants inputs in decisions on NBSs	3,89
Considerations of participant inputs	3,89
Number and type of stakeholders involved in Living Labs	3,78
Quality of Living Lab facilitation	3,75
Networking qualities	3,67
Stakeholder number committed to upscale NBSs	3,56
Number and type of core stakeholders engaged in Living Labs	3,56
Conformity with work plans	3,56
Number of new stakeholder relations	3,44
Frequency of Living Lab sessions	3,25
Ratio local stakeholders/external experts	2,67

Table 3: Ranking indicators according to their importance (1=most relevant, 16=least relevant, n=20, 9 valid cases completing the task)

Indicator	Average Rank
Perception of iterative knowledge exchange	1
Uptake of participant inputs in relevant decisions	2
Number and type of stakeholders involved in Living Labs	3
Innovation capacity enhancement	3
Uptake of participants inputs in decisions on NBSs	5
Achievement of learning goals	6
Rising NBS awareness, acceptance and perception change	7
Quality of Living Lab facilitation	8
Networking quality	9
Stakeholder number committed to upscale NBSs	10
Number of new stakeholder relations	11
Considerations of participant inputs	12
Conformity with work plans	13
Number and type of core stakeholders engaged in Living Labs	14
Ratio local stakeholders/external experts	15
Frequency of Living Lab sessions	16

Of least importance were the number of stakeholders engaged and committed as in most cases, only quite a small number of core stakeholders in rural areas were identified with the stakeholder mapping task and it was seen more important that those individuals were continuously engaged. Related to this was the number of new networks created. Finally, following and in conformity with work plans and the number of Living Labs were seen less important. While this might have been influenced by COVID-19 and the need to decide more on a day-to-day basis about formats and possibilities to meet, it also reflects the need to adapt or readjust processes and topics according to the stakeholder inputs and needs based on the first experiences with the processes made before COVID-19.

Discussing the indicators and the outcome of the ranking and evaluation task for PHUSICOS, most important indicators to be most important ones were "to achieve learning goals", "perception change of stakeholders towards NBS". "uptake of inputs brought in by stakeholders", "iterative knowledge exchange" and "innovation capacity". The following chapters link with the respective indicators and give room to stakeholder and participant views.

Performed regularly, monitoring and evaluation make use of impact indicators, supports progress reporting and serves as an instrument for both the overall project and the case study sites. It is intended to help keep the Living Lab processes on track and to gain valuable insights concerning the Living Labs` advancement to ultimately achieve the desired stakeholder support and ownership for the co-designed NBSs at the local level (Fohlmeister et al., 2019a, 2020). Based on PHUSICOS Work Package (WP) building blocks, monitoring and evaluation follows three main strands (Figure 1). Strands relate to Living Lab strategies, performance and stakeholders´ knowledge.

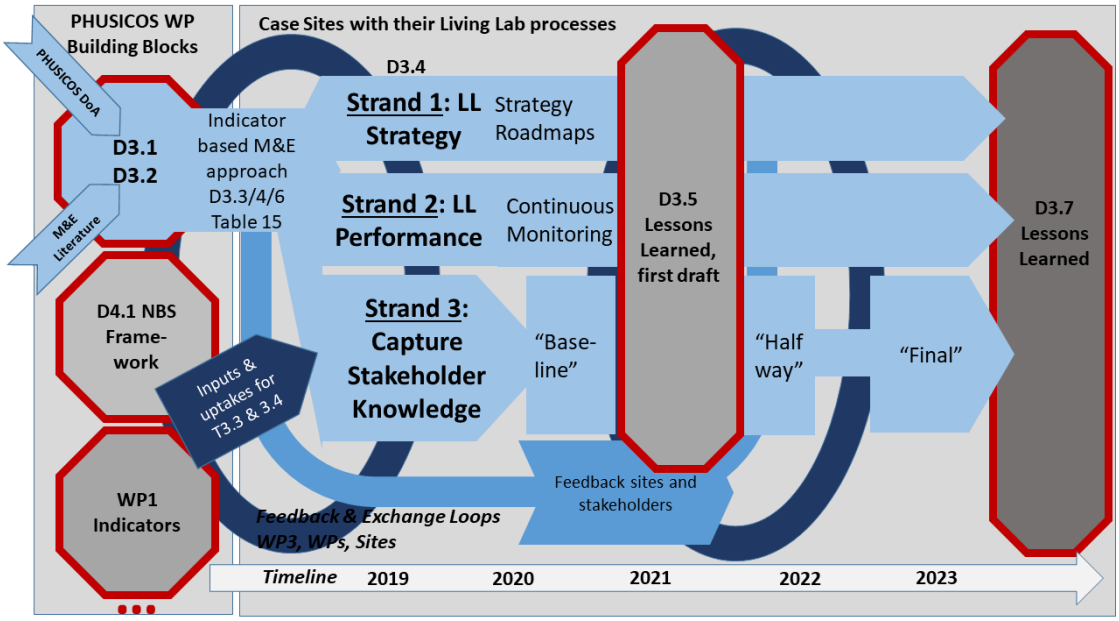

Figure 1: Operationalization of the M&E scheme with different strands

An important component of the M&E scheme is the Living Lab participants' awareness and acceptance of NBSs. This strand in M&E supports detection of changes concerning the NBS perception among the key stakeholders as well as more in-depth reflection of stakeholders. Repetition of the assessment around mid-term and at the end of the PHUSICOS project helps to describe the development of stakeholders´ knowledge, to develop the learning processes, to promote and to co-design solutions and to increase acceptance of NBSs and stakeholders´ commitment (Fohlmeister et al., 2019a, 2020).

The goals of this deliverable report D3.7 is to reflect stakeholder engagement process and the evolving knowledge on NBSs, on the role of PHUSICOS, on the Living Lab process and its goals. Experiences of the stakeholder engagement and participation with Living Lab experiences are highlighted. This deliverable follows the main guiding questions:

- What are the overall stakeholder perceptions of NBSs or neighbouring concepts?
- What are the overall main interests and concerns considering such solutions which apply to PHUSICOS?
- What expectations do actors have regarding collaborative planning of NBSs?
- What are the lessons that can be drawn from PHUSICOS´ experience?

This deliverable report presents insights from the PHUSICOS' Living Labs and in-depth collaborative planning process using Living Lab approaches. Findings from a literature review presenting experiences of other projects and theoretical reflections on stakeholder participation in the field of NBSs and neighbouring concepts are compared with our findings and outcomes. Based on the different perspectives, lessons learned will be drawn.

1.2 Target Groups of this Deliverable

As a service innovation legacy of the PHUSICOS project and in a bid to sharing experiences from stakeholder engagement and co-creating NBSs using Living Labs, this report is dedicated to supporting these target groups:

- Persons who plan to work with, facilitate and manage the stakeholder involvement processes in projects dealing with collaborative approaches to implement NBSs
- Scientific and end-user partners as well as participants of collaborative co-creation processes
- Project partners of such proposed processes
- PHUSICOS site owners and their partners to continue working on NBSs and applying Living Lab approaches

- A broader audience such as planning practitioners, politicians and scientists working on co-designing NBSs for climate change adaptation, land use planning, disaster risk management, and related fields.
- Finally, it is intended to serve as a source of inspiration for those wishing to employ Living Lab approaches to find innovative ways of developing and implementing solutions in other fields and to share and transfer experiences made by PHUSICOS.

2 Methodology

In order to answer the main guiding questions, the methodological approach is based on different knowledge sources:

1) Theoretical knowledge collected by a literature review and
2) Practical knowledge collected by
    a. in-depth protocol interviews with key stakeholders and tick box surveys among Living Lab participants
    b. collecting perspectives of demonstrator case site owners and facilitators with a group discussion and focus groups

All indicators from Table 1 were considered when creating the search strategies for literature. For the in-depth protocol interviews with key stakeholders and the tick box surveys, questions were developed in such ways to cover each indicator.

2.1 Literature Review

A literature review was conducted using the Web of Science, Scopus and Google Scholar databases between February 10 and 23, 2021. It was considered important to use more than one database since search algorithms may vary across databases. First, searches were made from all three data bases with the search term combinations, “NBS”, “nature-based solution”, “disaster-risk reduction”, “eco-disaster”, “risk reduction”, “eco-drr” AND “stakeholder awareness”, “stakeholder perception”, “stakeholder attitude”.

We also used some terms on neighbouring concepts of NBSs to collect work on stakeholder perspectives from these fields that promote a similar intention: more natural or nature-inspired solutions, as well as sustainable drainage approaches for storm water management to reduce risks, exposure and vulnerability of natural hazards triggered by hydro-meteorological events. With the growing popularity of more natural and nature-inspired solutions, the number of terms used to describe or conceptualize them has seen an explosive increase. Therefore, we realize our literature review was not exhaustive to include the abundance of all terms that currently exist.

A total number of 727 papers were identified. We utilized the PRISMA (Reporting Items for Scientific Reviews and Meta-Analyses) method (Moher et al., 2009) to identify the most relevant papers. First, we assessed the titles of these papers for relevance and categorized them accordingly. Then, we assessed the abstracts of the papers with the most relevant titles to further determine which papers would be useful for our research. In this way, we identified 49 relevant publications. We then reviewed the content and extracted the relevant information to be incorporated into our research for a qualitative content analysis (Mayring, 2000).

2.2 In-depth Protocol Interviews with Key Stakeholders, Tick Box Surveys and capturing Facilitator Perspectives

2.2.1 Interview Design

To assess the stakeholder perspectives on NBSs, Living Labs, evolution of knowledge on NBSs and the in-depth participatory approach and to draw lessons learned, we opted for a mixed methods approach. A qualitative approach (Atteslander, 2003) was chosen as a main source for information for both the perception of NBS and with Living lab experience.

Semi-structured in-depth protocol interviews were developed for this purpose (Marshall and Rossman, 1998). They were designed in order to be conducted during face-to-face meetings as well as telephone calls or during online one-to-one meetings. The intention was to have as much flexibility as possible dealing with given restrictions in place during the COVID-19 pandemic and very restricted choices of approaches for Living Lab formats between early 2020 and late 2022. The in-depth protocol interviews are based on templates G of Deliverable Report D3.3, D3.4 and D3.6 (Fohlmeister et al., 2019a, Fohlmeister et al., 2020, Fohlmeister et al., 2022). The in-depth protocol interviews intend to collect information on stakeholder knowledge based on the set of indicators from Table 1 and picking up incoming products and reports from the other work packages that are important building blocks of the Living Lab processes (Fohlmeister et al. 2019a) and following up the selected stakeholders throughout the PHUSICOS lifetime. The final set of questions were then elaborated, evolved and adapted together with facilitators, site owners and WP partners. The aim of this procedure was to tailor the resulting monitoring questions to the different case site needs while allowing cross case comparability and collecting in-depth information on stakeholder awareness. They picked up recent results and concepts available from PHUSICOS. For example, they link and reflect the ambits from D4.1 Comprehensive Framework for NBS Assessment (Autuori et al. 2019) and connected it with potential barriers and enablers of NBS implementation derived from D5.1, NBS in-depth case study analysis of the characteristics of successful governance models (Martin et al. 2019). Also, in the light of COVID-19 and associated restrictions, an in-depth qualitative approach was considered most useful as it best reflects that Living Lab processes almost came to a standstill in March 2020 as major adaptations triggered by the COVID-19 situation had to be made. For instance, meetings could only take place in the form of individual exchanges or with only very few stakeholders present in person at one time. Digital formats were developed and used when it became clear that the pandemic and restrictions in place from March 2020 would be kept up for a longer time. When restrictions were gradually lifted in 2022 in most countries, digital formats and meetings in the field continued to be very feasible formats and means of communication and exchange.

The in-depth interviews were designed to last for one hour at the maximum, and questions were communicated before the meeting to allow for preparation by the interviewees. The interview sheets that were used can be found in Appendix A1-3 of

this deliverable. Interviews were conducted in three rounds, one at the beginning of the Living Lab processes in 2020, one towards an advanced phase in early 2022 and one shorter final round focussing on remaining challenges and barriers as well as experiences made at the end of PHUSICOS in early 2023.

2.2.2 Selection of the interviewees

A preliminary systematic mapping and selection of key stakeholders is recommended to target representative stakeholders, to save time and effort for the interviews and to collect information at certain points of time. Considering PHUSICOS's larger Living Lab groups as well as the specificity induced at the different sites and to allow cross-site comparisons and similar standards, this recruiting and selection processes for interview partners should be done following an appropriate method over all the different case sites.

For this purpose, first, a systematic stakeholder identification task was conducted following an approach developed by the PHUSICOS sister project, RECONECT (Hüesker et al., 2019). Based on systematic stakeholder mapping described by Zingraff-Hamed et al. (2020c), potential stakeholders were listed according to available information from the different sites and on their documentation and available protocols from stakeholders meetings within the PHUSICOS project. Lists and documentation sheets were given to the local facilitator teams who were asked to add more potentially relevant stakeholders, for example those not responding to invitations, those unwilling to participate or those relevant only for a single step or final stages (Lynam et al. 2007, Reed et al. 2009). Based on the concept of interest-influence matrices and three-dimensional power-influence-attitude grids (Murray-Webster and Simon, 2006), local facilitators were asked to evaluate the roles of stakeholders as well as their importance for different co-design, co-implementation and co-monitoring/evaluation stages, their relation and affectedness by natural hazards and NBSs and decision processes on finding potential solutions to reduce risks. Once the matrices were filled in, the WP3 partners contacted each facilitator for a short exchange about their stakeholder assessment and asked for further actors and groups that could be missing, not existing or considered not relevant at first glance for the case. This exchange is based on theoretical information presenting stakeholder constellations in comparable cases.

Based on the results of the stakeholder mapping, together with WP3 partners, the site owners and the facilitators of the three demonstrator sites, interview partners were selected in an iterative process to ensure that at least one representative from the relevant groups in the co-creation processes were selected following a selection process suggested by Hunziker (2000). This approach was used to choose very different views, perspectives and backgrounds to encompass a broad range of attitudes over all case sites. To cover the different perspectives, attitudes and opinions, interviewees were selected according to criteria connected to the principle of maximum contrasts based on the grounded theory (Strauss and Corbin, 1990). The aim of this strategy is to cover a wide range of perspectives within a rather small group of interviewees. The criteria for selection can be the differences in socio-demographic characteristics, such as

professional background, but also obvious different opinions. However, not all of the initially identified persons could be interviewed. Some refused the request for an interview or were unavailable in the given timeframe. Also, some potential interviewees were difficult to reach during the COVID-19 pandemic, and approaches such as collecting interviews in suitable, good environments for building trust for exchange that are important for such qualitative interview approaches (Elwood and Marin, 2000), were difficult to realize. This might have led to a lack of participation as well.

Being largely a retrospective case with much expertise and experiences of stakeholders, the Isar concept case did not conduct baseline interviews. Interviews on lessons learned and experiences with NBSs and Living Labs were already conducted in the summer of 2018 for the elaboration of Deliverable D3.1 and in the spring of 2019 for Deliverable D5.1. The experiences gained during these interviews supported the design of the interview questions.

With the different nature of the Kaunertal concept case and a focus on communication and information around a novelty NBS, this case study was not included in this survey panel.

A total of 13 persons participated in the initial interview round covering all stakeholder groups from different levels media and international organizations (Table 4), which usually are observers rather than being intensively involved in the co-creation processes (Zingraff-Hamed et al. 2020c). The number dropped to 10 in the following round due to a sick leave, shift in responsibilities and occupational changes. For one case, a replacement representative of the initial stakeholder was interviewed.

Table 4: Identified and interviewed stakeholders (anonymized).

Initial Stakeholders	Stakeholder group (according to Hüesker et al., 2019; Zingraff-Hamed et al., 2020c)	Round 1	Round 2	Round 3
Agriculture 1 (Business)	Commercial Sector	✓	✓	✓
Agriculture 2 (Family-owned)	Commercial Sector	✓	✓	
Research, Agronomist	Academia	✓	✓	✓
Water Administration (Region)	Authorities	✓	✓	✓
Water Administration (County)	Authorities	✓	✓	✓
Authority (Region)	Authorities	✓		
Authority Infrastructure 1 (Province)	Authorities	✓	✓	
Authority Infrastructure 2 (Province)	Authorities	✓	✓	
Nature Manager Community (Change of person from Round 2)	Political Representatives	✓	✓	✓
Forest Administration	Political Representatives	✓	✓	
Decision Maker County	Political Representatives	✓	✓	✓
Decision Maker Community	Political Representatives	✓		
Representative of interest group for Nature and Outdoor Recreation	Civil Society	✓		✓

2.2.3 Conducting the In-Depth Protocol Interviews

Site owners conducted the in-depth protocol interviews in one-to-one meetings, by phone or video calls when persons agreed to the interviews and gave their consent following the guidelines and ethical standards of such work (see Ethical Statement Chapter). Notes were taken when interviewees preferred not to be recorded. Recorded interviews were transcribed and translated to English for the assessment. The texts were

then analysed, shortened and structured to highlight the key statements according to Mayring (2000). The interview protocols are defined as sensitive, confidential documents and will not be made public. Therefore, they are not added as an Appendix to this deliverable.

2.2.4 Tick Box Surveys capturing Perspectives of a Broader Audience

Standardized tick box surveys (Atteslander, 2003) were developed to reach out to a broader range of participants over all demonstrator case sites participating in larger Living Lab sessions to capture their perspective as well. The standardized tick box surveys were developed based on the outcome of the first-round of in-depth protocol interviews with the selected key stakeholders, asking the set of questions at a Living Lab session by the Serchio River basin and applying a draft version at the Isar concept case as a pre-test. Two different tick box surveys were developed.

1. The first, short tick box survey aimed to assess the participant satisfaction with the Living Labs, building networks and active involvement of participants linked to the indicators given in Table 1 (Appendix B1).
2. A second, longer tick box survey captured the perception of NBS and learning linked to the respective indicators in Table 1 (Appendix B2).

Sites could opt between using traditional paper surveys that are coded for further processing in the Statistics Program SPSS (version 23) or conducted online while still ensuring high privacy and data management safety. The online tool SoSci Survey[1] (Leiner 2019) was selected for the case sites opting to make use of a digital survey. The online survey was prepared by WP3 together with the sites in the different PHUSICOS languages (English, French, German, Italian, Norwegian and Spanish), pre-tested for functionality and logic with the site owners and facilitators. Around a Living Lab session, participants received a hyperlink to the survey during the Living Lab session and in a follow-up e-mail afterwards, with reminders sent out by the facilitators to achieve more returns.

With the two surveys being designed for larger in-person Living Lab meetings, with the COVID-19 pandemic and related restrictions, larger Living Lab formats almost came to a standstill between 2020 and early 2022 (see Appendix C for an overview of Living Lab activities). Site owners found it challenging to integrate the survey formats into many of the small-scale alternative formats such as field trips or small group work.

A total of 88 valid, at least partially filled tick box surveys about Living Lab satisfaction could be collected during in-person or after larger digital Living Lab sessions. In many cases, little to no response was generated both using paper or online surveys.

[1] 11 www.soscisurvey.de; SoSci Survey is a professional tool for online surveys. SoSci Survey is handled through the internet browser and there is no need to install software. The basis for the SoSci tool was developed at the Institute for Communication Science and Media Science at the LMU Munich in 2003. SoSci Survey is based in Munich and follows privacy regulations and respective data handling according to German law and privacy regulations.

A return of 47 started and 33 finished questionnaires was achieved for the longer tick box survey aiming to assess the perception of NBS mainly collected from an online Living Lab session of the Serchio team.

2.2.5 Collecting Site Owner and Facilitator Perspectives with Interviews and Focus Groups

The outcomes of the in-depth protocol interviews and tick box surveys were added with an approach to collect stakeholder perspectives, observations and experiences by engaging the site owners and facilitators of the demonstrator cases. The idea of this was to contextualize the statements from the in-depth protocol interviews and the tick box surveys and to draw on the lessons learned using a variety of perspectives.

Following up on Facilitator and Site owner perspectives, after the first round of key stakeholder in-depth protocol interviews, a set of questions were developed following the questions for the key stakeholder protocol interviews and addressing similar topics (Appendix D). The intention of asking the questions in a written form was to offer maximum flexibility with the COVID-19 pandemic. The three groups at the demonstrator cases were asked to answer the questions from their perspectives and to draw first lessons learned at an early stage of the Living Lab processes. The written protocols that we received from the demonstrator cases were assessed following the steps for analyses, shortening and structuring the key statements by Mayring (2000).

At the later stages of PHUSICOS, Facilitator and Site owners' perspectives from the in-depth interview rounds 2 and 3 were collected and discussed using two focus groups and a group discussion (Bohnsack, 2004). Linked to round 2 and with larger Living Lab activities in digital space and gradually resuming with in-person meetings, a group discussion took place during the in-person PHUSICOS consortium meeting in October 2022 followed by an online focus group end of November 2022. Linked to round 3 and a final retrospective perspective, an online focus group took place end of March 2023. The filled in documents, interview sheets and detailed Minutes of the Meetings are considered confidential, sensitive documents and for this reason, they are not added as Appendix materials to this deliverable.

3 Results of the Literature Review

3.1 Stakeholder Perception of NBS Implementation and Collaborative Planning in Literature

Despite the broad scope of the literature search that included neighbouring concepts and disaster risk reduction, not much work on stakeholder perceptions on strategies to reduce risk with NBSs or similar concepts could be found. Interestingly, disaster risk reduction and similar concepts and stakeholder perspectives mainly relate to describing their perception of natural hazards, risks, vulnerability and preparedness to react to an occurring disaster (e.g. evacuation). Related to disaster risk reduction, not much is mentioned about measures to reduce the risks. Buchecker et al. (2013) stated in their work that risk perception approaches in literature with a spotlight on disaster risk reduction have a strong theoretical nature and often focuses on the perception of risks rather than on the perception of risk prevention measures. Han & Kulicke (2019) scanned 1834 NBS papers for stakeholder perspectives and perceptions of NBSs in literature but only found 15 papers addressing how people value and perceive the co-benefits of NBSs and related concepts. Ferreia et al. (2020) conducted a systematic literature review on NBSs with a focus on urban areas related to establishment of Green Infrastructure (GI) and sibling concepts and came up with 142 papers on stakeholder perspectives. Piacentini and Rossetto (2020) analysed stakeholders in water-related NBSs and GI which were almost all situated in urban and peri-urban areas in Mediterranean France and Italy. They only found little interest and response from rural areas on these concepts and not much awareness of water-related NBSs. In this section we will synthetize their results.

3.2 Theories of Stakeholder Perception of Natural Hazards and NBSs

According to Heitz et al. (2009) who examined mudflows, risk perception and implementing solutions are based on stakeholders´ experiences, beliefs and psychological, social, economic, temporal or institutional factors. A number of theoretical approaches exist to describe perception of risks, behaviours and actions. Pagliacci et al. (2020) outline the varieties of rationalist and constructivist approaches with the protection motivation theory and protective actions decision model being the most frequently applied in the field of disaster risk reduction and neighbouring fields. These models are rooted in Planned Behaviour theories and consider subjective norms, attitudes, perceived behavioural control and background factors that influence decisions that trigger action. The concept consists of three components: attitude, norms and motivation.

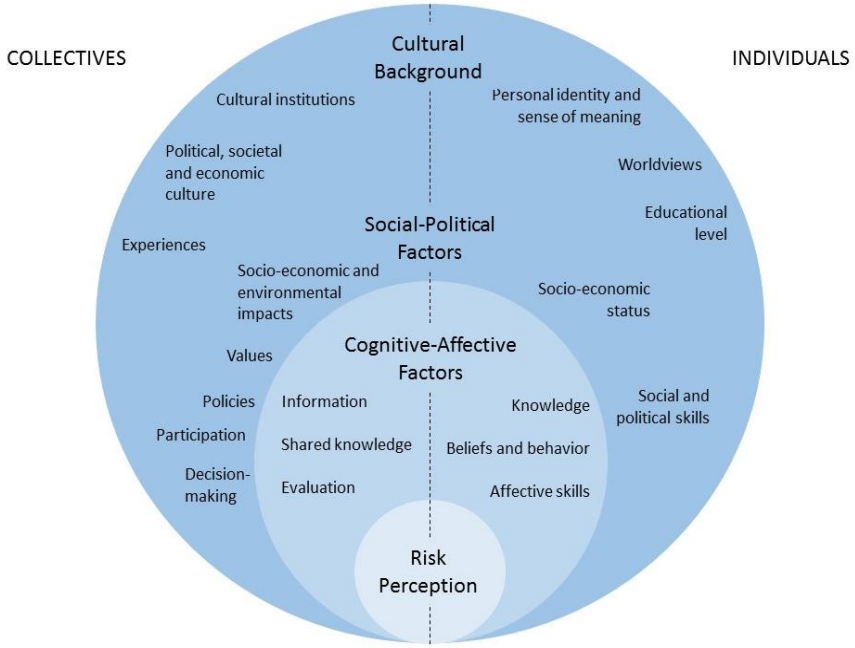

Figure 2: Factors determining risk perception (Source: taken from Mañez et al., 2016, adapted from Renn and Rohrmann, 2000)

Mañez et al. (2016) describe a series of three steps leading to active risk management that can constitute co-designing NBSs:

- Risk - consisting of the combination of hazards, vulnerability and exposure on the one hand, and the mental construction regarding it as a possible dangerous event on the other hand
- Perception of risks - based on interpretations and possible responses and based on a variety of factors such as social, economic, political and cultural contexts as well as experiences and knowledge
- Management of risks

Mañez et al. (2016) extended a model of risk perception as a key stepping stone for taking actions based on cultural backgrounds, socio-political factors and cognitive affective factors that are influenced by individual and collective backgrounds (Figure 2).

However, according to Lindall and Perry (2012), one major implication of the literature cited in the previous section is that, despite extensive theorizing and data collection, it still is not entirely clear what motivates people to take protective action. Venkataramanan et al. (2020) highlight the willingness to make changes depending on a variety of factors such as awareness of the problem, knowledge, attitudes and intention that lead to implementing or adopting solutions. Knowledge in this context is frequently identified in theoretical reflections (e.g. Bustillos Ardayaa et al., 2017; Pagliacci et al., 2020) as a key factor as it can shape attitudes such as perceived benefits, perceived dangers, perceived susceptibility to a problem and preferences for solutions.

Looking at these findings in the literature, it is important to understand worldviews, topics and aspects of NBSs of importance for stakeholders. This also underpins assessing stakeholder perspectives as suggested in the M&E schemes. This assessment is crucial for understanding stakeholders and is a vital cornerstone for continuous stakeholder engagement in collaborative planning processes such as Living Labs (Brugha and Varvasovszky, 2000, Lupp et al. 2021) as well as for understanding their motivation to act.

3.3 Familiarity with NBS Concepts

Bark et al. (2021) described in their study from the UK on natural flood management (NFM) that two-thirds of the respondents considered themselves familiar with NFM, but only eight strongly considered themselves experts. Understanding and information were collected mainly by participation in one or more natural flood management projects. Heitz et al. (2009) describe the farmer´s self-conception being “experts for soil”, and information providers from the Farmers’ Trade Union, technical papers and agricultural advisors. However, the examination of this case revealed that farmers often have a weak awareness of flood risks in the context of mudflows.

3.4 Perceived Positive Features of NBSs

Co-benefits and usability of NBSs are considered very important in urban areas in the literature. “Neat looking” solutions (Hoyle et al., 2017) can help to gain acceptance but might contradict the most desired co-benefits or the key purpose of NBSs which is to enhance biodiversity. Han and Kulicke's (2019) findings suggest that co-benefits are valued positively and important for many stakeholder groups. Thus, co-benefits are seen to have positive influence on people’s perception of NBSs, although in some studies, aesthetical aspects were found to be perceived as of lower relevance compared to other co-benefits. It was assumed that people support or prefer NBSs if they also positively value wider social and natural co-benefits, such as aesthetical, recreational, economic, and nature-related aspects. This result is confirmed by Pagano et al. (2019), particularly if people have direct access to NBSs in urban settings and can interact with them frequently. However, the studies assessed by Pagano et al. (2019) focused only on co-benefits related to recreational and aesthetical aspects. Other possible positive aspects such as health, wellbeing, cultural value, and economic development have not yet been considered.

For rural and mountain settings, a strong focus on addressing natural hazards and other features is important and decisive for successfully implementing NBSs. Bark et al. (2021) stated that for stakeholders in these settings, solutions should be cost-effective and needs to clarify issues such as tenure and coordination of maintenance of such solutions.

3.5 Concerns about NBSs

Han and Kulicke (2019) find that people often consider natural solutions as being less effective than traditional protection schemes. In the assessment of stakeholders by Bisonette et al. (2018), most of the interviewed persons stated that more information was needed on the biodiversity and ecological functionality of NBSs. Many participants in this study believed that an economic evaluation of ecosystem services is necessary to design effective planning interventions.

Several authors reporting on NBSs or neighbouring concepts in rural settings describe perceived negative economic aspects as important concerns or barriers to implement NBSs. Heitz et al (2009) also highlight economic issues as playing a role in measures that prevent mudflows. Portugal Del Pino et al. (2020) describes major concerns about NBSs with their high expected maintenance costs. Piacentini and Rossetto (2020) observed that stakeholders considered costs to be higher for NBSs compared to other solutions, but additional co-benefits might outweigh them. Pagano et al. (2019) state that the construction, maintenance costs and effort required are perceived to be the major limitations for disseminating and replicating more natural solutions. Bisonette et al. (2018) stated, that many participants believed that an economic evaluation of services such as recreation or aesthetics is necessary to design effective planning interventions. Santoro et al. (2019) highlight that stakeholders expressed their need to have a quantitative assessment of the effectiveness of the selected measures in reducing flood risk and expected impacts with specific reference to the costs and benefits of the chosen actions.

In their case of adapting to sea level rise in Scotland by Lieski et al. (2019), rural stakeholders claimed that decision-making should be based on economic rationality and locally derived evidence, and that poorly designed schemes might lead to increased maintenance costs. Willingness to manage flood risks with NBSs was accepted only if there would be evidence that considerable numbers of residents benefit from them with increased protection.

Pagano et al. (2019) refer to 10% of stakeholders explicitly preferring traditional grey solutions as they are well known and reliable. According to the authors, this stresses again the importance of demonstration pilots and capacity building.

3.6 Stakeholder Views on Involvement and Participatory Approaches Evolving Over Time

Only a few of the assessed papers followed up on stakeholder perception on participative processes and evolution of knowledge or changing attitudes in NBSs and neighbouring concepts. Wamsler et al. (2020) critically reflected on stakeholder involvement. In urban contexts, many stakeholders or involved citizens lack environmental awareness. As a

consequence, individual personal interests are mixed in that are not related to NBSs or GI development. Furthermore, a lack of awareness even after severe events does not change the attitudes or willingness to act. Huq (2017) reports on a case from local communities. Despite several severe flooding in recent years, most actors believed that such events will not happen again in the near future, and therefore they are not open for natural flood management ideas. Also, priorities of farmers are not met, and they remain an isolated community of their own in collaborative efforts. Therefore, also from this perspective, stakeholder involvement and collaborative planning is challenging.

However, in the study of Buchecker et al. (2013), the interviewees experienced the participatory process as an effective means of sustainable decision-making. At the end of the process, only one critical voice remained and doubted that the broad involvement of stakeholders would result in a feasible solution. Others, who had been sceptical in this respect at the outset, lost their doubts during the process.

4 PUSICOS perspectives of Stakeholder Knowledge and Experiences with the Living Labs

4.1 Stakeholders and the NBS concept

Looking at the in-depth protocol interviews at the beginning in round 1, about one-third of the 13 interviewees first became familiar with the NBS concept and related terminologies within the PHUSICOS activities (e.g. kick-off meetings at case study sites) (Figure 3). The others came across it within river restoration measures, related to agricultural practices or forestry. One interviewee encountered the concept in an urban context. For the stakeholders that felt that they were familiar with the concept already before the start of PHUSICOS, they indicated that they have gained their knowledge about the concept of NBSs through research activities or universities (Figure 4). For one interviewee who is a supporting partner institution for PHUISCOS, the proposal preparation phase was an important point to collect knowledge on NBSs.

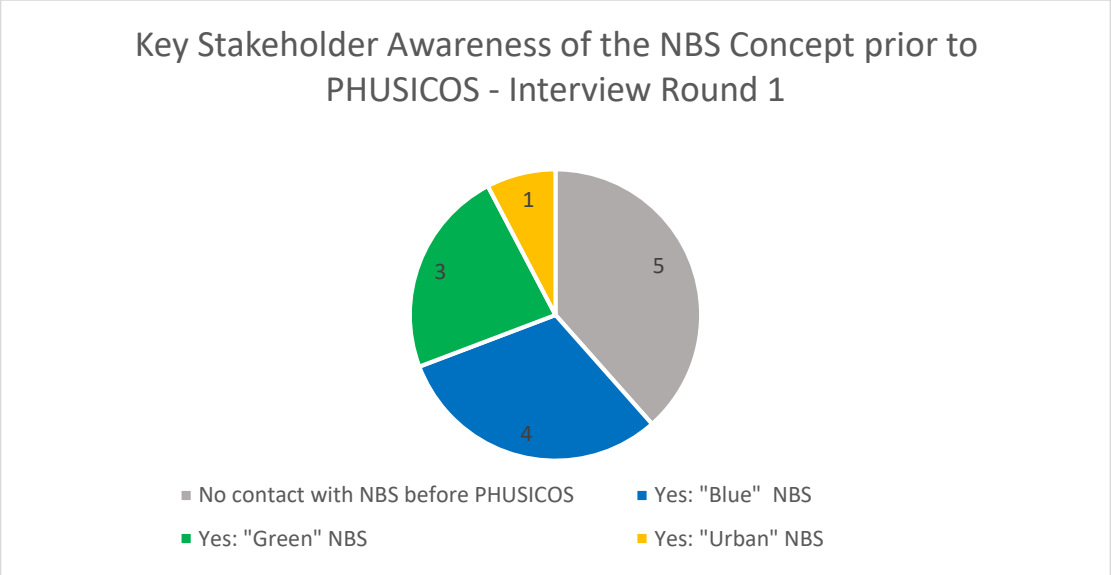

Figure 3: Key-stakeholder awareness of the NBS concept prior to the start PHUSICOS

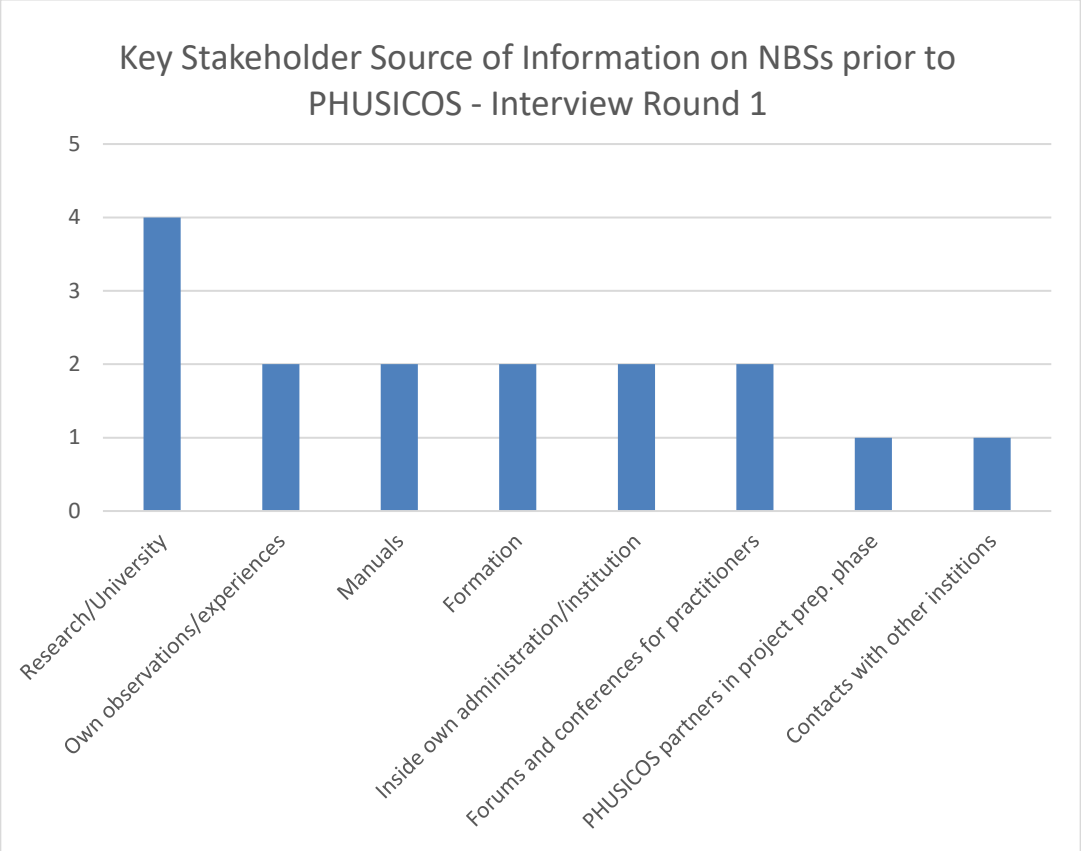

Figure 4: Source of information on NBSs mentioned by PHUSICOS stakeholders in the in-depth interviews prior to the project phase (multiple statements extracted from responses, 13 interviewees)

Looking at the perspectives of a broader range of Living Lab participants, the snapshot impression from the tick box surveys (Appendices B1 and B2) with most responses linked to a webinar at a later, advanced stage of PHUICOS provides additional insights. The results indicated that most participants have previous knowledge about NBSs. However, half of the respondents felt that they need more information to fully understand the concept (Figure 5). Again, an important source of information was PHUSICOS with its activities such as Living Labs and being in contact with persons or authorities involved in the project (Figure 6). This highlights the importance of projects such as PHUSICOS to raise awareness not only for NBSs, but also about more fundamental issues related to natural hazards resulting from hydro-meteorological events.

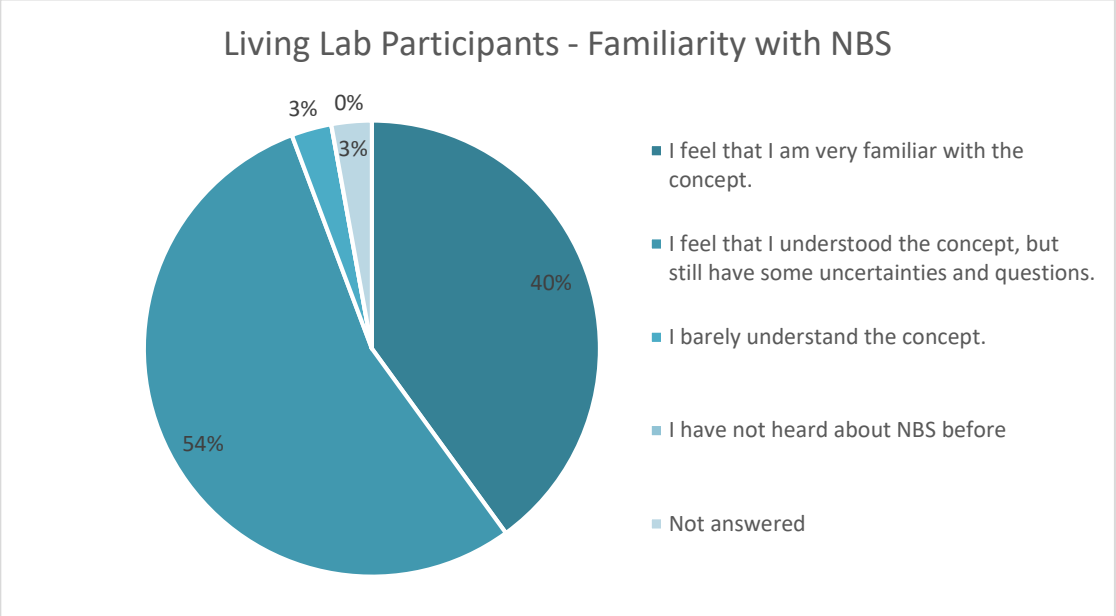

Figure 5: Awareness of Living Lab participants of the NBS concept (mainly responses from an event at an advanced state of PHUSICOS, n=47)

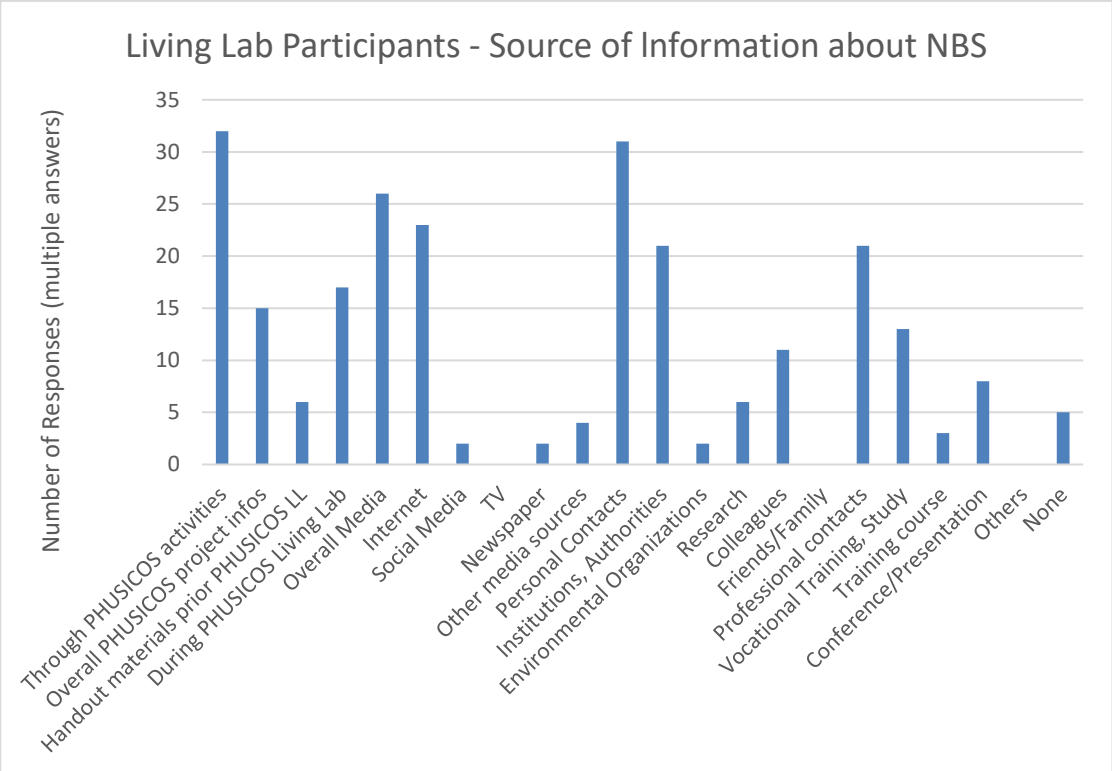

Figure 6: Source of information about NBSs of Living Lab participants (multiple answers, n=47)

4.2 Overall Experiences with PHUSICOS

4.2.1 Expectation towards PHUSICOS

In the first round of in-depth protocol interviews with key stakeholders, it was expected that PHUSICOS would provide more information on NBSs (Figure 7). Most stakeholders expect PHUSICOS to inspire them through the presentation of new solutions to address natural hazards or to reduce the risks at their case site. An important aspect throughout all interviewees was the desire to find solutions that are attractive and interesting from an economical point of view. For example, NBSs could provide new, interesting business models for land owners. With the pan-European perspective of the project, including the Isar as a retrospective case, learning from this case, upscaling and adapting the solutions or strategies related to implementing good NBSs were perceived to be an attractive opportunity provided by the project.

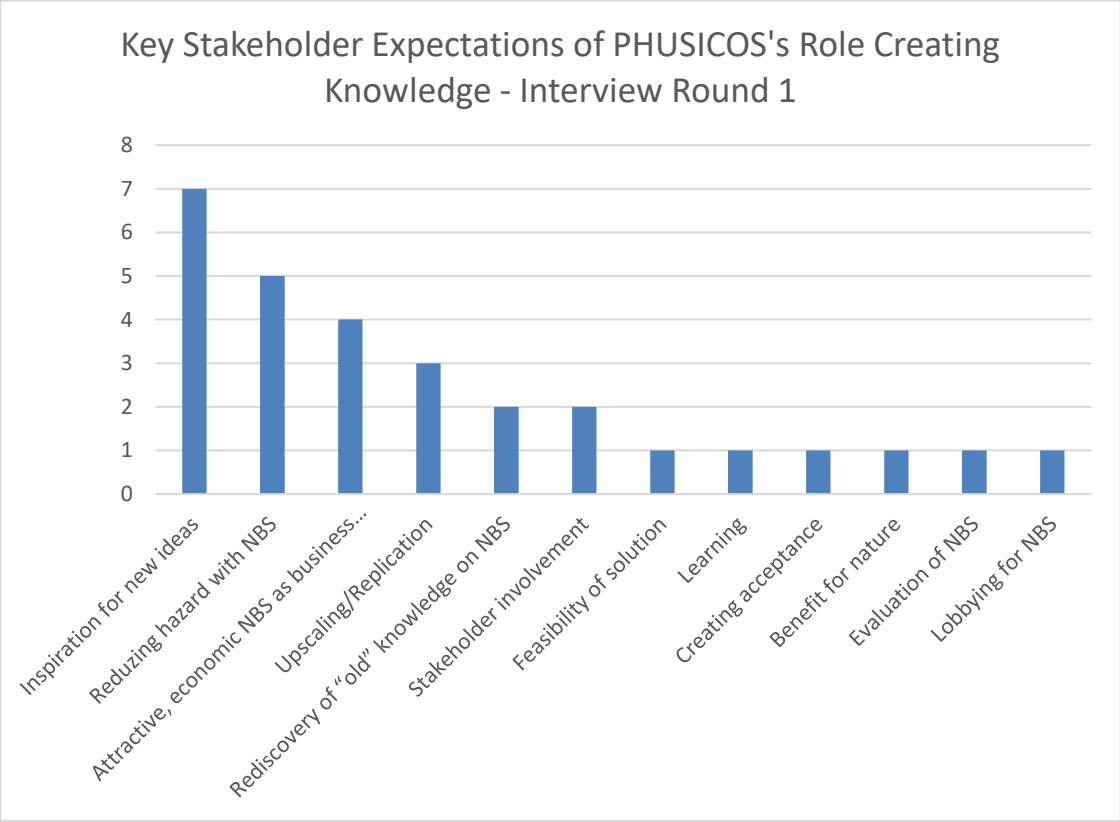

Figure 7: Expectations expressed by key stakeholders of PHUSICOS's role within the knowledge provisioning process (multiple statements extracted from responses, 13 interviewees)

4.2.2 Learning Processes in PHUSICOS

Being engaged in PHUSICOS, many of the key stakeholders interviewed in the in-depth protocol interviews expressed they learned much more about natural hazards and gained new, more general knowledge around NBSs (Figure 8). 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 connections to historic land uses, assessment of other cases, co-creating an NBS as well as verifying the effectiveness of NBSs by science and collecting monitoring data. Looking from a retrospective perspective, during the project lifetime, PHUSICOS has, according to most interview partners, met many of their expectations in terms of knowledge and awareness for natural hazards and risks, creating knowledge about NBSs and achieving exchange and dialogue with different actors (Figure 9). Nonetheless, some points remained only partly achieved, such as perceiving NBSs as potentially capable to reduce risks of natural hazards but still missing long-term proof of data based on monitoring. Another point was developing business models around NBSs and creating value chains to make NBSs attractive for land owners or secure a long-term management or existence.

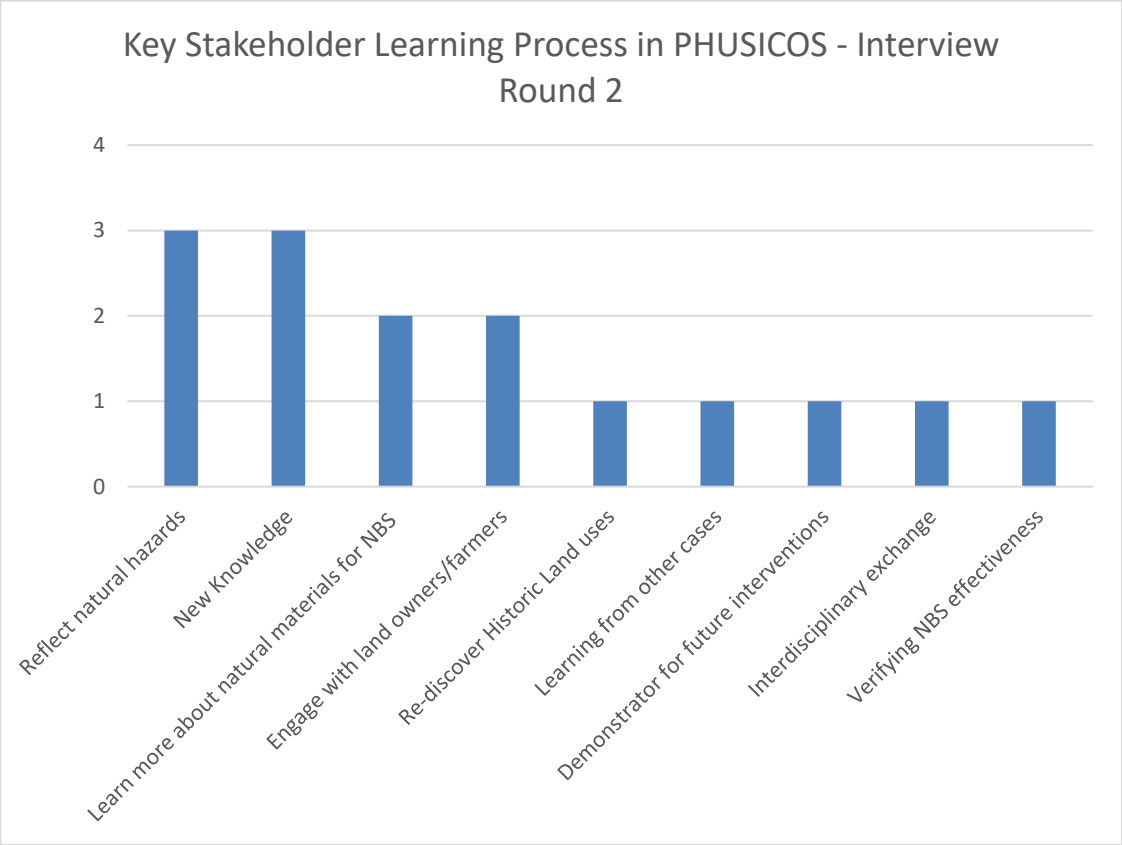

Figure 8: Learning processes for interviewed key stakeholders during advanced stage of PHUSICOS (multiple statements extracted from responses, 10 interviewees)

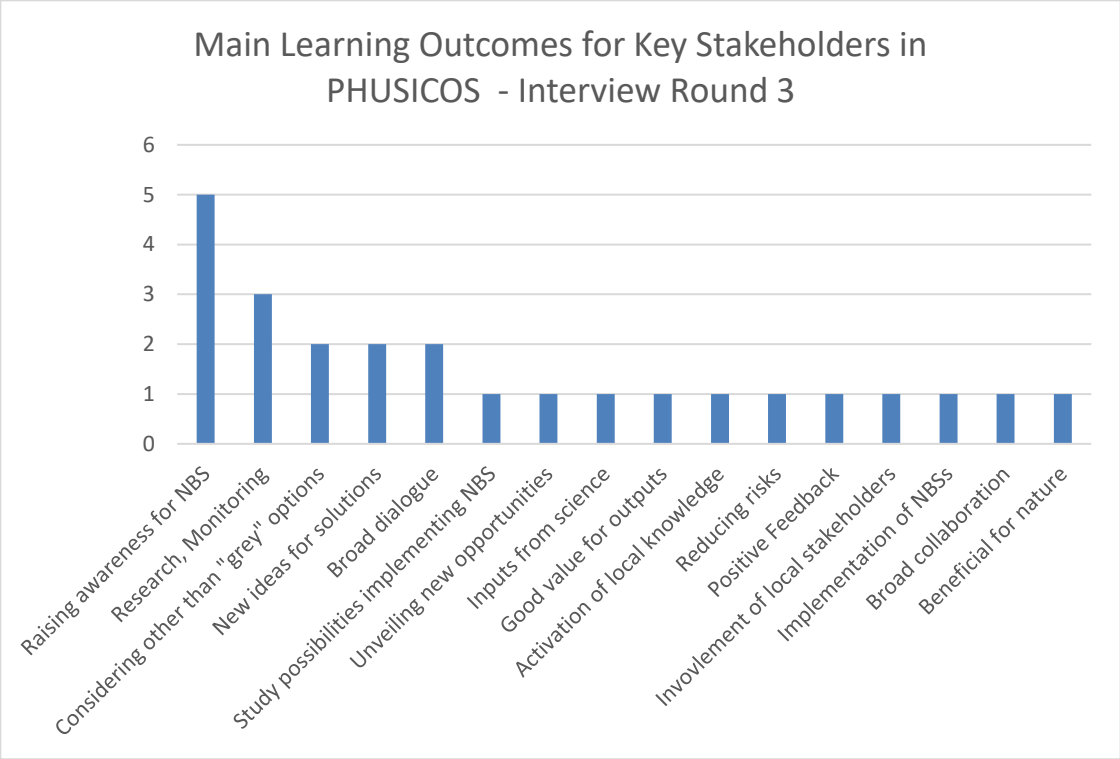

Figure 9 Main Learning Outcomes of PHUSICOS for key stakeholders (multiple statements extracted from responses)

4.2.3 Role of PHUSICOS for Stakeholders – Site Owners´ and Facilitators´ Perspective

Reflecting the outcomes of the tick box surveys among Living Lab participants and the and in-depth protocols in the two focus groups and the group discussion, site owners and facilitators have experienced very different levels of knowledge about NBSs. With activities of the sites, some of the stakeholders have developed a more nature-based way of thinking, and they have picked up and included ideas and learned about NBSs in the Living Labs during their engagement in PHUSICOS and several barriers related to a lack of knowledge were overcome. From a site owner and facilitators´ perspective, approaches to meet the needs of stakeholders is fourfold with different emphasis at the different demonstrator cases:

1. Knowledge provision and dissemination: Provision of scientific and evidence-based data played an important role for the site owners and facilitators, especially in terms of overcoming scepticism and the frequently stated lack of proof of concept. The R&I nature of PHUSICOS was seen a very useful tool to bring information and existing experiences to the sites and the different actors. The project offered both the opportunity to showcase good and concrete existing

examples that were important for the stakeholders and the possibility to co-design and co-implement real NBSs in the demonstrator cases. A key success element was seen to conduct site visits and working with actual cases. This contributed to a better understanding of the problems that needed to be addressed.

2. European Research: With the R&I nature of PHUSICOS, it was able to offer scientific evidence-based information and data for many proposed and implemented NBSs. This helped to increase publicity and decrease scepticism. Implemented NBSs and monitoring over time could showcase how NBSs work and can contribute to create proof of evidence. Despite modelling approaches to showcase benefits, NBSs take time to mature and on-site data about positive effects might be only available in the long term. With some of the partners committed to monitoring beyond the lifetime of PHUSICOS, it will be important to follow up and continue to generate data that could serve as a long-term proof of concept.

3. Stakeholder involvement: Identification with mapping and engagement of different stakeholders as early as possible was seen as a key success factor to co-design and co-implement NBSs. Openness and expressing different opinions were seen challenging but important to encourage stakeholders to learn a new way of thinking. Integrating stakeholders with different levels of knowledge was difficult and a factor to slow down processes. A solution was adopted by providing different formats to address different groups and separate communication and learning tasks. Stakeholder involvement throughout the process of elaboration to implementation and the technical coverage of the solutions could show stakeholders how robust NBSs are and their ability to serve multiple interests. In a similar way, discussed solutions and a broad variety of backgrounds contributed to improved NBSs. The co-created, implemented outputs will work as advocates and knowledge vectors for NBSs. The created hands-on cases support stakeholders working in other sites in the region and beyond.

4. Application and Demonstration of NBSs: PHUSICOS's role was to showcase good NBS applications. PHUSICOS provided several "well thought-through" measures that took many different interests into consideration, which ultimately lead to measures that many stakeholders appreciated a lot. A full coverage of the solutions adopted could demonstrate robustness to stakeholders while serving multiple interests (although multiple benefits were less explicitly mentioned as important) and provide synergies among many interests or needs. Finally, NBSs can encourage others to replicate good practices both in the demonstrator case areas and elsewhere.

4.3 Perception of NBSs

4.3.1 Perceived Benefits on NBSs

The in-depth protocol interviews showed that at the beginning of the Living Lab process, key stakeholders perceived NBSs as beneficial for nature and providing interesting opportunities for local businesses and risk reduction towards higher acceptance by the public. Other or multiple benefits were mentioned at an early stage of PHUSICOS only to a little extent (Figure 10).

During the project, the perspective of NBS shifted more towards “working with nature”, the use of local materials and NBSs being more aesthetically pleasing solutions. Also, it was seen as a solution that integrates with farming and farming practices (Figure 11). The idea of working with local companies decreased, as first experiences in tendering processes to implement NBSs showed that often only very few companies have the necessary skills, knowledge and abilities to implement NBS in an appropriate manner. With a big emphasis on co-benefits in both theoretical discussions and policies, multiple benefits were of lesser explicit importance to interviewed stakeholders throughout the interview rounds. Still, even at the end of the project, many of the interviewed stakeholders expressed that they or “fellow stakeholders” have scepticism towards NBSs.

In the tick box surveys with Living Lab participants that mainly present a snapshot from one session at an advanced stage of PHUSICOS, with given items derived from literature and first round in-depth interviews, perspectives were more positive (Figures 12-16). Participants largely agreed that NBSs are suitable to reduce hydrometeorological risks, are a good means to adapt to changing climate and were quite optimistic about that NBSs could create economic value chains. Still with a majority on the positive side, some scepticisms are apparent when looking at the responses for the items “acceptance for NBS” and “robustness” (Figures 15 and 16 with a high number of responses “neither – nor”).

Looking at the facilitator and site owner perspectives for this topic, in the group discussion and the focus groups, they perceived that with the beginning of the stakeholder processes, awareness of risks from natural hazards rose and NBSs were seen as an option to reduce threats. When actors worked on NBSs, they started to see more values and benefits provided by NBSs. However, quite strong fears or concerns were observed towards “new” solutions and “the unknown”.

NBSs were later reported to be perceived as well integrated solutions within the rural environment that can be built and maintained by stakeholders as for example by farmers using their agricultural machinery and historical practices. Another main advantage of NBSs for stakeholders was observed by the facilitators and site owners was their potential reversibility. Compared to grey solutions, NBSs could easily be removed,

dismantled, decay or can be converted to other (previous) land uses, if they did not work as expected.

With an intermediate look at the Living Lab processes and discussing the outcomes among site owners and facilitators in the focus group in November 2022, the question arose as to whether "multiple benefits" and some aspects in the NBS discussion might be more of an academic nature. For many engaged stakeholders, the main challenge was seen to be implementing NBS on the ground and for the main purpose of reducing risk since it is a more sustainable solution.

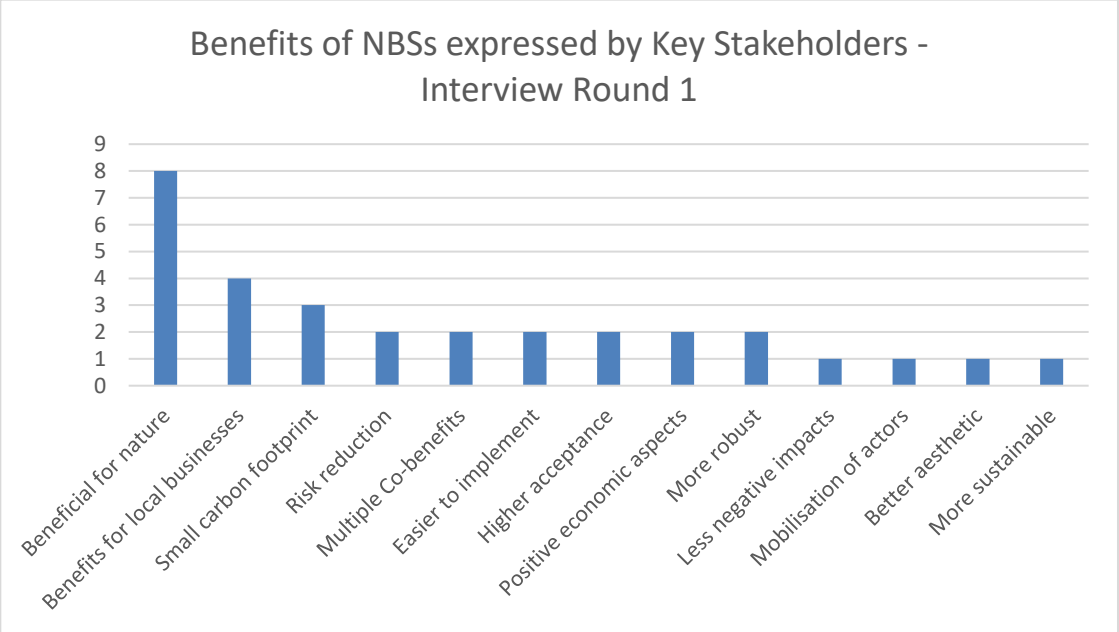

Figure 10: Perceived benefits of NBSs from a key stakeholder perspective (multiple statements extracted from responses, 13 interviewees)

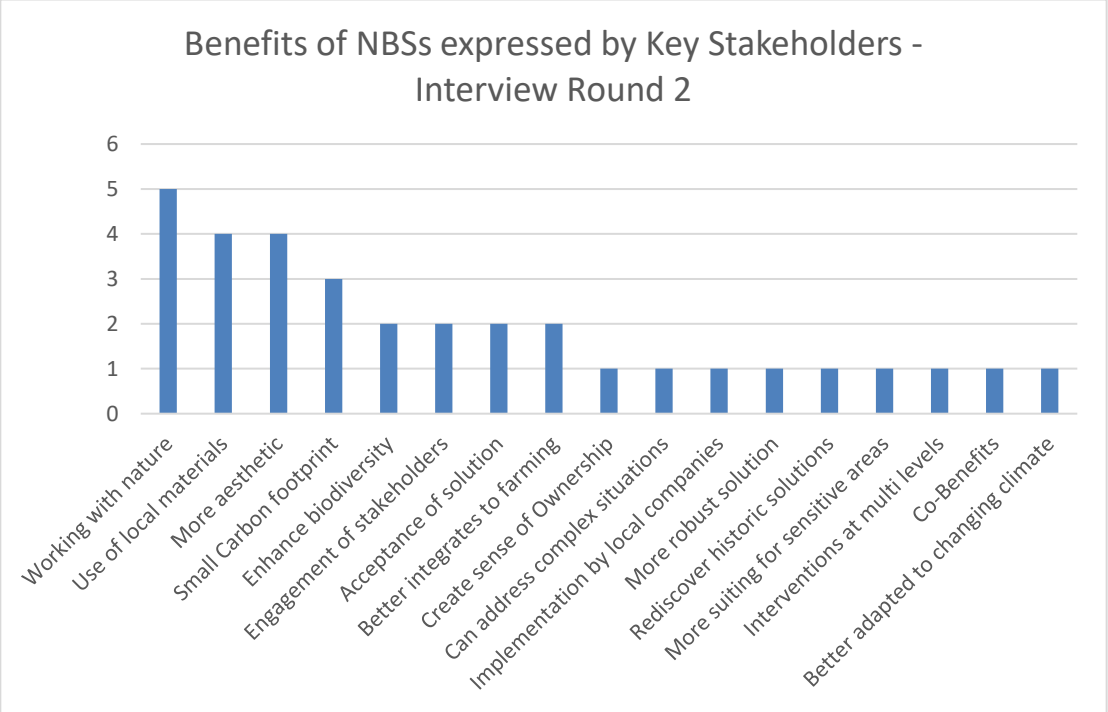

Figure 11: Perceived benefits of NBSs from a key stakeholder perspective in the second round of interviews (multiple statements extracted from responses, 10 interviewees)

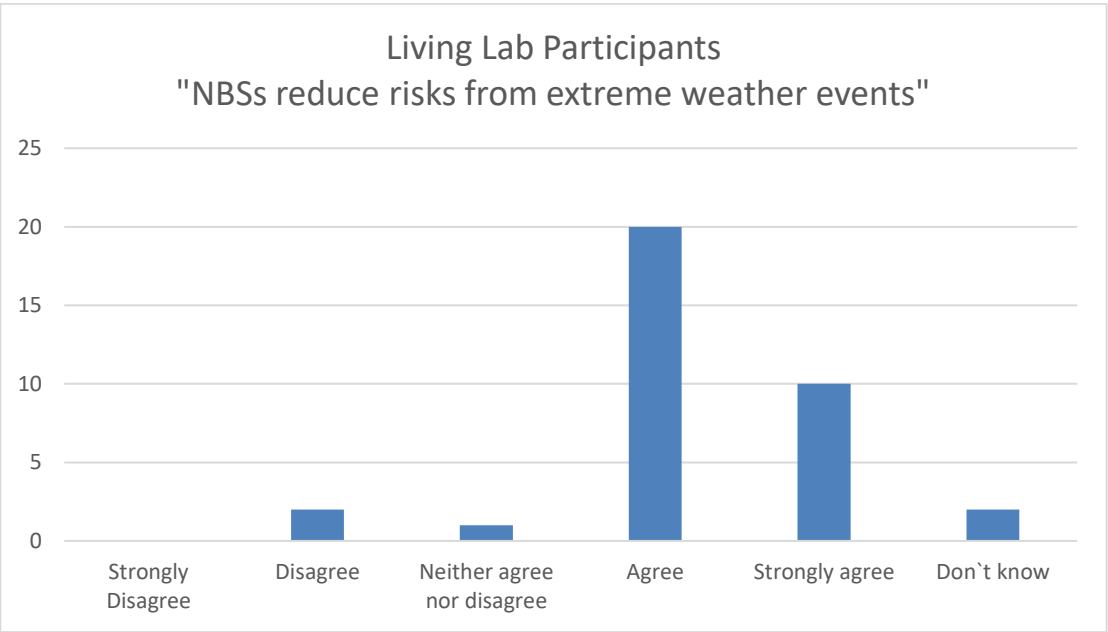

Figure 12: Perception of Living Lab participants on potential benefits of NBSs (mainly responses from an advanced state – given item with 5-Step Lickert scale, n=47)

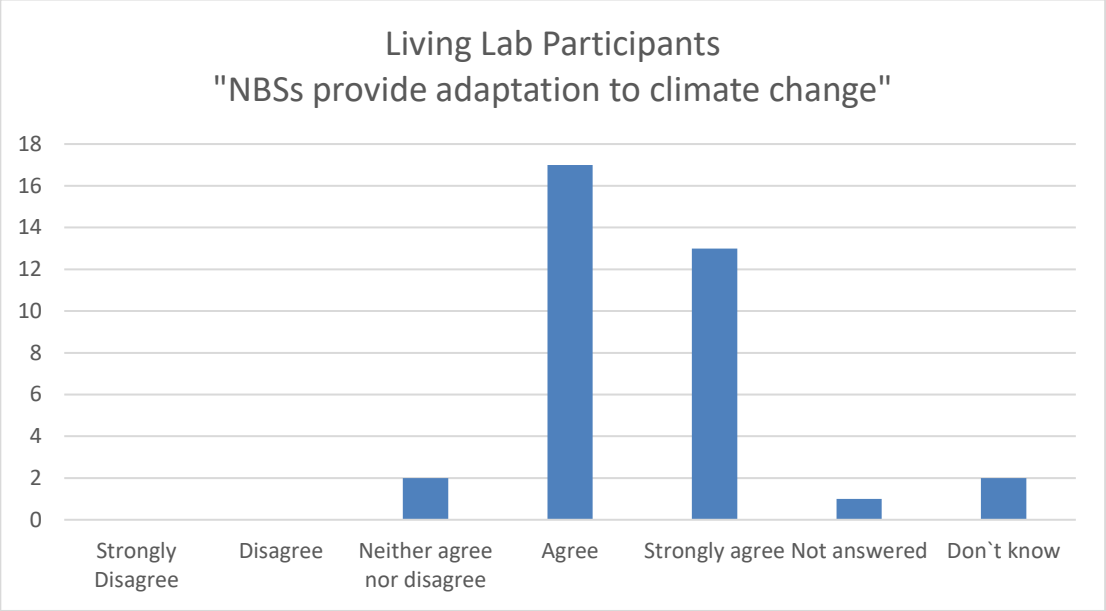

Figure 13: Perception of Living Lab participants on potential benefits of NBSs (mainly responses from an advanced state – given item with 5-Step Lickert scale, n=47)

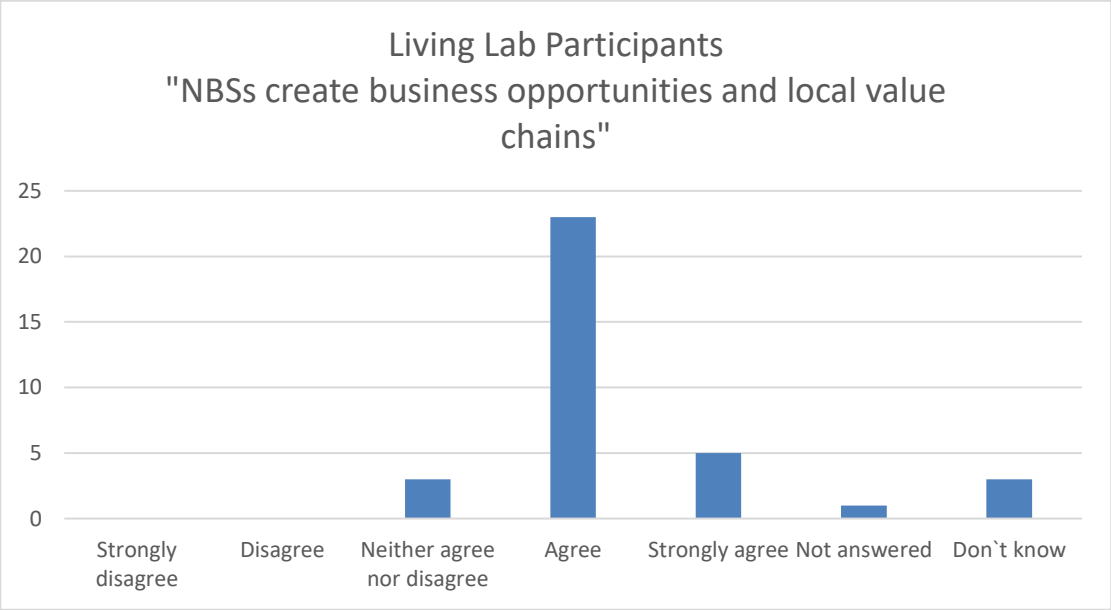

Figure 14: Perception of Living Lab participants on potential benefits of NBSs (mainly responses from an advanced state – given item with 5-Step Lickert scale, n=47)

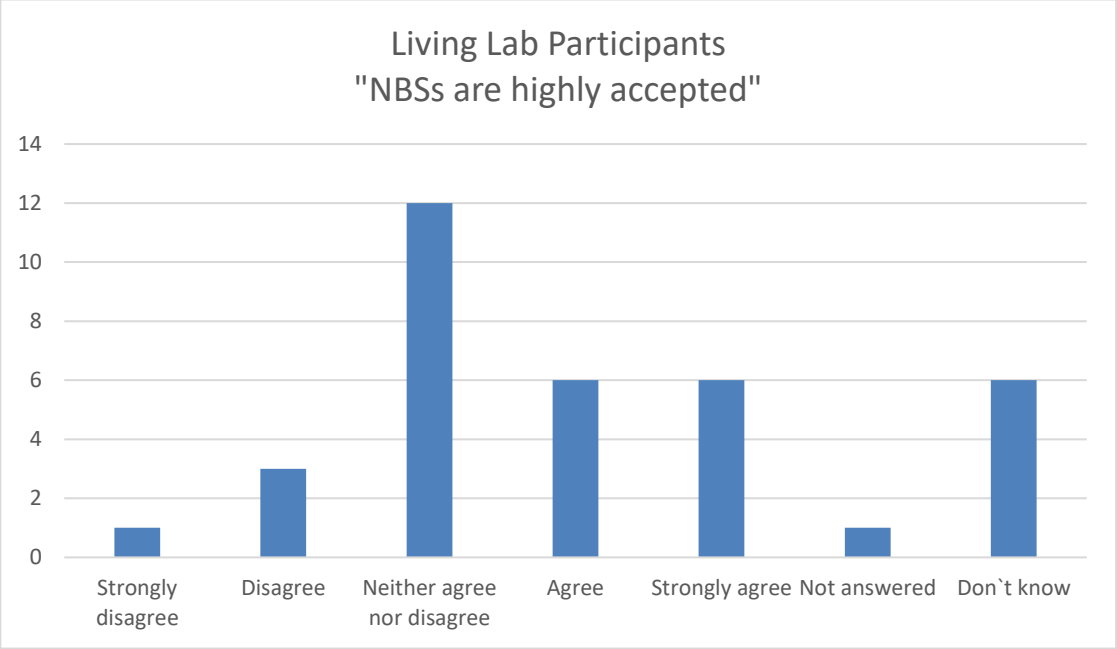

Figure 15: Perception of Living Lab participants on potential benefits of NBSs (mainly responses from an advanced state – given item with 5-Step Lickert scale, n=47)

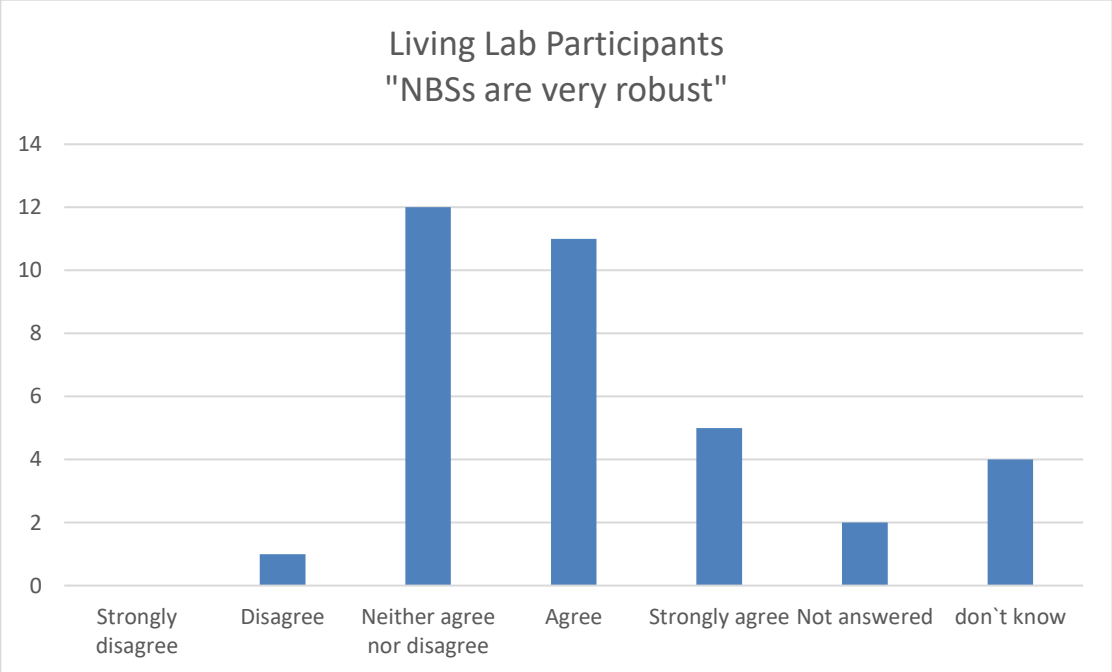

Figure 16: Perception of Living Lab participants on potential benefits of NBSs (mainly responses from an advanced state – given item with 5-Step Lickert scale, n=47)

4.3.2 Concerns about NBSs

Main concerns in terms of negative aspects 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. Another main concern was that NBSs are perceived as being potentially less reliable than grey solutions and therefore cause scepticism (Figure 17). In particular, NBSs are perceived as less reliable in mitigating extreme events. Beside the lack of evidence of effectiveness of NBSs or applicability at the case site, another concern was the time needed until NBSs reach their functionality. The concern is especially related to the time needed to achieve the necessary vegetation cover. Other concerns about NBSs were that they might not be sustainable if materials such as wood are imported from long distance or if excessive helicopter transport is needed for transporting materials and workers to remote mountain areas. As a consequence, carbon footprints might be quite large for such solutions.

During the engagement in PHUSICOS, many of the concerns got smaller but some main points were mentioned frequently throughout all in-depth protocol interview rounds (Figure 18 and 19). NBS were perceived to be costly. Linked to the scepticism expressed on the overall reliability of NBSs in the beginning, in the round 2 in-depth protocol interviews, the lack of proof of concept was frequently brought up and from a retrospective perspective in round three, the long-term proof of concept. Similarly, the time needed to reach functionality was mentioned and was also seen as a barrier to consider or implement NBSs.

In the tick box surveys with Living Lab participants (Appendix B2), with given statements expressing concerns derived from literature and key stakeholders in-depth protocol interview statements from round 1 (Figure 20-25), perceptions were more positive. However, scepticism might be expressed to some extent with many participants judging “neither agree or disagree”. More agreement to concerns was found in “time until NBSs work” and “providing space for unwanted plants and animals”.

In the group discussion and focus groups, facilitators and site owners mentioned these concerns as important issues to be worked on and were solved to some extent during the project in the Living Labs. It was seen that in many cases, stakeholders would not actively carry out an NBS project themselves without any kind of European or national grant or support scheme, and conversely, projects and funding opportunities are needed to stimulate action. Within PHUSICOS, NBSs that were brought up, suggested, discussed, evaluated and decided for being implemented, benefited from EU funding to put them into place. However, the long-term maintenance of NBSs beyond the project lifetime remains a major concern. But also, this was seen as a starting point for continuing collaborative work beyond PHUSICOS. To address this issue, stakeholders and site owners expressed plans for further activities and Living Lab approaches to develop business models for farmers for the maintenance of NBSs or compensation schemes such as payment for providing ecosystem services.

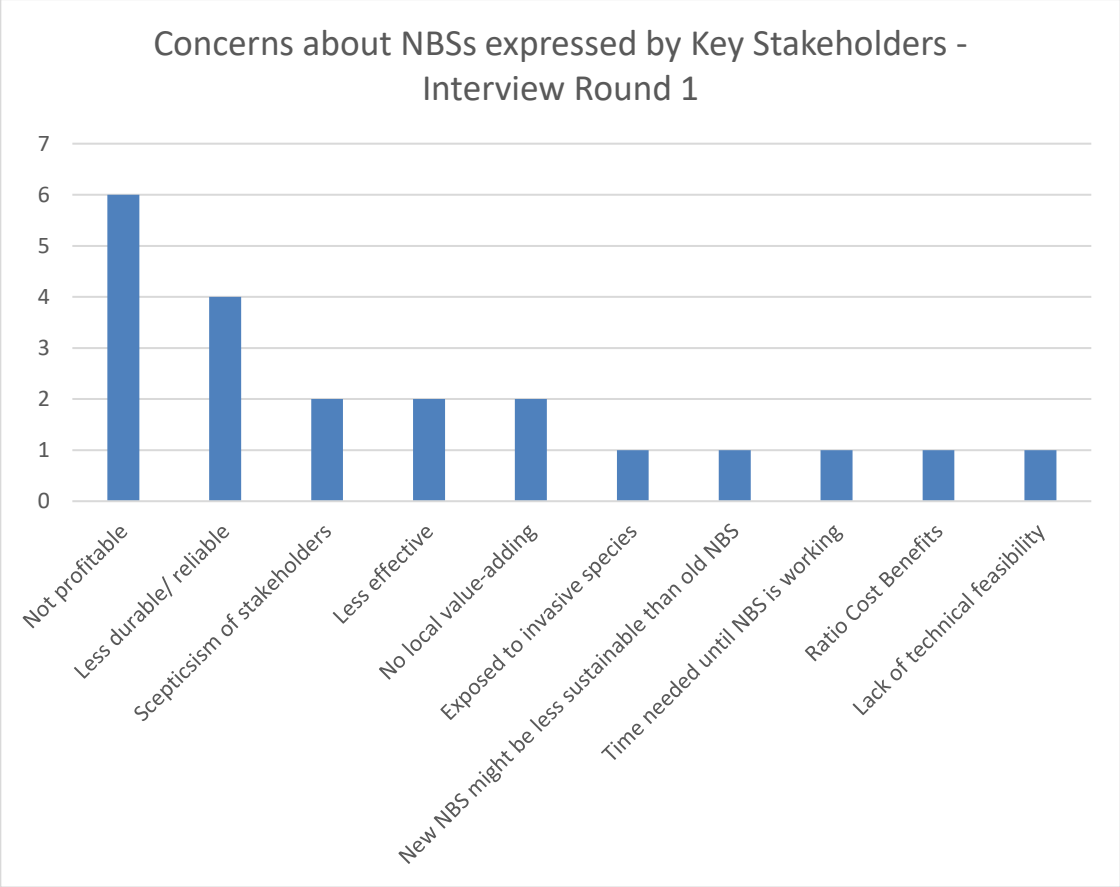

Figure 17: Concerns expressed by interviewed key stakeholders on NBSs towards the beginning (multiple statements extracted from responses, 13 interviewees)

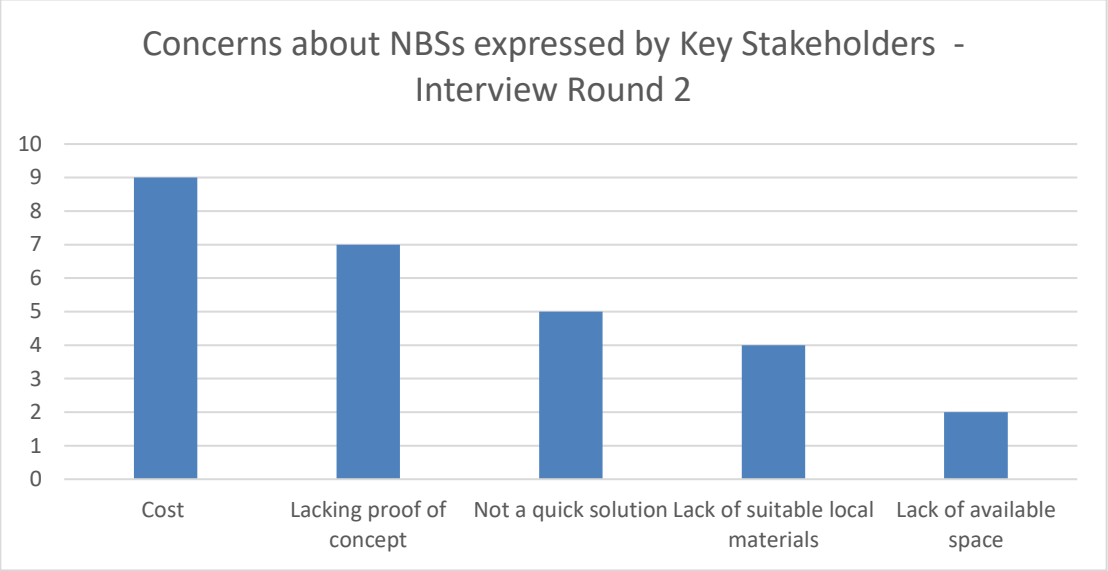

Figure 18: Concerns expressed by interviewed stakeholders on NBSs in round 2 (multiple statements extracted from responses, 10 interviewees)

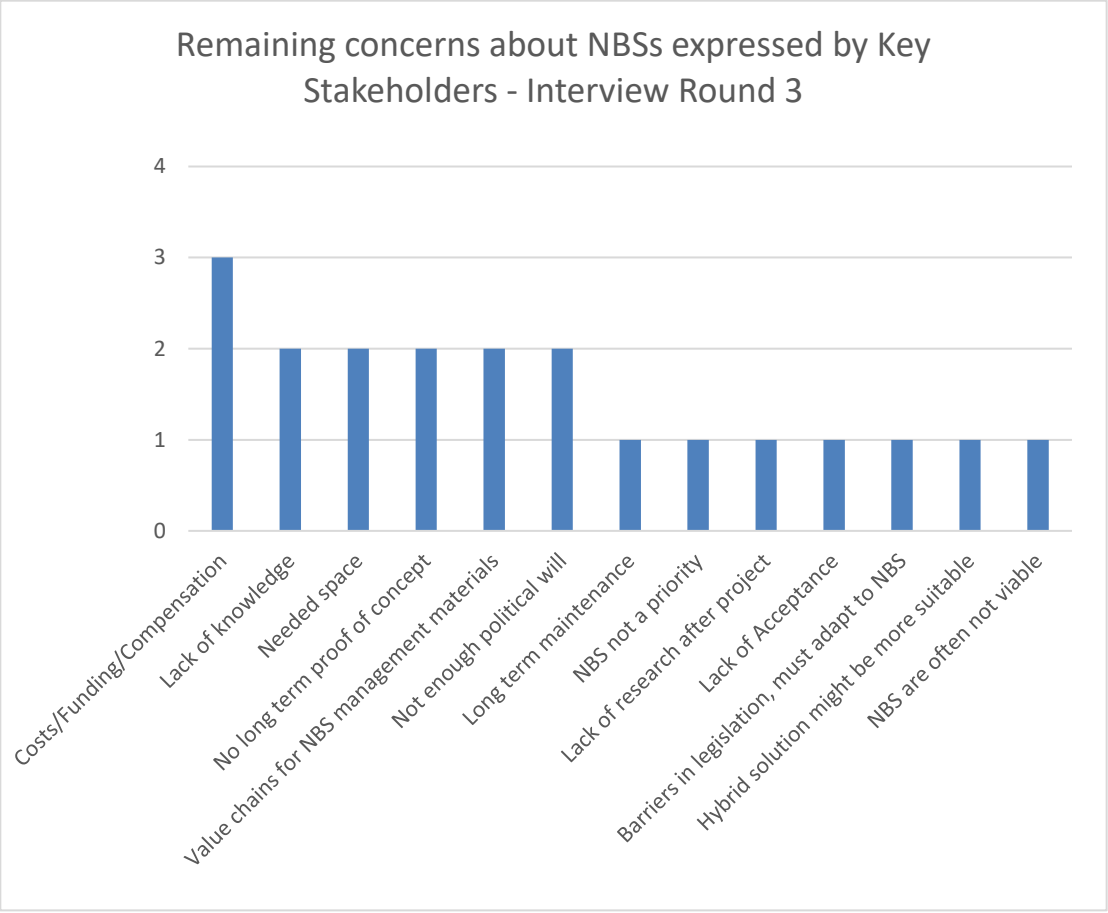

Figure 19: Concerns expressed by interviewed stakeholders on NBSs at the end of PHUSICOS (multiple statements extracted from responses)

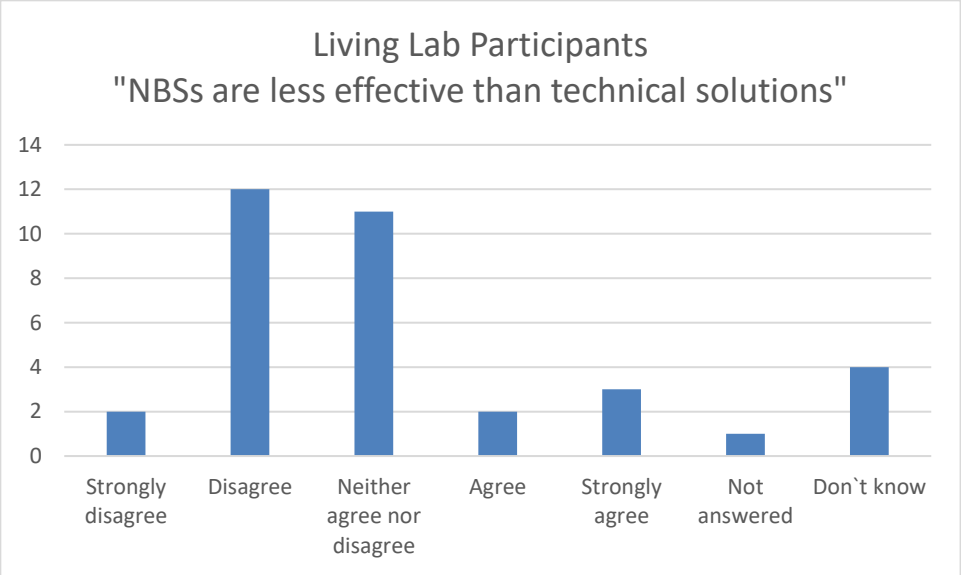

Figure 20: Perception of Living Lab participants on potential negative aspects of NBSs (mainly responses from an advanced state – given item with 5-Step Lickert scale, n=47)

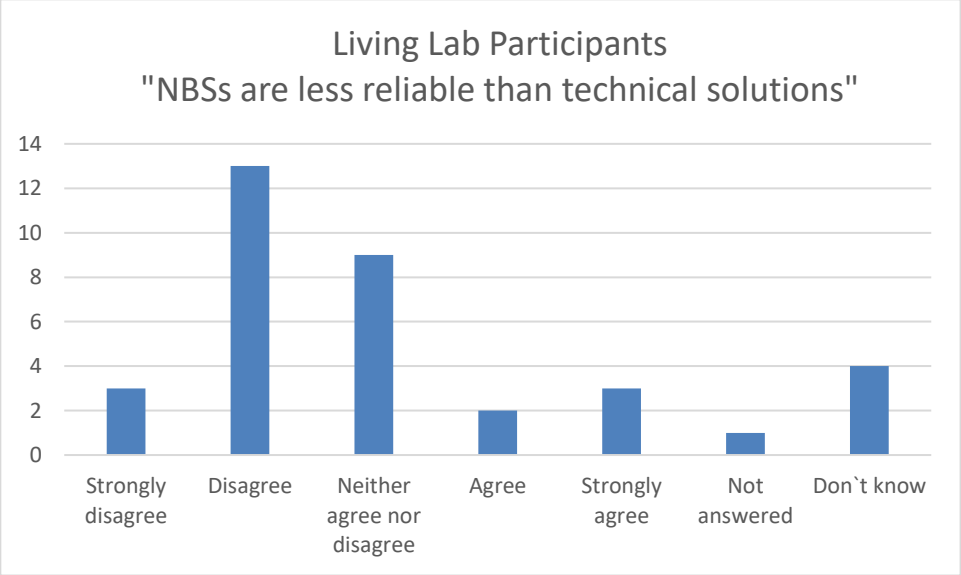

Figure 21: Perception of Living Lab participants on potential negative aspects of NBSs (mainly responses from an advanced state – given item with 5-Step Lickert scale, n=47)

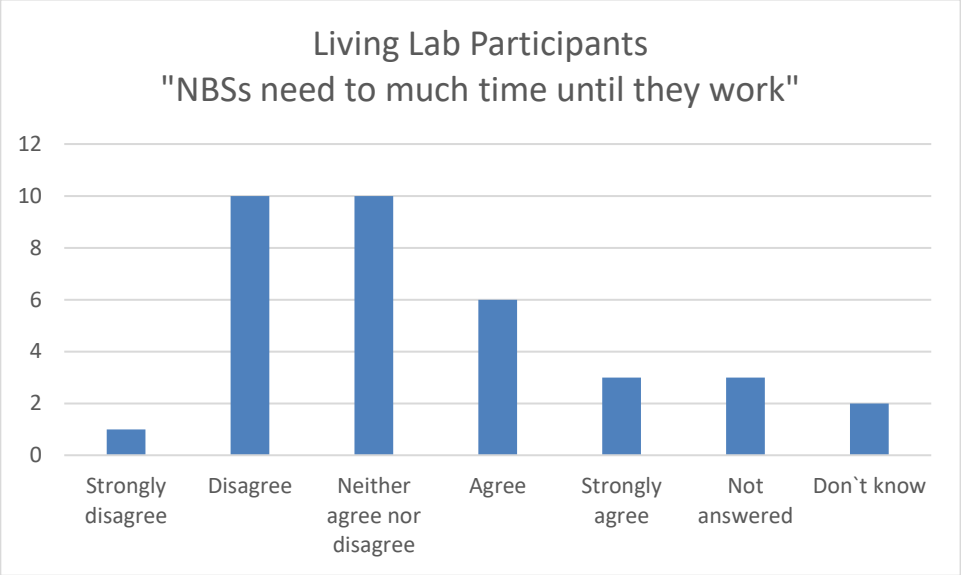

Figure 22: Perception of Living Lab participants on potential negative aspects of NBSs (mainly responses from an advanced state – given item with 5-Step Lickert scale, n=47)

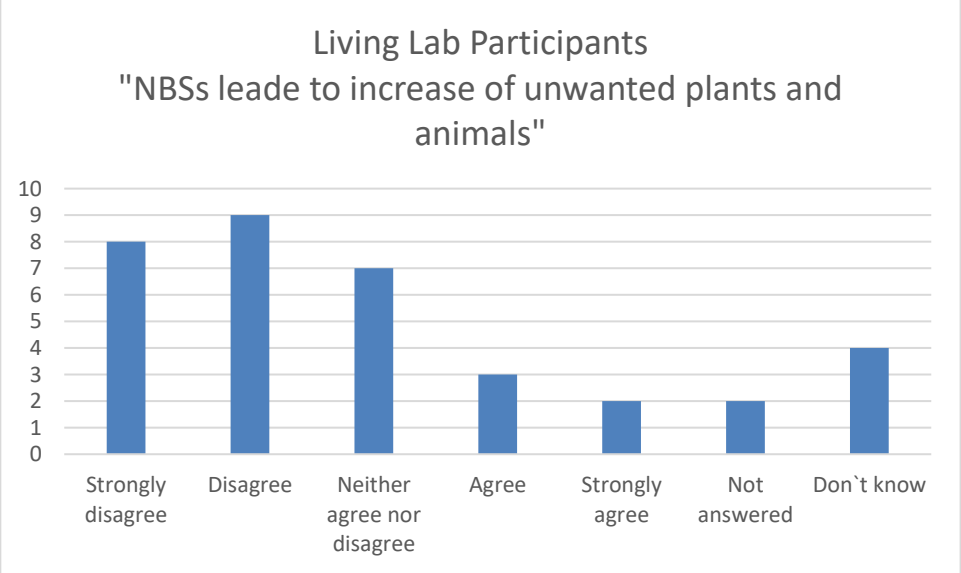

Figure 23: Perception of Living Lab participants on potential negative aspects of NBS (mainly responses from an advanced state – given item with 5-Step Lickert scale, n=47)

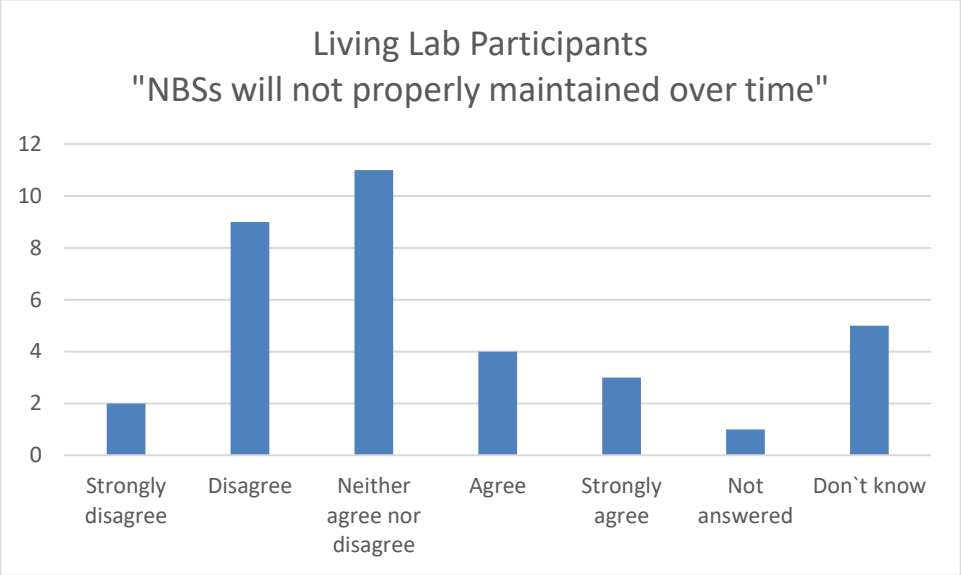

Figure 24: Perception of Living Lab participants on potential negative aspects of NBSs (mainly responses from an advanced state – given item with 5-Step Lickert scale, n=47)

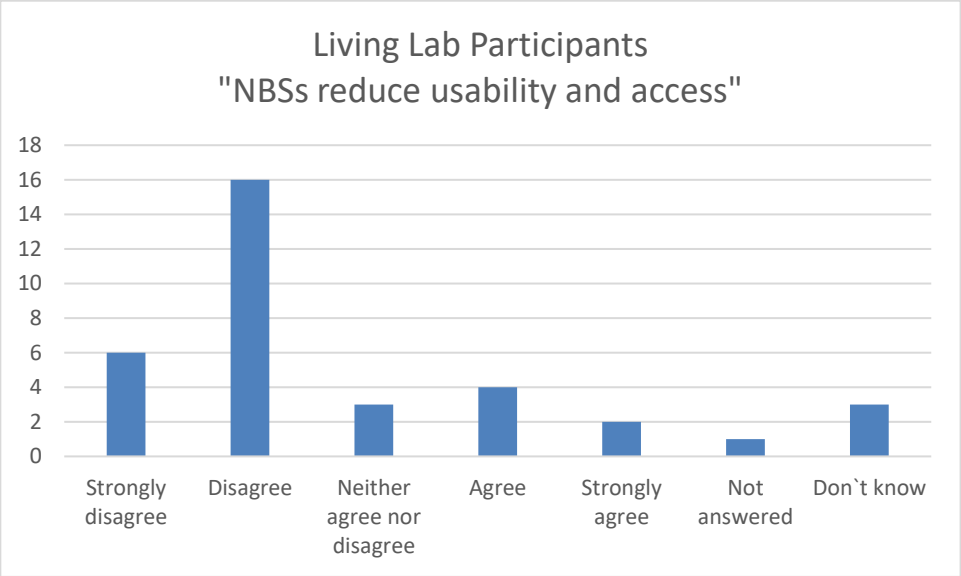

Figure 25: Perception of Living Lab participants on potential negative aspects of NBSs (mainly responses from an advanced state – given item with 5-Step Lickert scale, n=47)

4.3.3 Perceived Barriers to implement NBSs

Analysing the interviews and experiences from the sites showed several barriers for implementing NBSs, with some of them remaining throughout the lifetime of PHUSICOS (Figure 26-28). Observed barriers by the interviewed key stakeholders in the in-depth protocol interviews were a lack of knowledge of key persons. In the group discussion and the focus groups as well as the initial interviews, facilitators and site

owners underscored that for a broader implementation of NBSs, more detailed studies and explanations of the problem would be required. This would be important especially for some of those actors with power to make decisions better understand natural hazards, resulting risks and how NBSs could help to address them. This lack was perceived to be an obstacle slowing down processes until the project´s end and still remained to be an issue at the end of PHUSICOS despite numerous activities and learning opportunities. Other human factors were a lack of stakeholder acceptance or lack of collaboration – or as stated, the fear of "new" or "the unknown".

During the project, the lack of available land or space to implement NBS became more prominent, as well as a long-term political will and commitment in both the in-depth protocol interviews as well as in the focus group in November 2022. One aspect emerging in the round two in-depth protocol interviews with key stakeholders 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.

Linked to knowledge and during the project, a lack of skilled companies was seen as a barrier. However, this was solved when finally, companies were found to conduct the work. The challenge mentioned was the non-existence or lack of knowledge for the application of natural materials in the construction of protective infrastructures. A lack of skilled companies, legal challenges and no standardizations or norms linked to NBSs was an important barrier for the implementation of NBSs. From a facilitator and site owner´s perspective but also glimpsing through the in-depth protocol interviews, outside a project like PHUSICOS, this might lead to aborting the idea of implementing NBSs and the construction of standardized, defined "grey" solutions.

From a retrospective perspective by both in-depth protocols with the key stakeholders, missing actors needed for making decisions were identified as an obstacle that could slow down processes. An emerging concern in round two and three of the in-depth protocol interviews with key stakeholders were missing viable business models around NBS and its long-term management.

Looking at the perception of Living Lab participants, large numbers agreed on the given statements on barriers for implementing NBSs resulting from a lack of lack of political will, legal frameworks and related funding (Figure 29-41).

Facilitators and site owners identified the lack of knowledge at the different levels of decision-making as a key challenge in the two focus groups. With differentiation of processes and the formation of different working groups and formats for the Living Lab process, these barriers were overcome in PHUSICOS. Stakeholder mapping was useful to have all relevant stakeholders on board from the beginning and bringing together different levels and overlapping competencies and decision powers at the table to take the step from planning to the implementation phase.

For the planning and implementation work, site owners experienced barriers for NBS implementation by administrative procedures, regulations and tasks such as tendering

processes. Finally, high costs were mentioned by the site owner and facilitator teams as being a barrier for implementation. Nonetheless, this was seen as an overall barrier for reducing disaster risks in general, no matter if NBSs or "grey" solutions were considered, leaving hydro-meteorological risks unresolved.

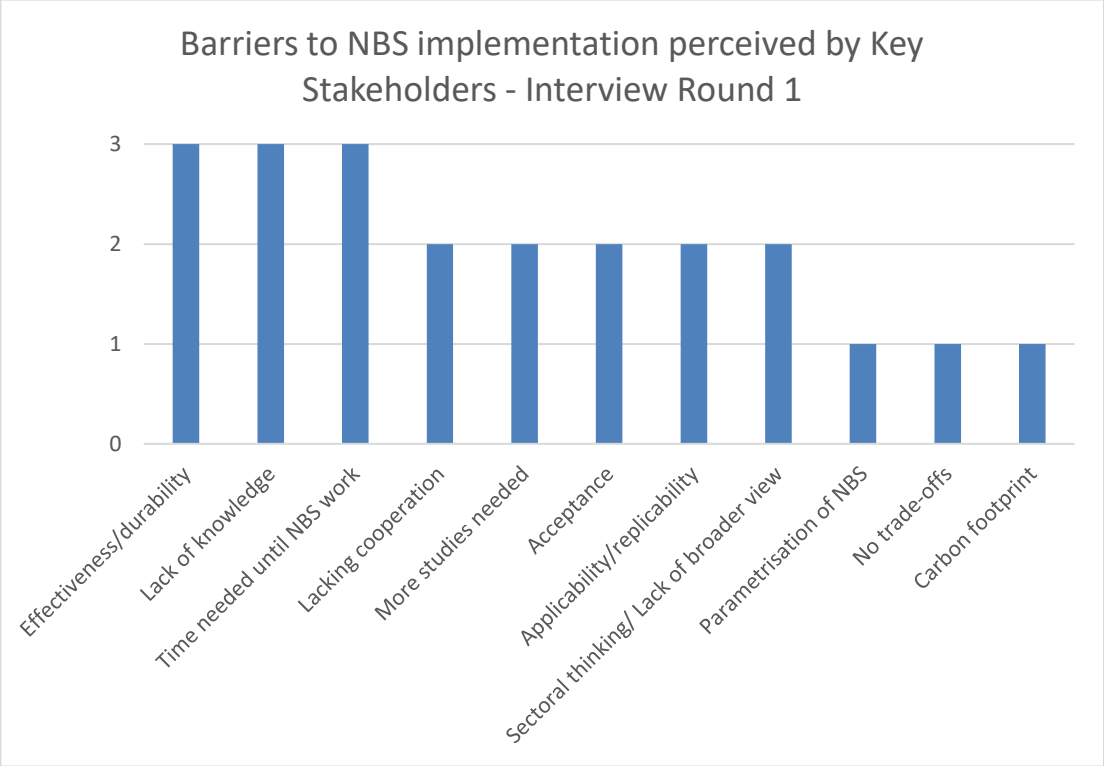

Figure 26: Perceived barriers expressed by interviewed stakeholders (multiple statements extracted from responses, 13 interviewees)

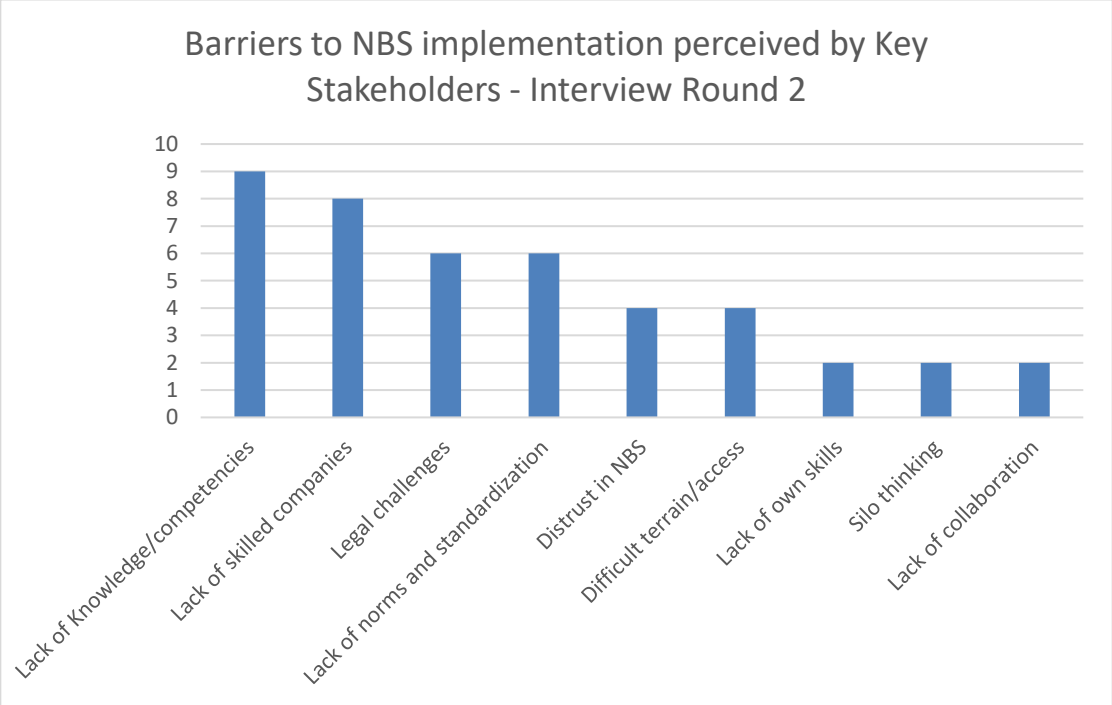

Figure 27: Perceived barriers expressed by interviewed stakeholders in round 2 (multiple statements extracted from responses, 10 interviewees)

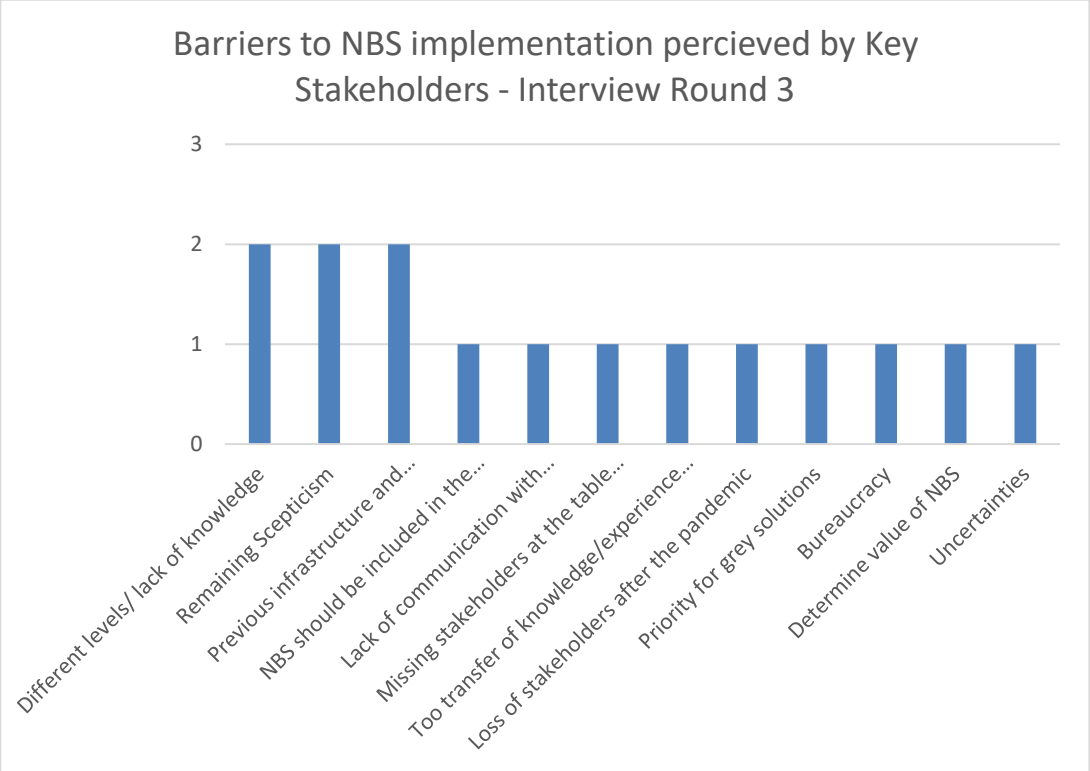

Figure 28: Perceived barriers expressed by interviewed stakeholders in round 3 (multiple statements extracted from responses)

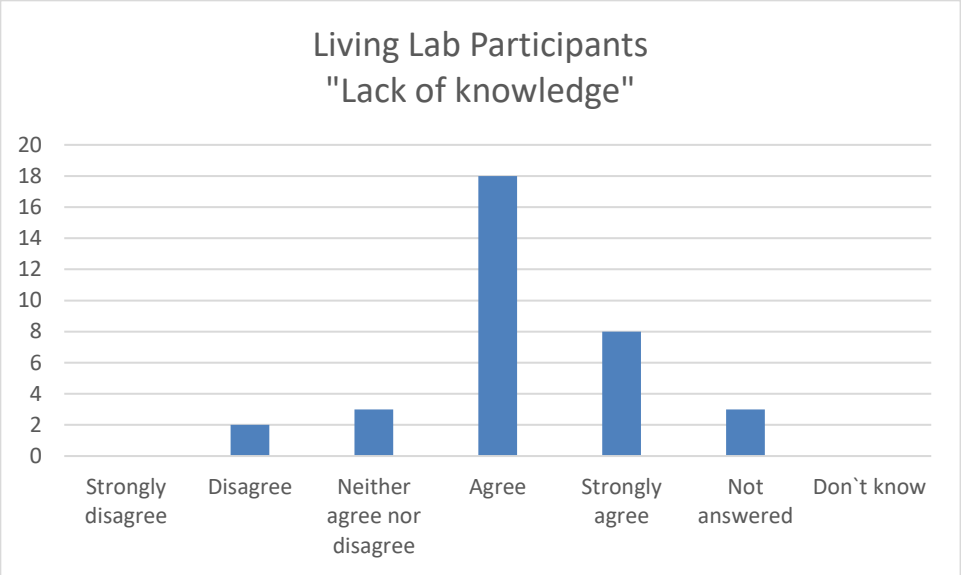

Figure 29: Perception of Living Lab participants on barriers for implementation of NBSs (mainly responses from an advanced state – given item with 5-Step Lickert scale, n=47)

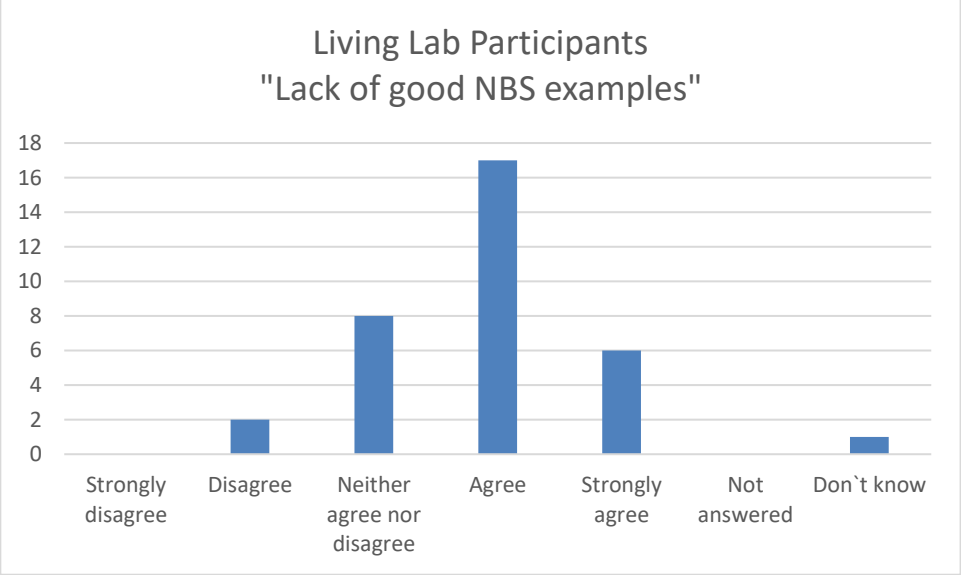

Figure 30: Perception of Living Lab participants on barriers for implementation of NBSs (mainly responses from an advanced state – given item with 5-Step Lickert scale, n=47)

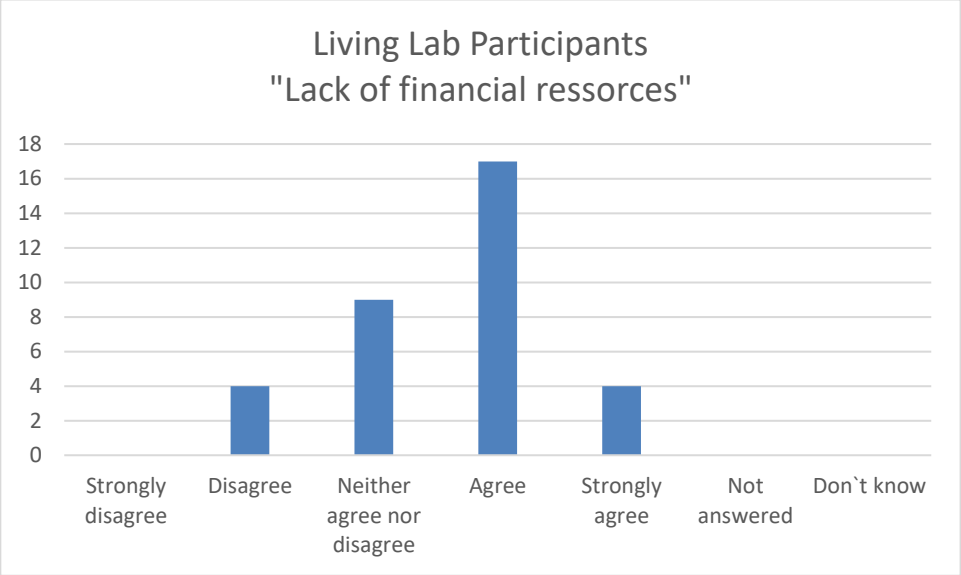

Figure 31: Perception of Living Lab participants on barriers for implementation of NBSs (mainly responses from an advanced state – given item with 5-Step Lickert scale, n=47)

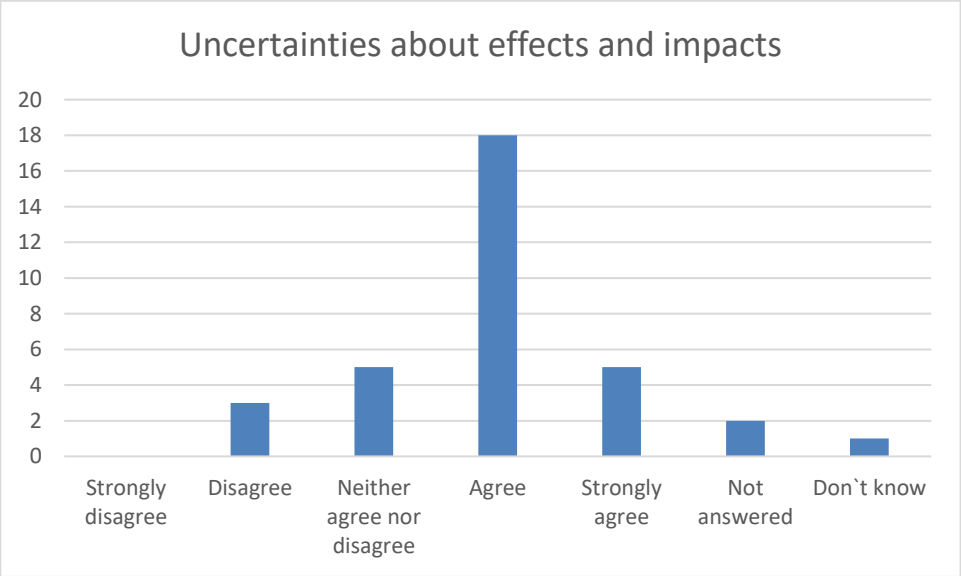

Figure 32: Perception of Living Lab participants on barriers for implementation of NBSs (mainly responses from an advanced state – given item with 5-Step Lickert scale, n=47)

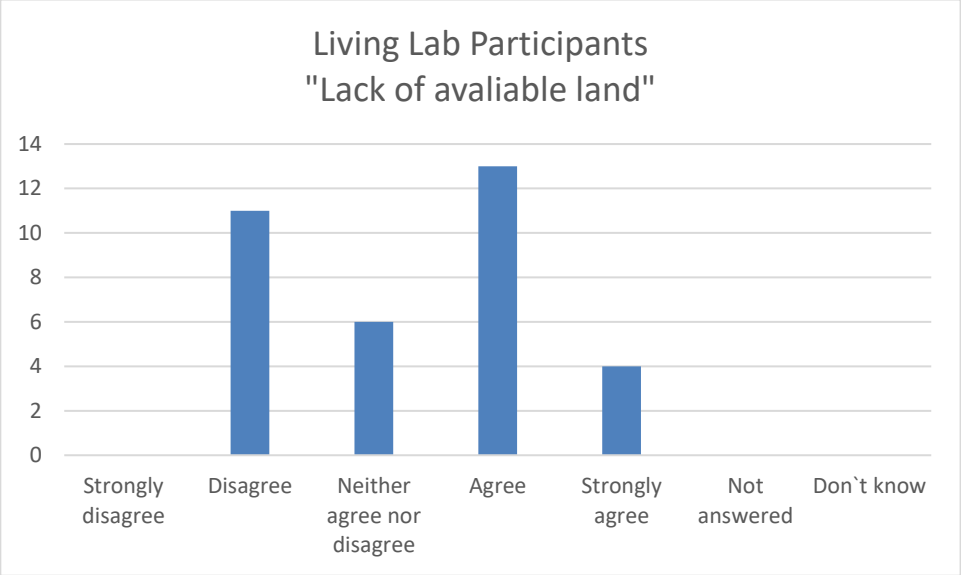

Figure 33: Perception of Living Lab participants on barriers for implementation of NBSs (mainly responses from an advanced state – given item with 5-Step Lickert scale, n=47)

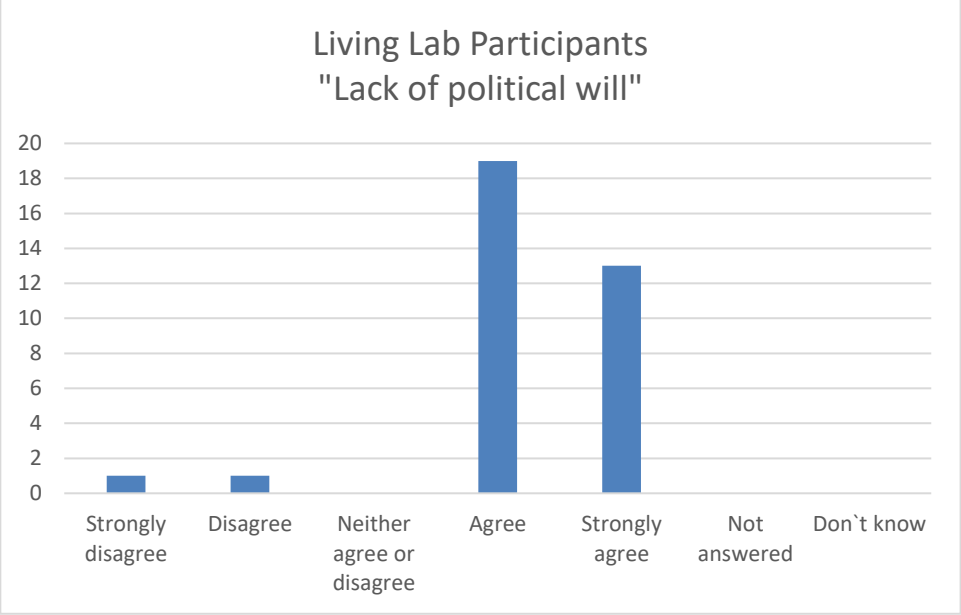

Figure 34: Perception of Living Lab participants on barriers for implementation of NBSs (mainly responses from an advanced state – given item with 5-Step Lickert scale, n=47)

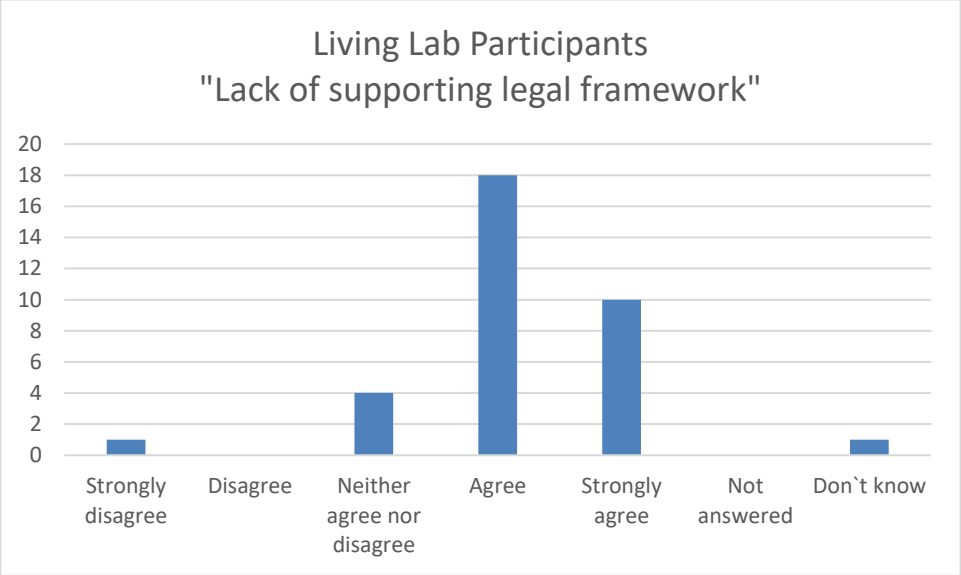

Figure 35: Perception of Living Lab participants on barriers for implementation of NBSs (mainly responses from an advanced state – given item with 5-Step Lickert scale, n=47)

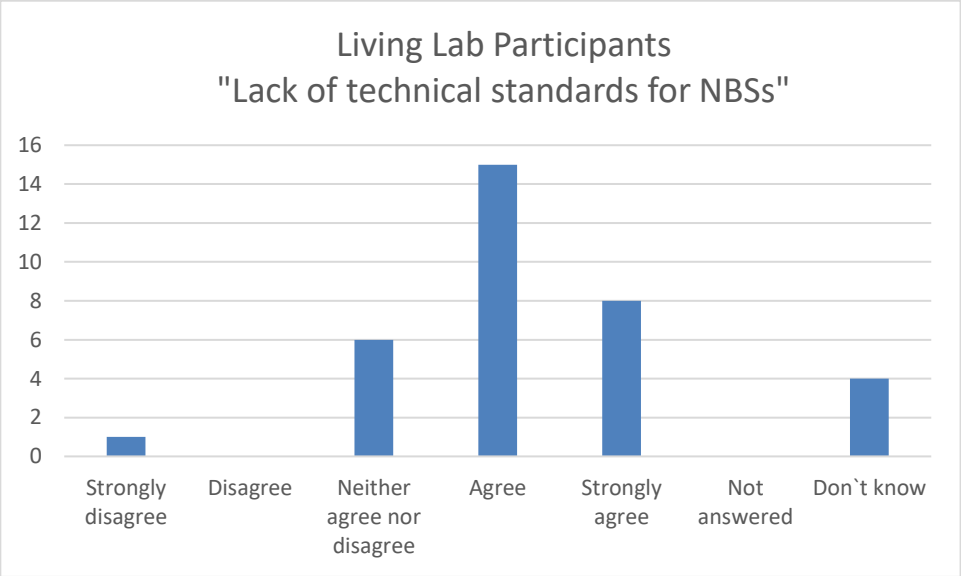

Figure 36: Perception of Living Lab participants on barriers for implementation of NBSs (mainly responses from an advanced state – given item with 5-Step Lickert scale, n=47)

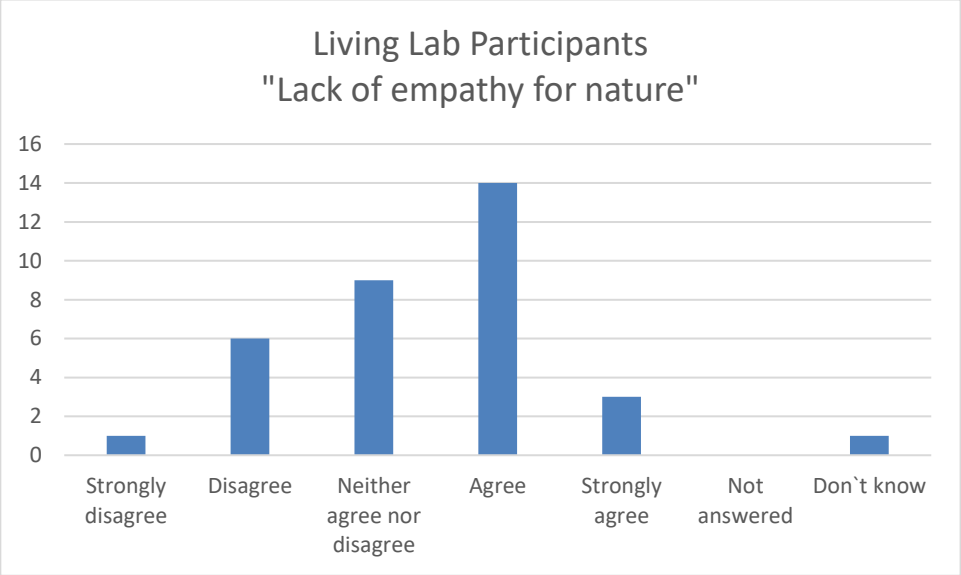

Figure 37: Perception of Living Lab participants on barriers for implementation of NBSs (mainly responses from an advanced state – given item with 5-Step Lickert scale, n=47)

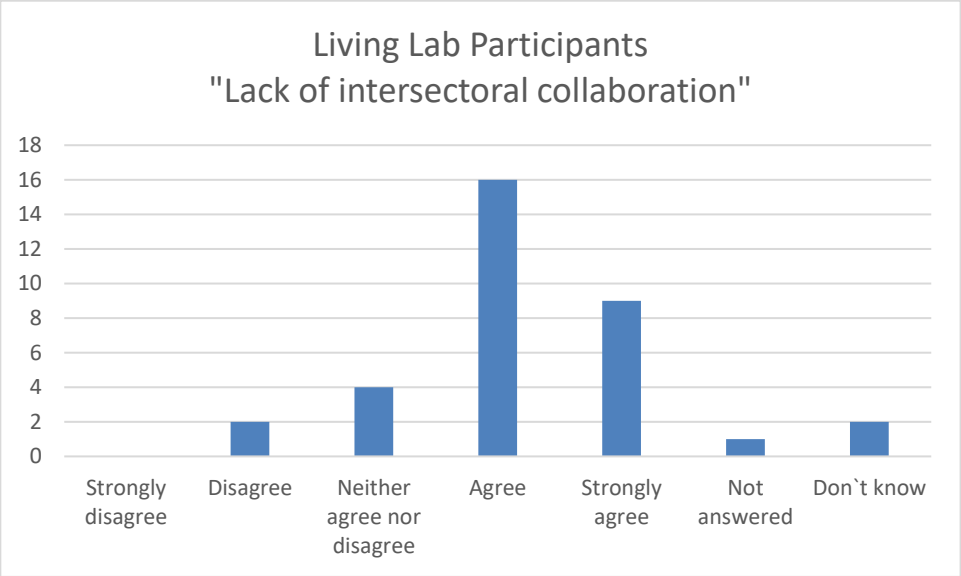

Figure 38: Perception of Living Lab participants on barriers for implementation of NBSs (mainly responses from an advanced state – given item with 5-Step Lickert scale, n=47)

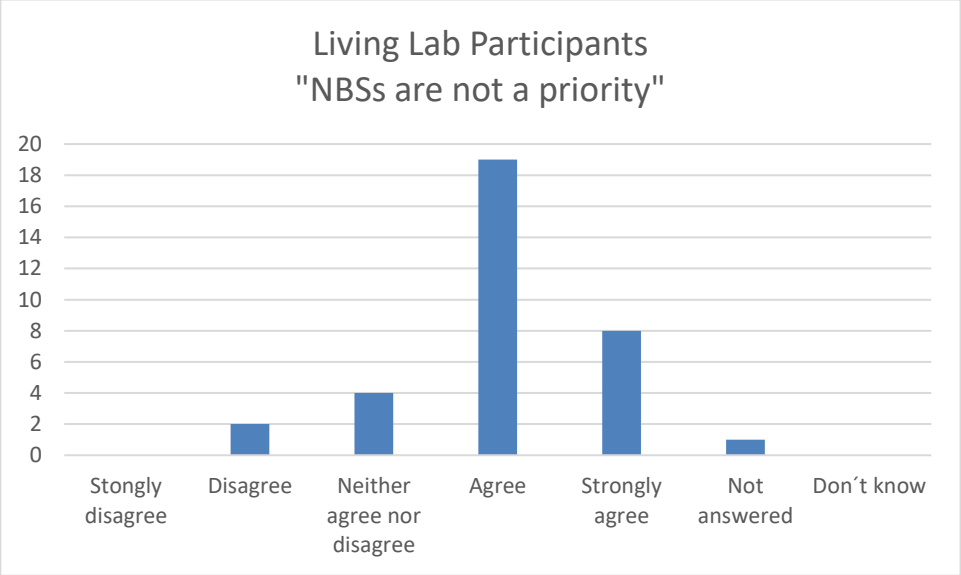

Figure 39: Perception of Living Lab participants on barriers for implementation of NBSs (mainly responses from an advanced state – given item with 5-Step Lickert scale, n=47)

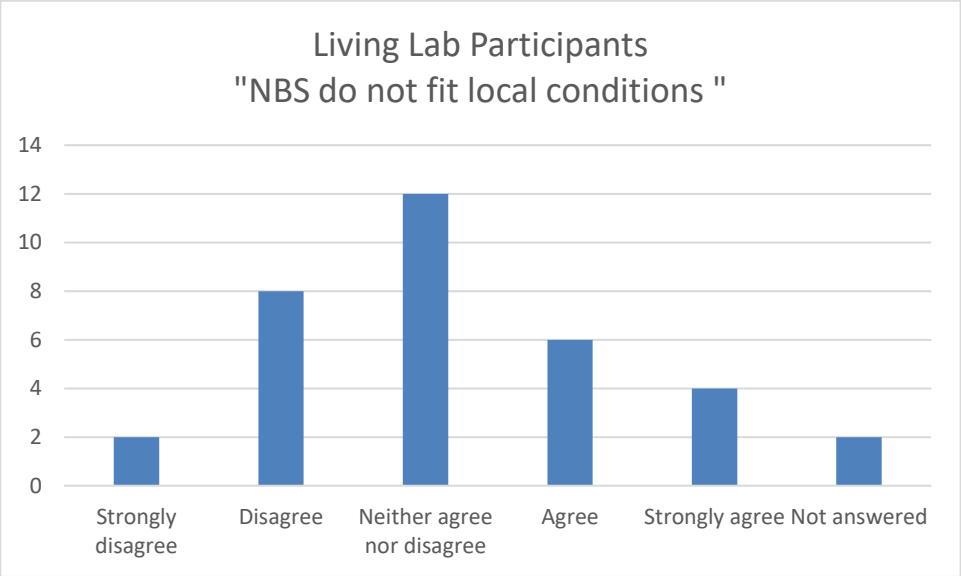

Figure 40: Perception of Living Lab participants on barriers for implementation of NBSs (mainly responses from an advanced state – given item with 5-Step Lickert scale, n=47)

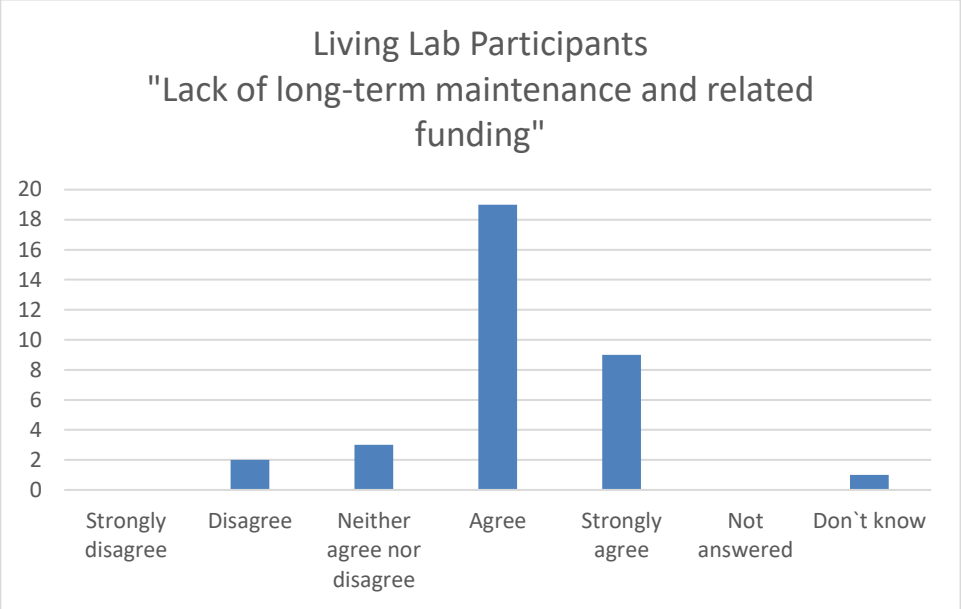

Figure 41: Perception of Living Lab participants on barriers for implementation of NBSs (mainly responses from an advanced state – given item with 5-Step Lickert scale, n=47)

4.4 Living Labs Process: Expectations, Experiences, Barriers and Outcomes by Key Stakeholders, Site Owners and Facilitators

4.4.1 Expectations towards Living Labs

Expectations towards Living Labs were assessed in the in-depth protocol interview rounds 1 and 2 with the key stakeholders. Most interviewees in the first round of the in-depth protocol interviews expected that the Living Labs will lead to higher engagement in NBSs and that they provide opportunities to create knowledge about NBSs. Also, dissemination activities, raising awareness and networking were mentioned (Figure 42).

Interviewed key stakeholders in the initial interview round 1 expressed most frequently topics or interests that relate to economic aspects of NBSs as already stated earlier in the expectations of benefits of NBSs. For this reason, these topics should be an important aspect to be discussed or elaborated in the Living Lab processes (Figure 43). It also was considered important that the processes raise awareness, support stakeholder engagement and stimulate learning. With the perceived scepticism or personal concerns, seeing and demonstrating that NBSs can be a good and effective solution for their region is an important element of the Living Labs. Other subjects of interest that were mentioned were the dissemination of successful NBSs and the provision of learning opportunities on NBSs.

The key stakeholders were asked to reflect on the goals that the Living Lab processes should achieve (Figure 44). The interviewed key stakeholders identified the demonstration or showcasing of the effectiveness of NBSs as a very important goal of the Living Lab. They also mentioned that evidence validating the cost-effectiveness or economic attractiveness of the solutions was important. Another important goal was to disseminate NBSs, raise awareness and acceptance and stimulate learning processes, not only related to NBSs, but also to natural hazard risks in general. For the stakeholders that were interviewed, it was also important that the Living Labs of PHUSICOS enable NBS implementation in their region during the project lifetime. Other goals of interests that were mentioned was the co-design of NBSs, building of networks and cooperation.

During the Living Lab processes, in the in-depth protocol interview round 2, key stakeholder interest shifted towards a diverse range of more implementation-oriented topics such as positive effects of NBS on landscapes including the simulation of NBSs and how they evolve during the different phases with the state before, during and after the intervention (Figure 45). The idea was that such visualizations could demonstrate that NBS integrate well into the landscape. Interviewed key stakeholders also expressed their wish to have formats linked to a better understanding of data related to NBSs in terms of proof of concept and abilities to reduce risks of natural hazards. Further interests were looking at economic aspects and creating value chains created by managing NBSs. A point affected by the restrictions of COVID-19 was related to have more opportunities for knowledge exchange and transfer between the different pilot cases.

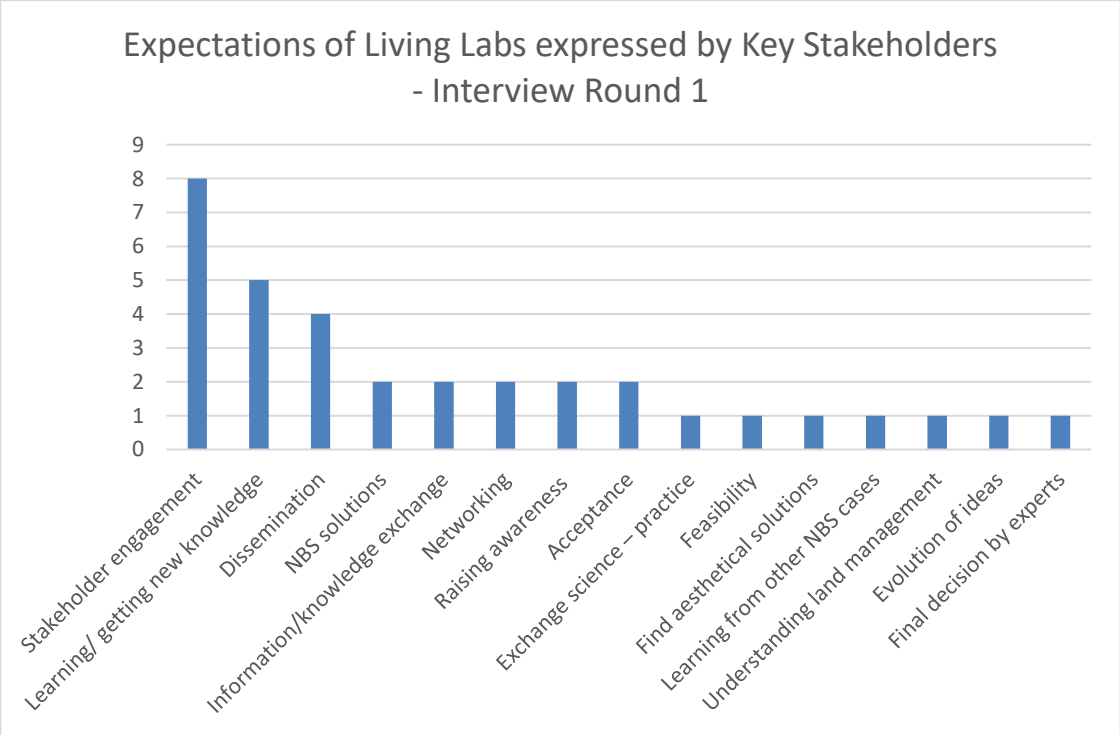

Figure 42: Key Stakeholder expectations of Living Lab processes at the beginning (multiple statements extracted from responses, 13 interviewees)

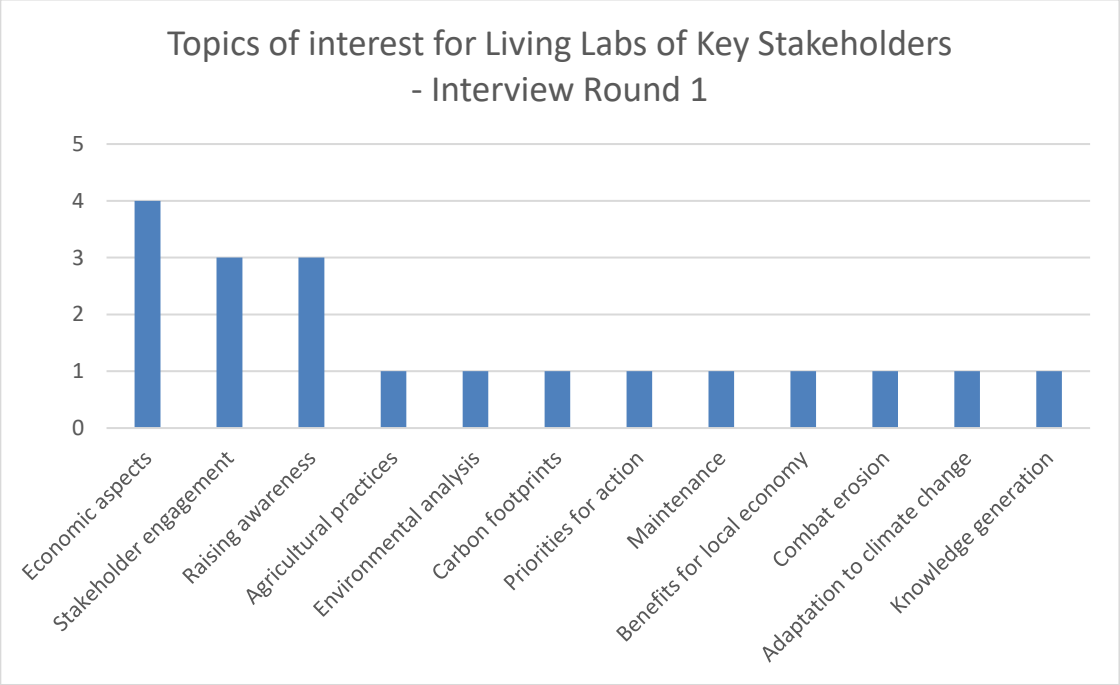

Figure 43: Key Stakeholder expectations of Living Lab processes (multiple statements extracted from responses, 13 interviewees)

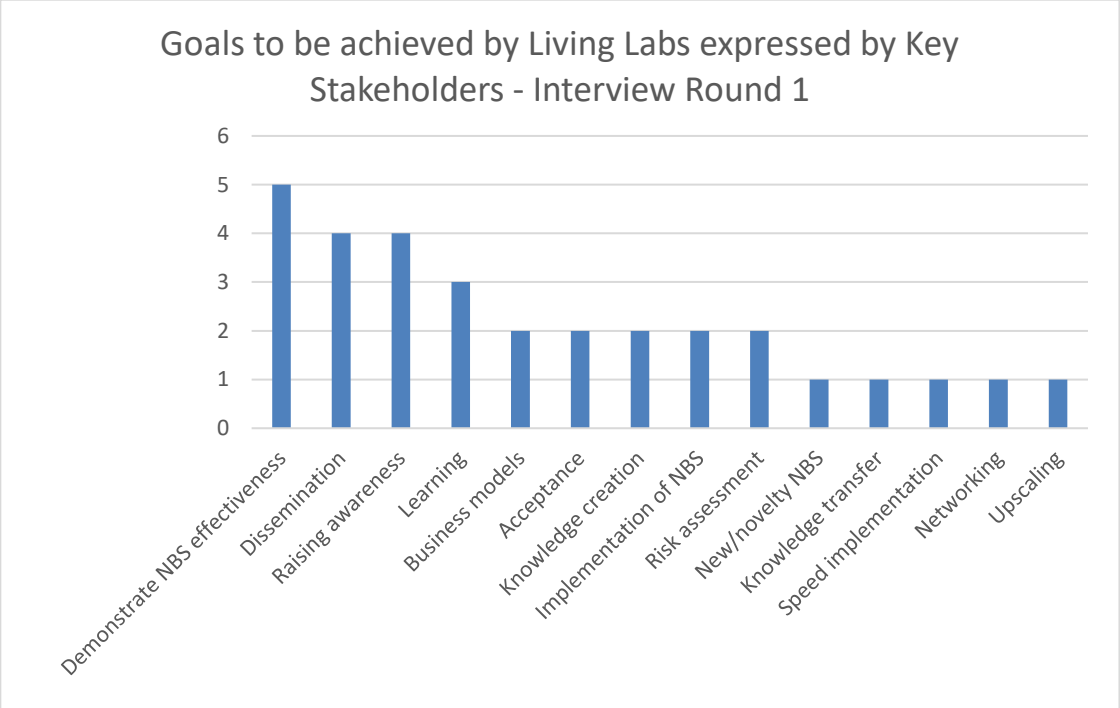

Figure 44: Goals for Living Labs expressed by Key Stakeholder at the beginning (multiple statements extracted from responses, 13 interviewees)

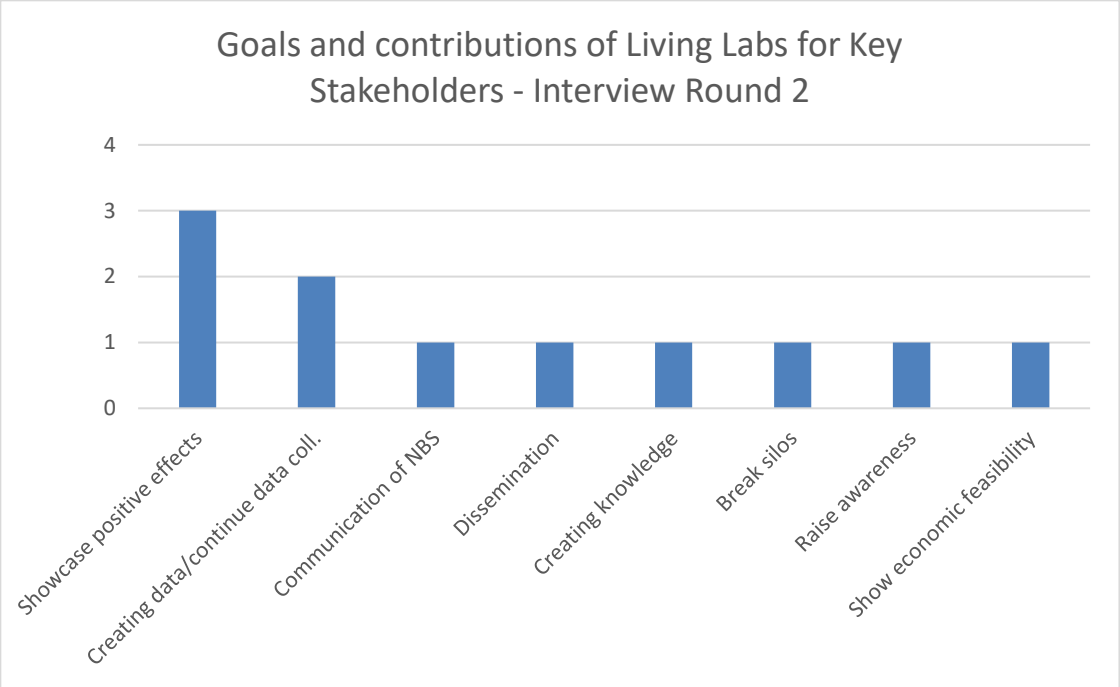

Figure 45: Stakeholder expectations of Living Lab processes (multiple statements extracted from responses, 10 interviewees)

4.4.2 Experienced benefits of the Living Lab processes

Interviewed stakeholders experienced a multitude of benefits linked to the Living Labs (Figure 46-47). Most interviewees perceived increasing knowledge as the most important, followed by integrating a broad range of stakeholders into the co-creation of NBSs. Other frequently mentioned positive aspects of Living Labs were working on a specific solution, raising awareness, mobilizing stakeholders, increasing knowledge and dissemination of NBSs. Several stakeholders recommended more communication and promotion activities related to these points.

Collecting the facilitators and site owner expectations on Living Labs with protocol interviews at the beginning of the Living Lab processes, one of the best outcomes of the PHUSICOS Living Labs would be that stakeholders would act as ambassadors of the NBSs for other sites under their responsibility in order to replicate and upscale these solutions. Another desire was that the Living Lab process would contribute to the learning and changing of attitudes towards NBSs and finding solutions most stakeholders could agree on. Another positive outcome would be the growth of the participatory culture during the planning process. In other words, successful collaboration and increased trust between the stakeholders will encourage collaborative planning beyond the lifetime of PHUSICOS.

Furthermore, Living Labs should enable networking and investigation of the upscaling potential of NBSs, economic opportunities that could arise from the implementation of the NBSs and additional funding to increase NBS implementation. Another goal for site owners and facilitators would be the knowledge transfer, benefit from local knowledge and collective learning. An important driver of knowledge exchange are site visits and dialogue about implemented NBSs.

With an intermediate and retrospective perspective from the in-depth protocol interview rounds 2 and 3 with key stakeholders, PHUSICOS and Living Labs were seen to contribute to showcase positive effects of NBSs, creating or collecting data to contribute to a proof of concept and supported the exchange between different stakeholders to break silos and inform on NBS to be an economical, effective way to address problems linked with hydro-meteorological events.

According to the site owners and facilitators of the demonstrator sites in the focus groups in November 2022 and March 2023, benefits in strong stakeholder engagement led to better design solutions of NBS, a better understanding of measures and better management. Living Labs in general contributed to raise interest and increase knowledge on natural hazards and NBS. A mix of both engaging larger and smaller formats was seen most useful. Larger formats helped to contribute to awareness-raising and stimulating processes.

The variety of approaches were discussed when site owners and discussants reflected the most stimulating aspects and moving the Living Lab processes in PHUISCOS during the group discussion and the two focus groups. The Serchio River Basin team experienced a Webinar with 150 stakeholders during the first wave of COVID-19 as most fruitful in terms of outreach activities, creating knowledge and raising interest. The Spring School in Laruns and Erill la Vall in April 2022 for the Pyrenees case was seen very important. It aroused much attention among local stakeholders and filled them with pride to showcase their sites as well how the communities work on natural hazards with NBS. Discussions with participants from all over the world made a good moment of exchange and further moving the processes afterwards.

For Skjåk, the Innlandet team working on NBS from scratch to address flood risks gained momentum when during the Living Lab session, the local stakeholders brought in the system of historic waterways originally designed for irrigation of fields and providing water to farms as something of interest to build on. In the following work, the focus was laid at looking at their potential for water retention in extreme hydrometeorological events.

Research institutions were seen as important contributors to the Living Labs processes as being neutral actors providing data and facts. The innovation action project type was seen very useful to frame the project as created ideas could be implemented and offered something of value and provided an incentive for stakeholders to actively engage.

An external facilitator was seen useful for many cases, as this also ensures neutrality. An authority hosting a Living Lab might have been perceived by some stakeholders as someone with an agenda and therefore might not be perceived fully committed to support the voices of all stakeholders.

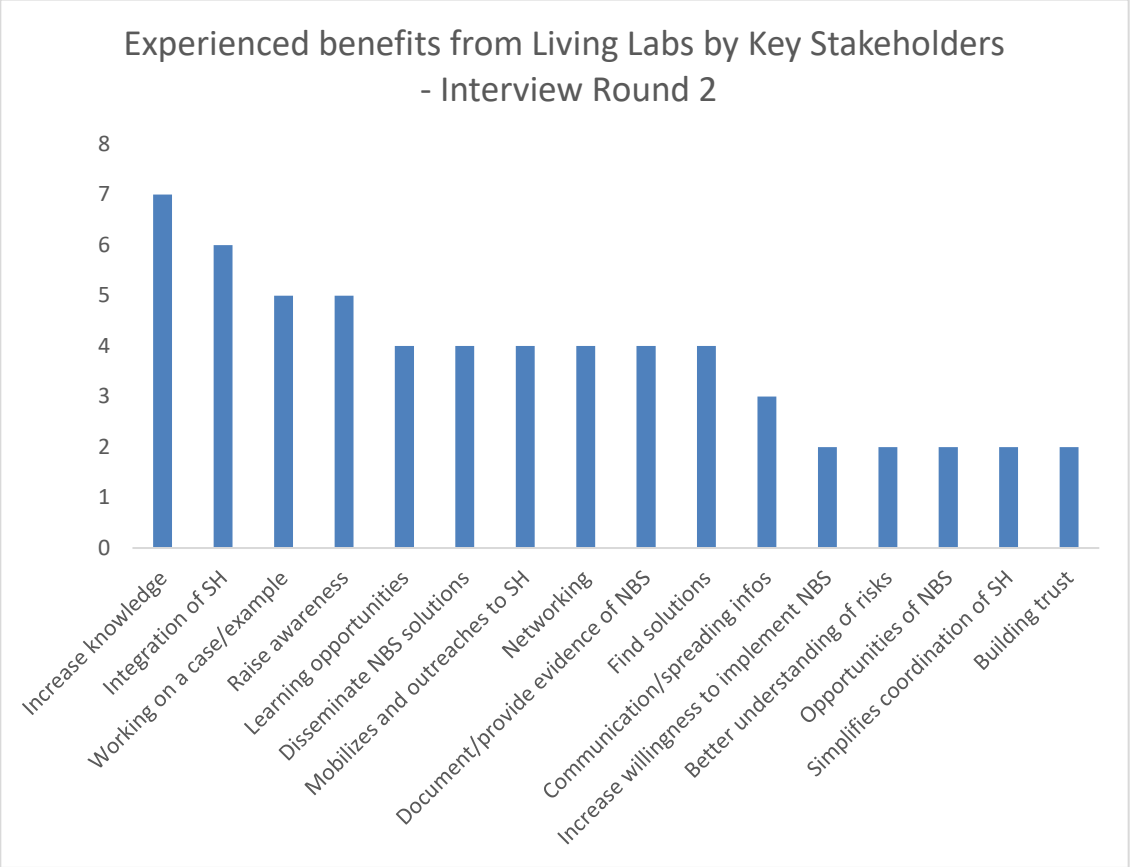

Figure 46: Experienced benefits from Living Labs by key stakeholders – Round 2 (multiple statements extracted from responses, 10 interviewees)

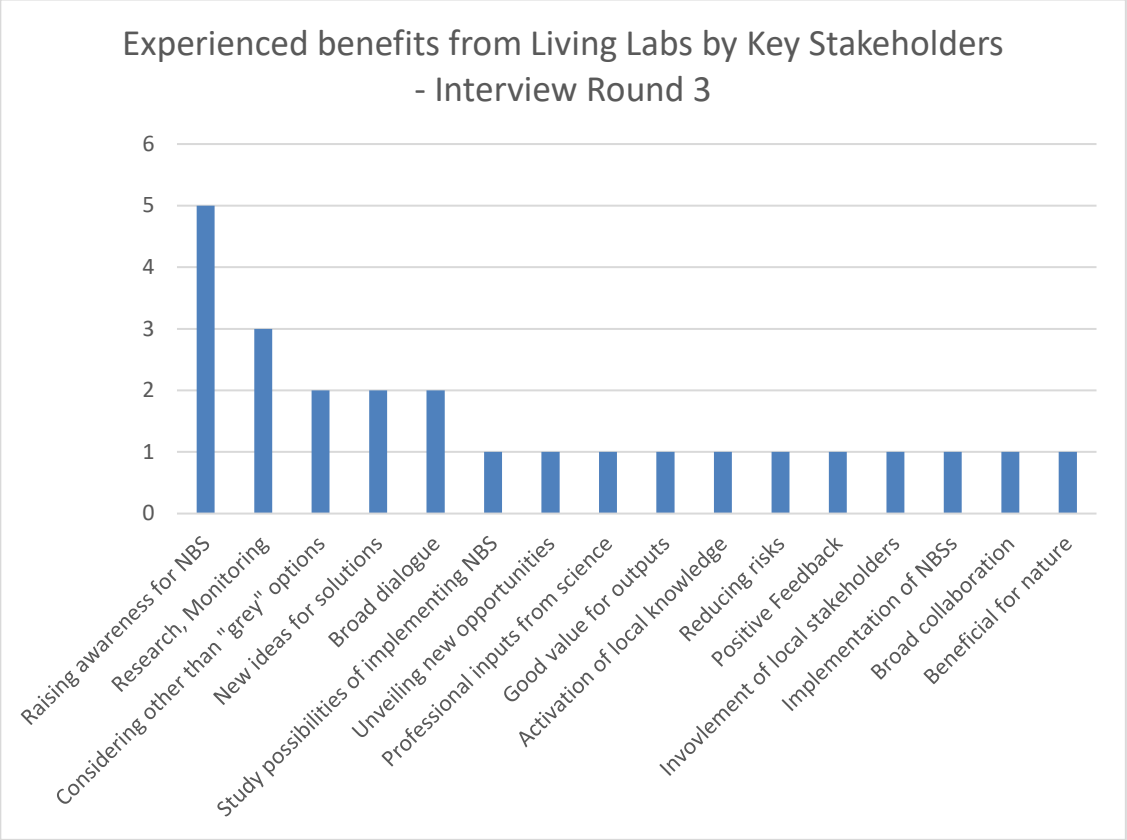

Figure 47: Experienced benefits from Living Labs by key stakeholders – Round 3 (multiple statements extracted from responses)

4.4.3 Experienced Negative Aspects and Barriers in Living Labs

With a very positive perspective on Living Labs, some negative aspects were also mentioned related to the speed of the NBS processes (Figure 48-49). Key stakeholders in the in-depth protocol interview rounds 2 and 3 mainly related them to even more activities and communication to provide knowledge about NBSs. Another point raised were scattered responsibilities of stakeholders participating in Living Labs making it difficult to come to decisions.

Another aspect mentioned was creating more dynamism in projects or upscaling activities. A point for the interviewed key stakeholders involved working on NBS from scratch was finding and implementing NBS in the given time frame of the PHUSICOS time-frame. Adopting strategies to mobilize the different stakeholders and trying to engage more persons who make or influence decisions throughout the Living Lab process were seen useful to overcome these bottlenecks.

A negative aspect working in Living Labs were seen in the limited available time and number of meetings given with the comparatively short PHUSICOS lifetime compared to the time needed to build trust or prepare decisions. Related to the given project

timeline, short deadlines for getting measures funded were brought forward. One factor mentioned was the dependency on favourable weather conditions being a decisive and limiting factor for works in mountain areas. COVID-19 was seen a negative factor for Living Labs as digital formats reduced the enthusiasm of participants.

Single points mentioned one time each in the final in-depth protocol interview round 3 was the difficulty for many actors in understanding the long-term nature of NBS, time needed to express and bring together differing interests and perspectives, dealing with different levels of knowledge and stakeholders joining in at a later time, and similar to this, relevant stakeholders were not present in a living lab session. A suggestion was made to make the participation a bit more "mandatory" including filling in materials and surveys.

Facilitators and site owners in a similar way identified a number of barriers within the Living Labs in the two focus groups. The necessity to handle both the co-design and the implementation of the proposed NBS including formal steps such as tendering in a rather short timeframe of the PHUSICOS project (3-4 years) was seen challenging. The retrospective good practice example from the Isar river in comparison had a timeframe of 30 years from first ideas to the actual restoration of an 8 km river stretch. In addition, another barrier was the launching of a public tender for the implementation of a NBS that includes enough description of the service and at the same time flexibility to integrate suggestions from the stakeholders.

From the site owner's and facilitator's perspective, it was difficult to persuade local stakeholders to get involved in a Living Lab process at the beginning because the NBS concept was not understood. Other local stakeholders had never participated in such collaborative approaches and believed that they would not be able to contribute in a Living Lab.

In the two focus groups in November 2022 and March 2023, site owners and facilitators named several aspects of Living Labs that make such processes challenging but solvable. Starting from evaluating all the input and ideas during and after the process, conflicting interests can be difficult to solve and might take time. Creating a common understanding about the fact that not everyone will have their needs met is seen as a challenge as well. Two major issues about Living Lab processes from site owners and facilitators perspective were formulated:

1) The need to continuously generate interest among the participants so that participants follow the process closely and participate in all the Living Lab sessions.
2) Some Living Lab results would require governance and policy changes that are beyond the competence of the Living Lab members.

From the PHUSICOS demonstrator cases perspective, working with very large groups in many cases did not produce clear outcomes in the implementation of NBS. Making good process and a final decision linked to the implementation of an NBS was often

achieved with smaller groups and field visits. For the Serchio River Basin team, a field trip in July 2021 was seen as a very positive format. 22 stakeholders from students, citizens and farmers visited the NBS that was under construction. When mingling on site, the different participants started discussions and a lot of exchange was observed. This meeting generated a lot of new ideas to follow up.

Dealing with different layers of competencies, for the Pyrenees team, a coordination meeting for the Artouste case was seen as the most useful for bringing together institutions and management staff to focus on making decisions.

Similar to the key stakeholder perspectives, it was perceived challenging to discuss about very technical issues, such as monitoring after the implementation with all stakeholders. In general, it was seen very important that the technical teams and risk modelling and calculation teams go beyond just sharing information and present their methodology in an understandable and adapted way to the different target audiences within the Living Lab integration process.

Furthermore, the participants in the Living Labs should realize that their contributions have had a real impact on the final solution. With the philosophy of Living Labs to engage all stakeholders throughout the processes, a way to move forward with the NBS implementation processes is to differentiate stakeholder groups. A variety of session types was seen feasible, creating smaller groups providing and collecting respective data to work with and providing sessions with more general information and learning opportunities for broader user groups.

Finally, facilitators and site owners underscored that further barriers can arise if the participatory process is not well conceived and inserted within the planning and implementation of the project, especially because it could prolong the time and not coincide with the deadlines of the project and related funding. A solution was seen in the engagement of stakeholders already at very early stages of a NBS project and stakeholder mapping approaches were seen helpful to systematize the identification.

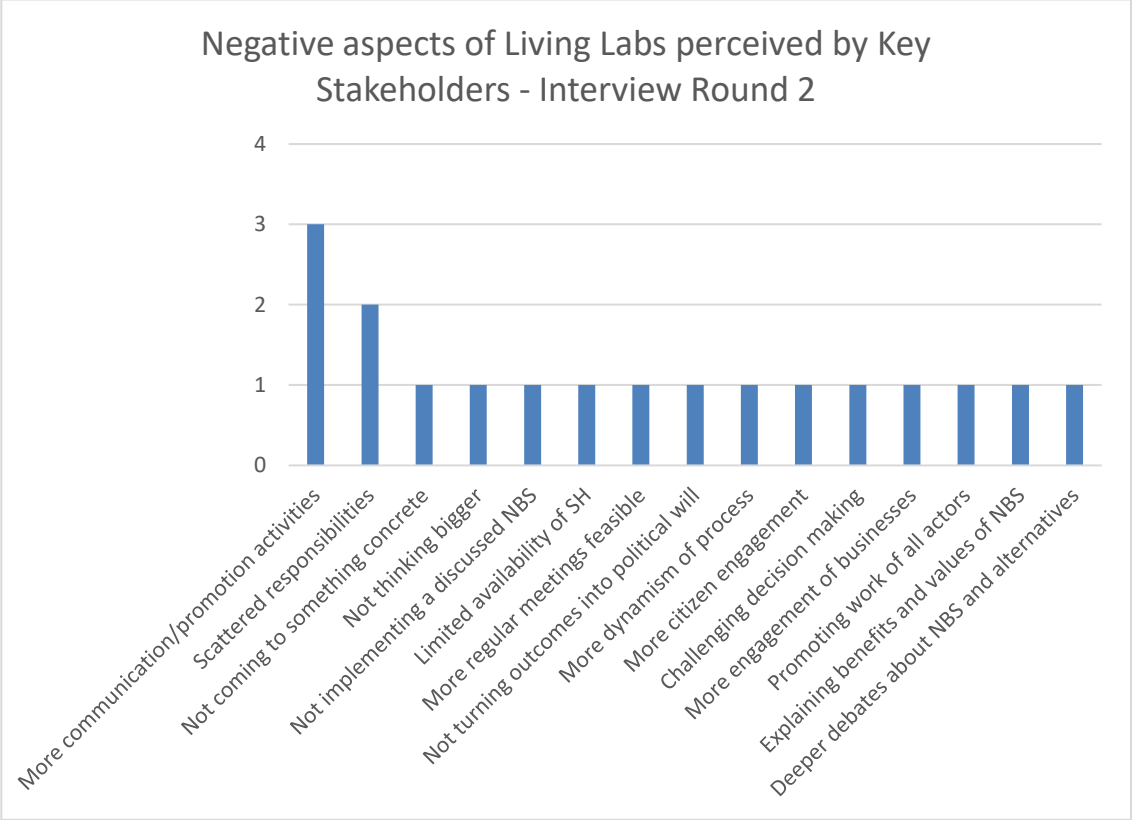

Figure 48: Negative experiences from Living Labs by key stakeholders – Round 2 (multiple statements extracted from responses, 10 interviewees)

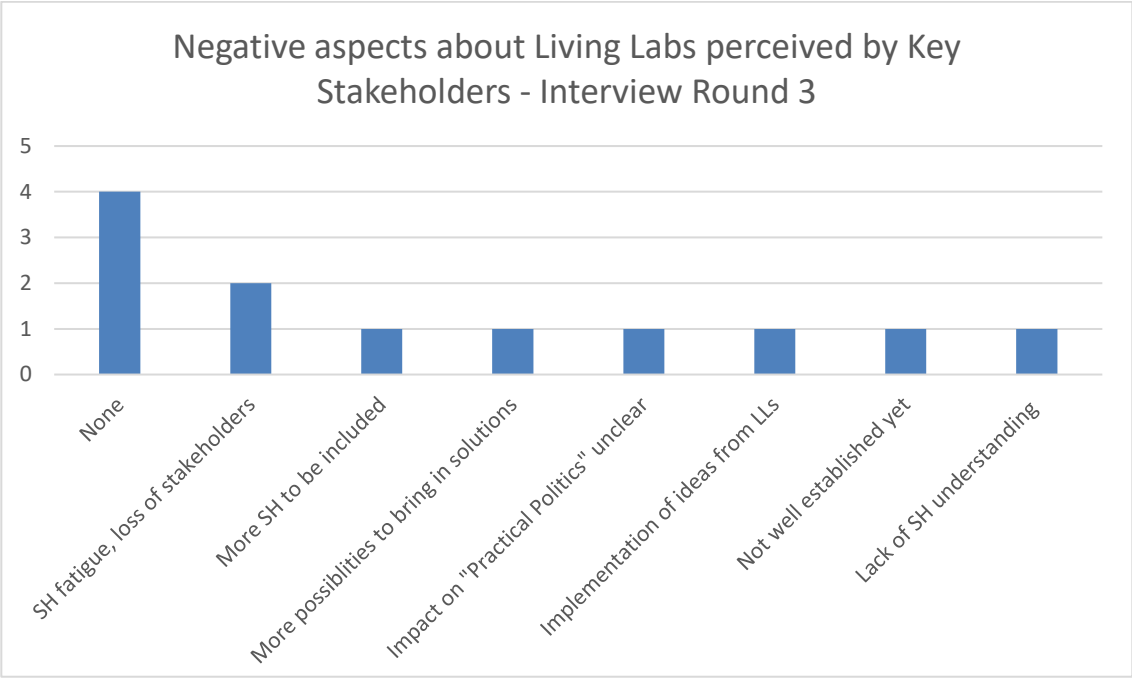

Figure 49: Negative experiences from Living Labs by key stakeholders – Round 3 (multiple statements extracted from responses)

4.4.4 Living Lab evaluation by participants

Using the data collected from tick box surveys conducted among the participants at the end of some of the larger Living Lab sessions (see Appendices B1 and B2), together with the collected qualitative reflections of key stakeholders as well as site owners and facilitators, the outcomes can be put into a larger context. Looking at the perspective from participants of selected Living Lab sessions where the standardized tick box survey could be implemented, expressed experiences were considered very good and satisfaction with the formats was high (See Appendix E for details of the survey outcomes).

The raised point of varying knowledge and participation by key stakeholders and site owners is mirrored in the survey data. Quite a large number of participants indicated that they would attend for the first time or have attended not so many meetings so far. However, this result might be influenced by the survey results that have a bias towards the time before COVID-19, where several of the larger formats covered by the surveys took part and not including final larger meetings in 2023, that could not be considered any more for this deliverable report.

Looking at the stakeholder distribution, a majority of participants in the larger Living Lab sessions were from authorities. Only to a less extent, land owners and farmers participated in the covered formats. From this broader perspective, participants to some extent indicated that stakeholder groups were under-represented. If it was specified, mainly land owners and farmers were mentioned missing (Figure 50).

Facilitation was seen very positive in all given aspects, such as duration, attempt of providing a good representation of stakeholder groups, the number of participants, ensuring stakeholder engagement during the sessions, providing enough interactive formats, networking and learning opportunities. Participants indicate their satisfaction also with a high willingness to continue participating in future Living Lab sessions (see Appendix E for details).

With a closer look to core ideas of Living Lab processes and indicators in Table 1, participants were very positive about bringing in their voice, uptake of ideas and points brought in by stakeholders, learning something new, the creation of new knowledge and outputs, moving the Living Lab processes forward and creating new networks. Participants felt that Living Labs created a more positive impression of NBSs for them and many expressed their willingness to continue working and the commitment towards NBSs.

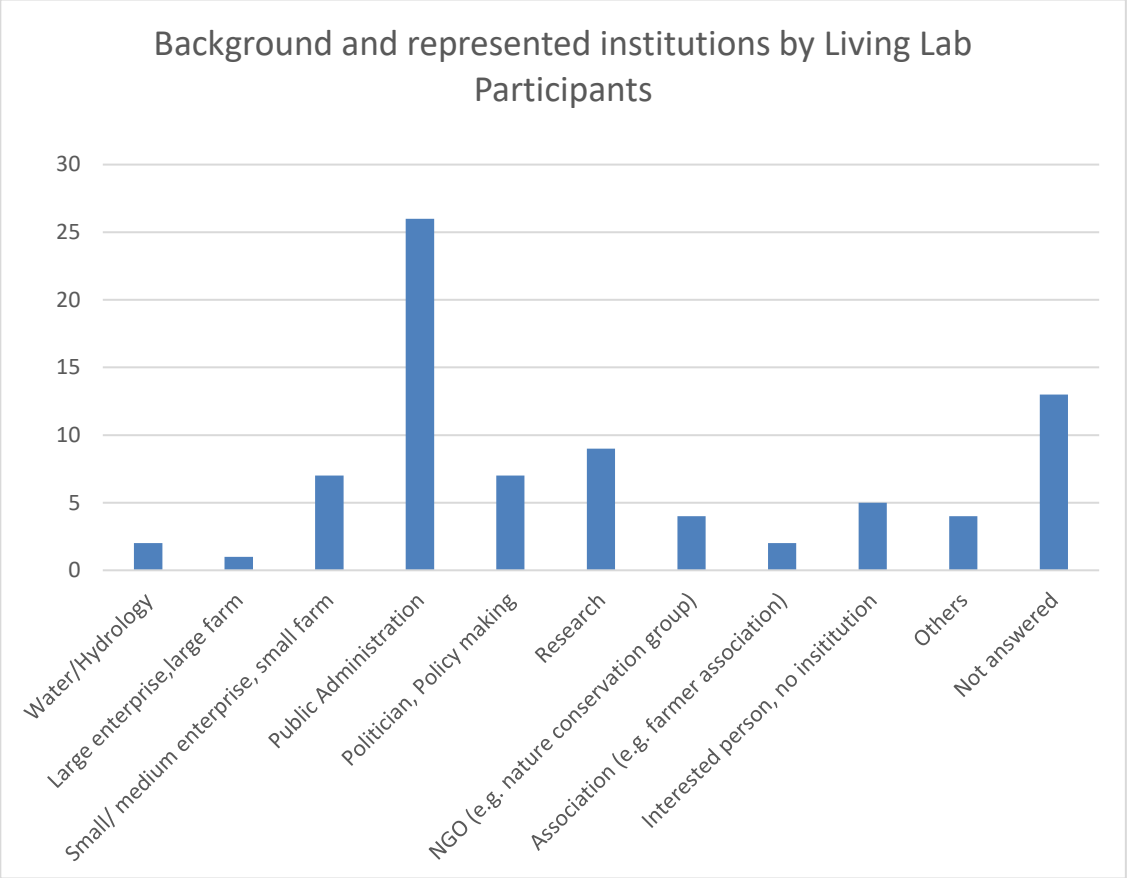

Figure 50: Background of Participants (mainly responses from early stages of PHUSICOS, n=88)

4.4.5 Comparing the Literature and PHUSICOS Results

Comparing the findings from the literature and PHUSICOS, several points are similar but a number of distinct perspectives and issues can also be detected for co-implementing NBSs in rural mountain settings (Table 3).

Despite their importance on political and research agendas, literature and PHUSICOS perspectives from key stakeholders, Living Lab participants and experiences made by site owners and facilitators, the knowledge of on-the-ground stakeholders on NBS is limited. Addressing scepticism and doubts about effectiveness of NBS, approaches like Living Labs can help to address those issues to some extent and PHUSICOS key stakeholders and participants perceived them very useful for providing learning opportunities. Forming groups and different formats are useful to cover the different needs and levels of knowledge. While literature suggests more overall scepticism towards NBSs, working in PHUSICOS, the main remaining point was the long-term proof-of-concept of NBSs.

Despite the involvement of researchers working on evidence-based data and modelling, this shows the importance of hands-on cases and the long-term observation of solutions beyond the timeframe of a project. Working with NBSs and stakeholder acceptance was

especially successful in cases where monitoring data already was collected before such as Erill la Vall and the Serchcio River Basin.

Additional support for considering NBSs is commitment to further collect and monitor the found solutions to create data. Established NBS demonstrators such as those created within PHUSICOS could provide long-term hands-on cases and with committed stakeholders co-monitoring the solutions together with academia. This can help to overcome the expressed fear of "the unknown" or to support and encourage the local stakeholders to take such a pathway so they don´t feel left alone. While for NBSs in urban areas, the importance of co-benefits for society are emphasized, this is less the case for PHUSICOS. Most important beneficial aspects related to NBSs were addressing natural hazards, acceptance and, working with nature. Most important for rural areas was working with nature and solutions fitting into farming and land use practices and linking to existing or unveiling old knowledge. While several authors reporting on NBSs or natural flood prevention measures in rural areas have observed similar concerns of high costs to implement NBS expressed by stakeholders (e.g. Bisonette et al.,2018; Lieski et al., 2019, Portugal Del Pino et al., 2020, Piacentini and Rossetto, 2020), main aspects in PHUSICOS were value chains and business models along managing and maintaining the NBSs.

Despite efforts taken in Living Labs especially in the Serchio River Basin case study to discuss and work on this topic, for the long run and beyond PHUSICOS, financing mechanisms for maintenance and compensations or Payment for Ecosystem Services making NBSs attractive for land owners to opt NBSs were seen important and are topics that need to be further studies collaboratively using Living Lab approaches. However, several of the factors influencing the value chains such as agricultural policies and financing mechanisms are partly outside the competencies of the stakeholders that work on a regional or local level.

Table 5: Comparison of findings in the literature and PHUSICOS

Description	Findings from the literature review	PHUSICOS site owner observations	PHUSICOS key stakeholders' answers	PHUSICOS Living Lab participant snapshots
Stakeholder familiarity with NBS and related concepts	Lack of knowledge, but land users and farmers consider themselves the experts (e.g. Heitz et al., 2009). Most of the literature underlines the importance of NBS projects for learning and raising awareness/knowledge (e.g. Bustillos Ardayaa et al., 2017; Pagliacci et al., 2020)	Some familiarity at the beginning of PHUSICOS, importance of knowledge provision and learning, topics related to benefits are gaining interest and are attractive for stakeholders	About one third have not encountered the concept of NBSs before the start of PHUSICOS, "entry-point" knowledge often provided from universities and related contacts	Towards the end, quite many participants had some idea about NBS, but still expressed the need to still learn more about NBSs
NBS benefits perceived by stakeholders	Mainly urban NBSs in the literature, mainly co-benefits for society are valued (Han and Kulicke, 2019), managerial views relate to easier maintenance (Bark et al., 2021)	Desired outcome is a broader view on the "multiple benefits" achieved. While "multiple benefits" might be more an academic discussion, it is important to get NBS on the ground and implemented with key elements to be achieved are well integrated solutions properly built and managed. Their economic attractiveness will be a key factor for stakeholder motivation for implementing NBSs	Interviewees mainly refer to benefits for nature and working with nature, while expressing potential economic opportunities. Multiple benefits were explicitly less mentioned.	Quite positive perspective on given items picked from literature and in-depth interviews relating to ecology, socio-cultural, economic aspects as well as their contribution to reduce risks from hydrometeorological events
Concerns of stake-holders on NBSs	Less effective especially in severe events (Pagano et al. 2019), high maintenance costs (Portugal Del Pino et al., 2020), little acceptance	Stakeholders need stimuli in the form of projects as a starting point for collaborating, long-term commitment and collaboration for	Lack of long term proof of concept, evidence of durability or functionality is largely missing, effectiveness is perceived to be	Uncertainty about NBS functionality and durability, lack of good examples and leaning cases, lack of long-

	for solutions that are not aesthetically pleasing (Hoyle et al. ,2017)	maintenance of NBSs beyond project life time, learning opportunities and engagement of research to address scepticism and proof of concept. Long term co-monitoring	lower, long-term maintenance might be challenging	term maintenance, NBS might do not fit local conditions
Perceived barriers to NBSs by stake-holders	Often, a lack of knowledge and awareness of evolution and importance of participation (e.g. Venkataramanan et al., 2020; Buchecker et al., 2013)	Lack of knowledge on NBSs, lack of stakeholder acceptance or lack of collaboration and long- term commitment, need to develop of viable business models and value chains is needed, or development of schemes such as Payment for Ecosystem services	Lack of knowledge, PHUSICOS 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	Lack of knowledge, funding, lack of available land for NBS, lack of political will, supporting legal framework, technical standards, lack of intersectoral collaboration, NBS not a priority
Collaborative processes	Mixed experiences, critical reflections (e.g. Wamsler et al., 2020) as well as positive reports (Buchecker et al., 2013)	Living Lab approach considered very useful, engaging stakeholders, improving understanding of natural hazards and NBSs at the local level. Living Labs supported decision making bringing together relevant stakeholders with power, improved design and define what to work on. Challenges were seen in different levels of knowledge, layers of competencies and power important for taking decisions but elements such as early stakeholder engagement can overcome many barriers	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 scepticism	Very positive feedback from Living Lab participants, e.g. perceived learning, creating knowledge, moving processes, creating networks, being actively engaged, own ideas being picked up, encourage to engage

5 Lessons Learned

5.1 Importance of the Learning Processes and Perception Change

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.

The starting point to trigger action is an awareness of natural hazards, recognizing negative impacts on society and personal concern to trigger action (Böhm and Pfister, 2000, Ding et al., 2019). However, even with a high level of awareness of natural hazards and benefits of NBSs, the motivation to act is often low. Despite several attempts to explain stakeholder perception, researchers cannot fully explain stakeholder actions or inactions (Lindall and Perry, 2012). Appraisal of risks does not necessarily result in protective actions and may even cause dissonant attitudes or grey solutions are preferred. Motivation is a decisive element but considered to be a very complex system with a multitude of theories (de Brabander and Martens, 2014). The main elements of importance are "perceived competence", "effects of own action" and "expected benefits" (Lupp et al., 2016). Key factors for motivation in the field of NBSs (Maidl et al. 2020) triggering action is seem to be in having a sense of responsibility to implement a shared solution among different stakeholders, a collaborative engagement in risk mitigation and the importance of dialogue.

Comparing the findings from the literature with the interviews from PHUSICOS (Table 3), we can underline a lack of knowledge of ecosystem-based, near-natural or NBSs, that persisted among some stakeholders at the end of the project lifetime.

Both literature and outcomes from the interviews highlight the importance of learning. This could take place in an indirect way, such as visiting implementation sites and discussing implemented projects or in a direct way such as providing documentations, brochures and newsletters or digital learning tools on the topic. In many cases described in the literature, the effectiveness of NBSs are perceived very critically and scepticism exists towards such solutions. PHUSICOS stakeholders that were interviewed provided a much more positive perspective. Nonetheless, they considered more learning and demonstration of the durability and effectiveness of NBSs in particular to be useful. Knowledge institutions such as academia, "champions" and exchange with successfully implemented NBSs can be involved in the learning process. Living Labs can be a tool for such learning processes, but slowing down processes leading to reduced enthusiasm of other stakeholders. Balancing and forming different groups with different activities were seen as useful, offering formats for two different target groups: one for specific technical aspects moving forward processes and one with a more open format and more basic orientation. In a similar way, it was seen useful to consider several communication tasks as well as very fundamental, basic learning opportunities on NBSs to be conducted outside the Living Labs.

Knowledge institutions are one of the necessary core groups of the Living Labs according to theories presented in Deliverable D3.1 (Fohlmeister et al., 2018). They are able to provide a basic understanding of NBSs and are widely accepted by most of the other stakeholders as a neutral actor. Stakeholder mapping also showed that within PHUSICOS and RECONECT, academia is the major component of both stakeholder groups, "the wise and active stakeholders" and "the observers" (Zingraff-Hamed et al., 2020c). Both groups are mainly in the least affected by the hazard and/or the least affecting the NBS implementation category. Our results show that they play an essential role in the co-creation processes.

A lesson learned from literature and especially in PHUSICOS is that, neutral committed partners from knowledge institutions can support co-creation processes in Living Labs with a proof of concept by collecting data and monitoring to overcome scepticism. A useful tool is learning from a "hands-on" demonstration case or other successfully implemented cases ideally having a multitude of monitoring data available supporting a proof-of-concept for NBSs. In addition to demonstrating durability, literature with a focus on urban areas emphasize the importance of co-benefits for society. While it was of lesser explicit importance in PHUSICOS, in the long run, it 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 an NBS (e.g. opportunities for recreation and bird-watching at Serchio measures).

The highlighted importance of economic aspects of NBSs in PHUSICOS can also be found in some of the literature where NBSs are implemented in more rural settings as well as in some described managerial perspectives from urban areas. However, only a few studies on the monetary value of NBSs in comparison with grey solutions exist, especially because the monetary value of the social co-benefits is difficult to assess (Perosa et al., 2021). Future efforts are needed to demonstrate for stakeholders that cost-benefit analyses for NBS could be promising from an economical perspective compared to grey solutions. The most important and a main motivation for rural mountain actors to participate in collaborative NBS planning processes are not only the benefits for nature, but especially the economic opportunities. For PHUSICOS, creating value chains around NBS management and resulting vegetation is a starting point to continue working in Living Labs processes.

5.2 Co-Creation, Living Labs and "Hands-on" Cases

The Innovation Action Type of projects to establish demonstrators is 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 NBSs 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 actual implementation that is put into reality during a Living Lab. This served as an incentive and motivation factor to engage for such a solution. As explained in detail in

the previous section on learning, the engagement of academia was seen to be very useful in PHUSICOS to overcome scepticism with contributing data and monitoring to provide information that can provide a proof-of-concept of NBSs and their abilities to reduce risks.

Especially for the Pyrenees case, several barriers had to be overcome to implement NBSs such as tendering procedures, a lack of experienced companies that could implement the NBS, handling of materials and lack of norms and standardisation of NBSs. With the support of PHUSICOS through work in Living Labs, there was strong will and commitment of all stakeholders that helped to overcome these barriers. Outside a project like PHUSICOS, experiencing such barriers might have led to aborting the idea of implementing an NBS.

Site or field visits were seen as the best experiences for stakeholders to learn about other NBSs in all demonstrator sites. With these "hands-on" cases, stakeholders began to perceive NBSs as an opportunity for widespread environmental improvement and not as a rival to the economic aspects. Stakeholders and in particular the farmers for example initially perceived the buffer strips or cover-crops as a limitation to their economic potential. In the Serchio River Basin, with help of the PHUSICOS project and Living Labs, a real-life NBS example was co-created that allowed to combine environmental sustainability and agricultural activities that developed into an interesting opportunity for farmers and land owners to implement. With committed stakeholders in the Living Labs, remaining challenges are addressed such as value chains, funding and payment schemes.

5.3 Converting Diversity of Opinions into Strengths – Facilitating Living Labs

In order to solve complex problems and to find innovative designs, partnerships and collaborative approaches have proven to be successful in implementing NBSs (Ershad Sarabi et al., 2019; Frantzeskaki et al., 2019; Zingraff-Hamed et al., 2020b). Formalized procedures for collaboration and participation can support the elaboration and implementation of such solutions (National Research Council, 2008), such as applying the Living Lab concept in PHUSICOS. A key element of Living Labs is to place the affected parties in the centre of the processes and to find good elaborated solutions collectively.

Meeting on equal ground with other actors was seen a key success factor not only in the literature, but also was seen as a very positive aspect of those participating and organizing the Living Labs as site owners. Co-creation processes with skilled and neutral facilitation was seen useful to ensure more neutrality. In this way, stakeholders do not feel pressured to get persuaded or pushed to a certain direction by actors such as authorities which might have an agenda. Such facilitation helps to consider all voices

including silent or quiet voices. Having "champions", forerunners or stakeholders with much creativity and ideas or actors with a lot of credibility and trust can be useful to stimulate Living Lab processes. A systematic mapping of stakeholders and involving relevant stakeholders as early as possible was seen a key strategy for successful co-creation and having the right stakeholders on board (Zingraff-Hamed et al., 2020).

For collaborative planning, despite the openness of Living Labs, a clear strategy to define overall goals and steps, identify barriers and bring in possible examples as a starting point for the discussion is seen as important for organizing a successful co-creation and implementation of NBSs. With the Serchio River Basin following such a clear laid out strategy and roadmap to implement NBSs, experiences from PHUSICOS showed the importance of flexibility in processes to adapt or create a new focus.

The Gudbrandsalen study area was a good example where the focus and ideas shifted and finally gained momentum when an actor brought in the idea to work on the historic waterways. Other stakeholders picked up this idea and expressed their willingness to work on them examining how to put a historic element with a lot of identity and pride into a new context. This resulted in the Stakeholders bringing up the idea to work on the historic waterways in Skjåk and examine their potentials to reduce hydro-meteorological risks.

Another example for a need of flexibility to cope with "the unforeseen" was the impact of the COVID-19 pandemic and the Living Lab activities. As it became clear that in some cases quite severe restrictions for in-person meetings and travelling would be in place for a longer time, there was the need to adapt to the situation and find other formats to commence working. Shifting to the digital space suffered from a "digital divide" (Ramsetty and Adams, 2020). Some stakeholders were unable to use such online tools or have little to no experience with digital means of communication. Case study sites experienced difficulties to reach out to certain stakeholders and groups with digital formats linked to age, education, income levels, available digital equipment, internet access, experience with online work and living in very rural areas with slower internet speeds making it difficult to attend video conferences (Ramsetty and Adams, 2020). A decrease in participants and fatigue with online meetings was observed. Despite a variety of attractive digital formats offered by the demonstrator case sites that were very much appreciated by the participants, face-to-face work was considered more effective and essential for building trust and more inclusive for all participant groups and "was not the same like meeting in person" according to stakeholders.

5.4 Repeating Negative Experiences: An Avoidable Pitfall?

Even with benevolent and interested stakeholders willing to implement NBSs, the collaborative planning process can be slow. With the lack of knowledge or awareness, the creation of a more common understanding for the problem of natural hazards, the building of trust and the overcoming of scepticism take time. From this point, a perceived negative experience might not necessarily be negative depending on the

perspective. Indeed, it can be a starting point for change, a new, different approach, start reflection processes and bring encouragement to work on something new.

Developing overall knowledge on NBSs with its mechanisms, abilities, proof of concept and providing needed learning opportunities are time-consuming and demand significant resources. Creating the needed environment of trust and understanding, developing knowledge through co-designing, and implementing a solution to serve as a local hands-on case within the lifetime of a project such as PHUSICOS was one of the dilemmas. Along with the challenge of impressing the stakeholders of the urgency to address natural hazards, there is a need to motivate them to continue with the processes beyond the project lifetime such as working on management of NBSs or follow up on created ideas that did not mature within the project lifetime.

Looking back at the Isar concept case described in-depth in D3.1 (Fohlmeister et al., 2018) and D5.1 (Martin et al., 2019), we can identify that the Isar river restoration faced the same difficulties. Often, intense negotiation and discussions are needed to find a solution that everyone is able to accept and agree upon for creating acceptance, identity, pride and sense of ownership. Key findings from the Isar (Zingraff-Hamed et al., 2019; Martin et al., 2021) were that NBSs conflicted with the long history of implementing grey infrastructure. Therefore, much time and effort were needed for addressing and overcoming doubts existing in all the actor groups. Technical challenges had to be worked on, as not much experience with NBSs existed, and many prototypes had to be tested to ensure efficiency. Furthermore, restricted space and budget were strong limiting factors. Moreover, conflicts of interest had to be resolved. Even between NGOs for nature conservation, interests varied greatly.

Finally, a long period of time was needed to build up the necessary trust between the stakeholders to enable effective collaborative planning (Zingraff-Hamed et al., 2019). Because of the intensive collaborative and in-depth participatory approaches within the context of a Living Lab approach (Lupp et al., 2021), the Isar Allianz leaders were able to effectively facilitate the associations that committed to work on a common vision. The result of this was the reduction of the historical conflicts. The NGOs and especially the Isar Allianz played a special role in the overall process to bring forward the Isar River restoration. The openness of the involved public authorities to share power and take into consideration citizens voices on many occasions was a factor of success. This largely contributed to the success of the Isar Plan despite it taking much time and resources.

5.5 Facing the Lack of Willingness at Governance Levels

A variety of challenges at several points of co-designing and collaborative planning of NBSs arise when looking at the initial experiences gained from coordinating the PHUSICOS sites at the beginning (Solheim et al., 2021). A number of barriers that were encountered are a result of external factors arising from governance obstacles. Overall legal frameworks or regulations such as tendering processes, specific legal framework

regarding water bodies, policies and financial mechanisms in agriculture that negatively affect the implementation of NBSs. Regarding stakeholder perceptions and engagement, the main barriers observed in the literature and experienced in PHUSIOCS according to Solheim et al. (2021) were:

- A lack of sense of urgency among policy makers even in the aftermath of natural disasters
- A lack of political will for action and long-term commitment in finding a solution
- A lack of public awareness and support
- Missing knowledge about hazard and exposure
- Risk aversion and resistance to change
- A lack of skilled knowledge brokers and training programs on natural hazards and NBSs addressing different stakeholder groups and their level knowledge

Cancellation of intended measures from a very early stage of PHUSICOS demonstrated that more time is needed to build trust and develop a close cooperation that includes the local and regional administrations as well as other relevant stakeholders such as farmers and landowners. This includes finding common ground, starting with a common understanding and defining the problem with natural hazards.

Looking at some of the results from governance analyses using retrospective cases such as the Isar (Martin et al., 2019, Zingraff-Hamed et al., 2019, Martin et al., 2021), it can be shown that despite the importance of NBSs and being at the top of political agendas, supportive governance at various levels from the European to local levels are lacking. There is a need for adaptation or change. Although some of the factors influencing the implementation of NBSs at the local level such as the EU Common Agricultural Policy are doing so in a negative way and local actors are unable to change them. Some of the barriers can be addressed and overcome at the local or regional level. Besides activities and advocacy for NBSs, ways to address these barriers might be related to local policy approaches of providing funding to support implementation or follow-up activities. Municipalities, citizens and NGOs, are important actors that can drive NBS implementation in urban as well as in rural areas. Local authorities have a crucial role in integrating NBSs into location-based planning strategies. Despite a lack of clear guidance or supporting instruments from the state and regional level, committed politicians at the municipal level can drive such planning outcomes to the implementation phase (Edelenbos 2005, Wamsler 2015, Zingraff-Hamed et al., 2020b). For example, the PHUSICOS Pyrenees case demonstrated that with commitment, barriers to implement NBSs could be overcome. For the Serchio River Basin, despite unsupportive stimuli set by some overall policies from EU and national level, Living Labs worked on solutions to make NBSs for farmers and land owners attractive and further efforts will be taken to develop regional approaches and mechanisms such as development of value chains, compensations or mechanisms such as payment for ecosystem services.

6 Synthesis and Recommendations

Climate change increases the frequency and intensity of extreme hydro-meteorological events triggering floods, landslides, mudflows, avalanches or rockfall in mountain areas. Nature-Based Solutions (NBSs) are increasingly considered as an effective, elegant means to reduce exposure or vulnerability for such risks. NBSs received a lot of attention on both political and research agendas as implementing NBSs do not only reduce the risk and exposure to natural hazards but also offer co-benefits for both nature and humans such as contributing to the United Nation Sustainable Development Goals. NBSs in rural mountain areas can be, for example, restoring rivers and wetlands, adapting land use practices such as soil conserving farming, agroforestry systems or conserving, regenerating, revitalizing and (re-)planting forests. While NBSs have received a lot of attention in urban areas, this is not the case for rural mountain areas until recently.

Formalized procedures for collaboration and participation are important for successful implementation of NBSs and increasingly become mandatory in many planning tasks. 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. One concept to support and institutionalize collaboration are so-called “Living Labs”. The common idea of this approach is to form partnerships between public organizations, private companies, academia and citizens.

Looking at the outcomes from other collaborative projects in the field of NBSs and neighbouring concepts and findings from PHUSICOS, many benefits can be achieved by applying Living Labs for co-designing, co-creating, co-implementing and co-monitoring NBSs. Although decisive stakeholders may have awareness about natural hazards, there is less awareness on how to address them and even less knowledge on NBSs as they have not come across this concept before. This demonstrates the importance of projects like PHUSICOS with its action-oriented component. Living Labs provide formalized arenas for in-depth collaboration in real world case sites. Stakeholders from different background meet on equal ground to discuss, co-create, co-design and co-implement their NBS.

A clear vision for working on implementing a real NBS is an important incentive and motivates actors to participate in collaborative processes to work and create their own hands-on case and creates a strong sense of ownership for the selected solution. Engagement of neutral knowledge institutions for information, data and for the development of monitoring concepts can provide trust in NBSs and contribute to a proof of concept, thus helping to create acceptance and to overcome scepticism towards NBSs. As such, this collaborative solution can serve for learning, upscaling, replication and with committed partners, can be used to collect the long-term data to evaluate the solutions and to provide a long-term proof-of-concept.

The nature of a project like PHUSICOS (meaning “according to nature”) is an important factor to overcome challenges given by the nature of NBSs such as they might be a tailored solution adapted to a local solution. These solutions often reflect that no standardization exists and there is a need to incorporate demands of stakeholders such as use of local materials to reduce carbon footprints, lack of skilled companies or the contractor´s need to gain experience with such solution by implementing them. The PHUSICOS project created a strong willingness of the actors to keep committed to NBSs and strengthened their will to overcome such barriers. Otherwise, outside of a project like PHUSICOS, this could have led to rejecting NBSs in favour of grey engineering solutions or even leaving problems unsolved.

Living Labs were an important tool for implementing NBSs. Stakeholder mapping is a key element and foundation to have all who have a stake included in the co-creation process. A focus is needed to include and give a voice to those who are affected the most but have no voice and who is influential or decisive for decision-making, as well as inclusion of champions and forerunners. A neutral facilitation helps to include all stakeholders and giving a voice to everyone. An engagement of stakeholders as early as possible is feasible to avoid delays and to create momentum. Different opinions and diverging interests or controversies might are perceived to slow down processes or avoidable pitfalls. Time is needed to build trust and mutual understanding. For such processes, in-person exchanges are important and that could not be replaced with digital formats.

An important success factor and strength of Living Labs was bringing together the different overlapping competencies and powers for a site to one table. This broke silos, enabled co-designing solutions and it became possible to make decisions to implement NBSs in timely fashion. Site visits and inspections facilitating discussion of topics on site were seen as most useful and inspiring for the Living Lab formats to further develop NBSs. With a lack of knowledge of many important actors and dealing with different knowledge levels, offering learning opportunities was seen as useful but slowing down the Living Lab processes. A solution was seen to form different groups dealing with different topics or to separate very fundamental learning topics as well as communication tasks from the Living Lab processes.

Despite the successful implementation of NBSs through Living Labs, raising awareness, interests and attractiveness of such solutions, several barriers outside of the competencies of the stakeholders, site owners and facilitators orchestrating Living Labs can be determined. They link to contradicting or inconsistent policies, such as the EU Common Agriculture Policy strongly influencing the land use and agricultural practices. Despite visible efforts to change to the better for NBSs and more sustainability, there is a need for further adjustments for even more valuing of such efforts and supporting NBSs.

Drawing conclusions from the Living Labs experiences in PHUSICOS, the following aspects can be highlighted:

- The importance of creating and disseminating knowledge: The participation of research and knowledge institutions in the Living Labs to provide and translate scientific and evidence-based data for actors played an important role especially in terms of overcoming scepticism and of proof of concept. The R&I nature of PHUSICOS creating data and information as well as sharing experiences from existing examples brought to the demonstrator sites and the local and regional actors was seen a key factor for implementing NBSs.

- Broad Stakeholder involvement and Living Labs: Stakeholder mapping, identification and bringing them together at one table is decisive for well working collaborative processes. A neutral facilitation, discussions of topics, building trust and commitment help to break silos. Dealing with different perspectives and opinions need time. No result or reaching consensus should not be considered a negative outcome but seen as an opportunity and starting point for something new or to come to a better solution.

- Stakeholder motivation: An important incentive and motivation to participate was working with real cases and the implementation of the co-designed NBSs. Living Labs with site visits to discuss the challenges and potential solutions were key success elements breaking silos and creating momentum, willingness to collaborate, overcome barriers and implement co-designed and selected NBSs.

- Creating and showcase NBSs: The co-created, implemented NBSs and the involved stakeholders act as advocates and knowledge vectors for NBSs. The created hands-on cases and sharing experiences encourage others to replicate such solutions elsewhere. It will be worthwhile to follow up on implemented NBSs over time to demonstrate effectiveness and determine co-benefits. Implemented NBSs and their monitoring over time will showcase NBSs and create the long-term proof of evidence over time when solutions mature and co-benefits become more tangible for stakeholders.

7 Ethical 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 – BDSG (new) from 2018 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.

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Appendix A1

Questionnaire for qualitative in-depth Key Stakeholder Protocol Interviews Round 1

List for Questions for the WP3 Baseline Assessment

Protocol interviews with selected stakeholders

Q.0 Introductory questions:

Q 0.1 Please briefly introduce yourself, your background and your function in the organization

Q.1 Meeting the Concept of Nature Based Solutions:

Q.1.1a How have you been involved in measures or solutions to reduce hydro-meteorological risks?

Q1.1b How would you describe these solutions? Were they traditional grey engineering solutions or were ecosystem Based solutions/green engineering/Nature Based Solutions among them?

Q1.1c Have you heard about Nature Based Solutions?

Q.1.2 Which sources of inspiration or information do you use to inform, design or decide about the design and implementation of measures to reduce hydrometeorological risks?

Please reflect on potential inspirations from science and education or professional training, media (other than related to professional training or education) and role of your professional contacts but also your private surrounding

Q.1.3 PHUSICOS is a European funded research and innovation project focusing on Nature Based Solutions to reduce hydro-meteorological risks. What has been the role of PHUSICOS in getting inspirations so far and how could PHUSICOS contribute to provide inspiration for you for the design and implementation of alternative solutions to reduce hydrometeorological risks?

Q.2 Benefits of, concerns/preoccupations about and barriers for implementing Nature Based solutions

Q.2.1 What do you think are the main benefits of implementing alternatives to grey solutions?

Q.2.2 What would be your concerns about implementing alternatives to grey solutions?

Q2.3 What might be the main barriers to implementing alternatives to grey solutions?

Please reflect on technical aspects, human and societal aspects or governance aspects (regulative framework and administrative settings) that might lead to opt for a traditional grey solution or not taking action at all.

Q.3 Living Labs

In PHUSICOS, an important activity is the active involvement of participants and Stakeholders beyond a “business as usual” approach. This activity is referred to as Living Labs.

Q3.1 How can the PHUSICOS Living Labs generate new knowledge and truly develop, co-design and implement together with different stakeholders new forms of non-grey solutions to address hydrometeorological risks?

Q3.1a What might be benefits of such an approach?

Q3.1b What might be concerns of such an approach?

Q3.1c What might be barriers for such approaches?

Do these barriers exist in general or are they only related to new forms of non-traditional solutions?

Q3.2 What contents or topics would you, from your perspective, like to discuss and elaborate in the Living Labs?

Q3.3 What would you like to see as outcomes of the PHUSICOS Living Labs?

Q.3.4 Is there anything else you would like to share with us or is there something important for you that we have not asked about?

Q.3.5 Would you be willing to participate again in an interview to reflect again on these points and share your views on the experiences made with PHUSICOS?

Thank you very much for taking your time! They provide very valuable and very relevant inputs to stimulate and improve Living Lab processes.

Appendix A2

Questionnaire for qualitative in-depth Key Stakeholder Protocol Interviews Round 2

List for Questions for the WP3 Baseline Assessment

Protocol interviews with selected stakeholders

Q.1 Meeting the Concept of Nature Based Solutions:

Q.1.1 What has been the role of PHUSICOS so far for you and what were important steps taken in terms of NBSs in your opinion?

Q.2 Benefits of, concerns/preoccupations about and barriers for implementing Nature Based Solutions

Q.2.1 Following up and being engaged in PHUSICOS, what do you think are the main benefits of implementing Nature Based Solutions? What were the most important new insights for you until now?

Q.2.2 Which concerns about Nature Based Solutions remain, appeared or proved to be true during your engagement in PHUSICOS so far?

Are they general ones related to the nature of NBS or to other factors? Can PHUSICOS contribute or work, address these concerns?

Q2.3 Have you experienced barriers when trying to work, plan or implement Nature Based Solutions when working in PHUSICOS?

Were they evident already before the project started and couldn´t be solved so far? Did they appear while working in PHUSICOS? To your opinion: Can they be solved during the project lifetime or likely can be solved at a later stage after the project end?

Q.3 Living Labs

Q3.1a Did the PHUSICOS Living Labs generate new knowledge and develop, co-design and implement together with different stakeholders so far already? What were the most interesting outcomes of the Living Labs so far?

Q3.1b What were, so far, the benefits of using Living Labs? What was the best experience or achievement so far?

Q3.1c What did not work so well so far in the Living Labs? How could this be addressed timely to improve the Living Labs in the remaining time?

Q3.1d Did you observe barriers in the Living Labs? Which ones? Are they more general ones or can they be removed timely?

Q3.2 What contents or topics would you like to discuss, elaborate or focus in the remaining time in the Living Labs?

Q3.3 What would you like to see as outcomes of the PHUSICOS Living Labs?

Q.3.4 Is there anything else you would like to share with us or is there something important for you that we have not asked about?

Thank you very much for taking your time! They provide very valuable and very relevant inputs to stimulate and improve Living Lab processes.

Appendix A3

Questionnaire for qualitative in-depth Key Stakeholder Protocol Interviews Round 3

List for Questions for the WP3 Baseline Assessment

Protocol interviews with selected stakeholders

Q.1 Meeting the Concept of Nature Based Solutions:

Q.1.1 Looking back, how has PHUSICOS contributed and provided inspiration for you to consider, work, design and implement Nature Based Solutions to reduce hydrometeorological risks?

Q.2 Benefits of, concerns/preoccupations about and barriers for implementing Nature Based solutions

Q.2.1 Looking back, for you, in which ways has PHUSICOS contributed to demonstrate that Nature Based Solutions might be an interesting option to address natural hazards? Which were the benefits of these solutions? Which appeared the most important benefits for your case area. What interesting, surprising or new interesting outcomes for you on benefits that Nature Based Solutions could provide?

Q.2.2 Looking back, what are remaining concerns about Nature Based Solutions? How can future work in your region or in future research and development projects address them?

Q2.3 Looking back - what were the main barriers to implementing Nature Based Solutions? Did PHUSICOS with the Living Labs and support from research help to address or overcome them in some ways or at least contributed to describe them?

Q.3 Living Labs

In PHUSICOS, an important activity is the active involvement of participants and stakeholders beyond a "business as usual" approach. This activity is referred to as Living Labs.

Q3.1a In which ways did the PHUSICOS Living Labs generate new knowledge to develop, co-design and implement Nature Based Solutions together with different stakeholders?

Q3.1b What were, in your eyes, the benefits of using such a Living Lab approach? What would be lessons learned?

Q3.1c At the beginning, you might have expressed concerns about the Living Labs. Did they manifest or come true to some extent?

Q3.1d Which barriers using a Living Lab approach did you observe? What slowed down or congested the processes and how could they be addressed? Or were they solved? Or could they be addressed?

Q3.2 What were the most important outcomes of the Living Labs in your eyes?

Q3.3 Can you give feedback on these formats and events? What were the most interesting formats or events for you? Which formats were not so well and how could they be improved in the future?

Q3.4 Are there general comments on Living Labs that you would like to share with others interested applying such an approach?

Q.4 Beyond PHUSICOS

In these questions, we will look ahead and beyond PHUSICOS.

Q4.1 From your perspective, did PHUSICOS encourage fellow participants and actors to continue working on NBS projects beyond the project lifetime, spreading words about NBS and share the concept with others to inspire, pick up or replicate such solutions? Can you give examples?

Q4.2 What topics should/will be followed up together with other the stakeholders after PHUSICOS?

Do you think that PHUSICOS and the Living Labs generated dynamics that stakeholders will follow up on their own or will additional help or support be needed (e.g. follow up project with facilitation)

Q.4.3 What will be the legacy of PHUSICOS for you after the project end?

(For example, continuous engagement, work on new projects, follow up ideas created in Living Labs etc.)

Q.4.4 Is there anything else you would like to share with us or is there something important for you that we have not asked about?

Thank you very much for taking your time! They provide very valuable and very relevant inputs to stimulate and improve Living Lab processes.

Appendix B1

Tick Box Survey for Living Lab Participants
Living Lab performance

The following questionnaire presents a set of questions asked to evaluate the Living Lab performance. The aim of the questions are to be understandable for different types of stakeholders with different educational backgrounds.

A basic set of questions should be asked at the end of each Living Lab session or in a follow-up close to the meeting. Depending on the selected formats and content of a session, some of the provided additional questions for certain purposes can be used to evaluate specific Living Lab content, e.g. questions related to decision-making processes. Facilitation teams are also encouraged to add site-specific questions e.g. to receive feedback together with WP3.

The following questionnaire is intended to give an overview and exemplary. To simplify data collection and handling, the use of an online survey tool is recommended. When providing the set of questions to the stakeholders as paper-based questionnaires, WP3 recommends some additional work on layout and providing enough space for comments.

Questionnaire

Evaluation of today's event from the point of view of the participants

Background

This questionnaire was developed as part of the EU Innovation and Research Program Horizon 2020, Project PHUSICOS. The project PHUSICOS (Greek for "according to nature") deals with the analysis, development and implementation of nature-based solutions to better protect mountain regions from natural hazards caused by heavy precipitation events. The project brings together 15 institutions in 5 territorial settings on the Serchio (Italy), the Pyrenees (France / Spain / Andorra), Gudbrandsdalen (Norway), Kaunertal (Austria) and the Isar (Germany). Together with different sectors comprising businesses, science, administration and civil society, good, practical and implementable solutions will be developed and implemented.

The aim of this questionnaire

The purpose of the questionnaire is to analyze your satisfaction as participants with today's event and identify your needs and wishes for improvement. This questionnaire was handed out to you by the leaders of today´s event. The information on the sheets will be confidential, anonymous and will be evaluated and assessed by employees of the Technical University of Munich. So please don´t put in names or addresses of yourself to maintain anonymity. The process of filling in should not take longer than 20 minutes. If you cannot or do not want to answer a question, feel free to skip it. You are also very welcome to comment on the questions, suggestions or other ideas. Use the back side of the sheet or directly contact the organizers of the event or us. We look forward to receiving your feedback.

Thank you for your help!

Contact information:

PHUSICOS Case Site Facilitator	**Contact information Work Package Service Innovation**
	Dr. Gerd Lupp, Dr. Aude Zingraff-Hamed Chair for Strategic Landscape Planning and Management Technical University of Munich Emil-Ramann-Str. 6 85354 Freising -GERMANY - : 08161-71-4671 E-Mail: gerd.lupp@tum.de, **aude.zingraff-hamed@tum.de**;

Part 1: To ensure that a good cross section of interested persons from all groups of society are involved, please fill in the following questions:

Q1.1 Gender

☐ Male ☐ Female ☐ Diverse ☐ Prefer not to say

Q1.2 Age

☐ Below 18 ☐ 18-24 ☐ 25-34 ☐ 35-44
☐ 45-54 ☐ 55-64 ☐ 65-74 ☐ Older than 75

Q1.3 Highest level of education achieved

(Need to be adapted to the context and culture of the different countries)

☐ Secondary School ☐ Grammar School ☐ Vocational Training
☐ Craftsmanship diploma ☐ University Degree ☐ None of the mentioned

Q1.4a Which type of organization do you represent in today's Living Lab session?

(Site specific tick boxes for sectors can be added if needed)

☐ Large company ☐ Small/ medium size company ☐ Self-employed
☐ Authority/Administration
☐ NGO (e.g. environmental organization)
☐ Association (e.g. land /forest owners, farmers)
☐ Interested individual person, not representing an association, NGO or company
☐ Policy
☐ Research
☐ Others, please specify: _____

Q1.4b Which sector do you represent? - several options can be ticked

(Site specific tick boxes for sectors can be added if needed)

☐ Water, Water construction ☐ Agriculture ☐ Forestry
☐ Fishing ☐ Environment/Nature protection
☐ Energy production ☐ Infrastructure
☐ Planning ☐ Education/youth work
☐ Culture ☐ Sport/Leisure
☐ Tourism ☐ Policy
☐ Engineering ☐ Research
☐ Land owner
☐ Other user group; please specify: _____
☐ Others, please specify: _____

Q1.5 On which geographical level do you work mainly for the organization you represent at the meeting?

☐ National level or federal state level
☐ Regional level
☐ County level
☐ Local at town or community level

Q1.6 How often have you participated in the meetings?

For the first Living Lab meetings

- ☐ Joined the meeting for the first time
- ☐ Attended one meeting before
- ☐ Attended several meetings before

Questions after 4-5 meetings

- ☐ Joined the meeting for the first time
- ☐ Attended a few meetings (< 25%)
- ☐ Attended regularly (half of the meetings)
- ☐ Attended all/most meetings (> 75%)

Q1.7 Are you willing to attend more meetings?

☐ Yes ☐ No ☐ Don´t know

Comments: _____

Q 1.8 What meeting terms would suit you best?

- ☐ 1 meeting per month
- ☐ 1 meeting every 2 months
- ☐ 4 meetings per year
- ☐ 2 meetings per year
- ☐ 1 meeting per year

Part 2: Satisfaction with the PROCESS QUALITY of today's meeting

Q 2.1 How was our experience with the meeting today?

Please indicate your level of satisfaction with the statement by ticking one option per line, for longer comments, feel free to make use of back site of sheet if necessary

Depending on time available time and stakeholders involved, statements and level of agreements (Lickert Scales) could be used to get more information compared of the simple approach presented here

Q2.1.1 Time of the Workshop

☐ too late ☐ too early ☐ ok

Comments:_____

Q2.1.2 Duration of the workshop

☐ too short ☐ too long ☐ ok

Comments:_____

Q2.1.3 Location of the meeting

☐ too far away ☐ should been in field ☐ ok

Comments:_____

Q2.1.4 Different participant groups and perspectives were represented at this meeting

☐ Too little ☐ Too many ☐ ok

Comments:_____

Q2.1.5 Number of participants

☐ too little ☐ too many ☐ ok

Comments:_____

Q2.1.6 Sent documents/materials to prepare for the meeting

☐ not enough ☐ too much ☐ ok

Comments:_____

Q2.1.7 Presentations/Talks

☐ too little ☐ too much ☐ ok

Comments:_____

Q2.1.8 Involvement of Participants in workshop

□ too little □ too much □ ok

Comments:_____

Q2.1.9 Level of interaction/ ability to express my opinion

□ too little □ too much □ ok

Comments:_____

Q2.1.10 Opportunity for building networks/ cooperation

□ too little □ too much □ ok

Comments:_____

Q2.1.11 Learning opportunities

□ not enough/ did know before □ felt overwhelmed □ good

Comments:_____

Q2.1.12 Facilitation of meeting today was unbiased, neutral and approachable

□ Biased □ Unbiased
□ Approachable □ Non approachable
□ Too forward □ Ok □ Not forward enough

Additional items for a good, skilled facilitation considered important can be presented as positive/negative/neutral tick boxes for this question to collect feedback for site teams

Comments:_____

Q2.2 Was there a good mix of external experts and local persons in today´s meeting?

□ Fine, well-balanced
□ Too many external experts, if yes, which ones? _____
□ Too little external experts, which ones were missing? _____

Q2.3 Were relevant local persons or groups missing?

□ No
□ Yes: Following groups were missing: Please specify which ones were missing:
_____
□ Cannot judge

Part 3: Satisfaction with the CONTENT, INVOLVEMENT & OUTCOMES of today's Living Lab Session

Basic set of questions for each Living Lab session

Please tick one option per line only

Q3.1		Strongly Disagree	Disagree	Agree	Strongly Agree	Don't know	Comments
Q3.1.1	**I had the opportunity to make my voice and opinion being heard.**						
Q3.1.2	**My voice was heard, views and important points were taken up in today's session.**						
Q3.1.3	**I learned something new and could improve some of my skills in today's session.**						
Q3.1.4	**Today´s meeting created new interesting and important insights and things**						
Q3.1.5	**Today's meeting brought forward a substantial input to further elaborate the project**						
Q3.1.6	**Today's meeting allowed me to connect and built up or strengthen networks to other interest groups.**						
Q3.1.7	**Today's Living Lab session contributed to positively influence my perception on NBS.**						
Q3.1.8	**The meeting encourages me to spread information about this project and NBS.**						

Additional Questions Q3.1a and b for specific Living Lab sessions

To keep regular evaluations for participants short, only a few from the following questions from Q3.1a and b should be selected carefully to collect additional information when needed. They should be clearly related to the specific content and purpose/targets of a Living Lab session.

Q3.1a Living Lab Process related questions

Please tick one option per line only

Q3.1a		Strongly Disagree	Disagree	Agree	Strongly Agree	Don't know	Comments
Q3.1a.1 *to be asked when scope of Living Lab is set*	**Today's Living Lab session contributed to achieve the main goals and sub-objectives, which define our Living Lab**						
Q3.1a.2 e.g. when important steps or decisions were made, e.g. NBS selection	**I knew and agreed on the objective of today´s Living Lab session**						
Q3.1a.3 When important decisions are made in a specific Living Lab session	**Participation and Decision making was communicated clearly when starting into today´s session**						
Q3.1a.4 e.g. when Living Lab session focuses on learning	**The insights and skills I gain through the Living Lab is worth the effort and time**						
Q3.1a.5 e.g. longer discussions, interaction formats or decision processes	**The atmosphere of the Living Lab session was constructive and characterized by fairness**						
Q3.1a.6 e.g. when specific tasks or decisions made in a specific Living Lab session	**The contributions of participants had an influence on relevant decisions made during the Living Lab session**						

Q3.1b Living Lab Content and Outcome

(Please tick one option per line only)

Q3.1b		Strongly Disagree	Disagree	Agree	Strongly Agree	Don't know	Comments
Q3.1b.1 e.g. when stakeholders are asked to interact with research	**I had the opportunity to influence the research agenda with my points that are important to me**						
Q3.1b.2 e.g. when having a strong focus on creating knowledge/new insights	**Participants of different backgrounds, stakeholders and viewpoints could contribute and share their knowledge. Thus, new insights were created**						
Q3.1b.3 e.g. when this was a core purpose of a session	**We co-created new knowledge between different stakeholders in today´s session**						
Q3.1b.4 e.g. when having a focus on learning	**Today´s Living Lab session strengthened my confidence to be able to contribute to the NBS co-design process**						
Q3.1b.5 e.g. when elaborating policy advice in a session	**Today´s Living Lab session will influence relevant decisions on disaster risk management**						

Q3.2 Do you recommend anything to improve for the next Living Lab session, e.g. improvements?

Thank you for your help!

Appendix B2

Tick Box Survey for Living Lab Participants

Assessment of NBS perception

Project Description

This survey is distributed in the context of the PHUSICOS project. The EU-project PHUSICOS (2018-2022) aims at fostering proof of the effectiveness of Nature-Based Solutions (NBS) as an approach to reduce the risk of extreme weather events in rural European mountain areas. The name PHUSICOS originates from the Greek term φυσικός and can be translated with "according to nature". The Innovation Action project is funded by the European Union's Horizon 2020 research and innovation program.

Mode of Use of the Assessment Template

Please fill out this anonymous survey to help us better understand the awareness and perception of nature-based solutions at your location as well as your experiences made with the Living Lab processes so far. It should take about 30 minutes. If you are not comfortable answering a question, please just skip it and move on to the next.

We are very grateful for your participation as it contributes to increase the quality of implementing NBS, the PHUSICOS project in general as well as future projects. Thank You!

If you have any questions regarding this survey or the PHUSICOS project please contact your local facilitator or Gerd Lupp, Technical University of Munich (gerd.lupp@tum.de).

Part 1: To ensure that a good cross section of interested persons from all groups of society are involved in the project, please fill in the following questions

Q.1.1 Gender

☐ Female ☐ Male ☐ Diverse ☐ Prefer not to say

Q1.2 Age

☐	Below 18	☐	18-24	☐	25-34	☐	35-44
☐	45-54	☐	55-64	☐	65-74	☐	Older than 75

Q1.3a Which type of organization do you represent in the process? (Please tick only one which represents you the most)

☐ employed in large company
☐ employed in Small/ medium size company
☐ Self-employed
☐ Authority/Administration
☐ NGO
☐ Association (e.g. land /forest owners, farmers)
☐ Interested individual person, not representing an association, NGO or company
☐ Politician (e.g. mayor, councilor, Member of Parliament)
☐ Research
☐ Others, please specify: _____

Q1.3b Which sector do you represent?

☐	Water/River management	☐	Agriculture
☐	Forestry	☐	Policy
☐	Aquaculture, professional fishing	☐	Environment/Nature conservation
☐	Energy production	☐	Infrastructure building
☐	Planning	☐	Education/youth work
☐	Culture	☐	Sport/Leisure (e.g. hobby fishing)
☐	Tourism and Gastronomy	☐	Research
☐	Civil Society		

☐ Other user group; please specify: _____
☐ Others, please specify: _____

Q1.4 On which geographical level do you work mainly for the organization you represent at the meeting?

☐ National level or federal state level
☐ Regional/County level
☐ Local at town or community level

Part 2: Questions related to the Concept of Nature Based Solutions (NBS)

Q2.1 Which sources did you use to inform yourself and specifically to learn about nature-based solutions?

PHUSICOS Project

- ☐ Project information
- ☐ Handout material previous to a meeting
- ☐ Information during PHUSICOS meetings, workshops, Living Lab sessions

Media

- ☐ Internet
- ☐ Social Media
- ☐ TV
- ☐ Newspapers
- ☐ Other media sources

Personal Contacts

- ☐ Institutions, Authorities
- ☐ Environmental Organizations
- ☐ Research
- ☐ Colleagues
- ☐ Friends/Family
- ☐

Professional Background

- ☐ During vocational training, study
- ☐ Training course for professional development
- ☐ Talk, Presentation, e.g. at a Conference

- ☐ Others, please specify: _____

- ☐ None of them

Q2.2 Do you feel that you have a good understanding of the Nature Based solutions concept or do you still need more information to get more familiar with the concept? (Please tick only one)

- ☐ I feel that I am very familiar concept.
- ☐ I feel that I understood the concept, but still have some uncertainties and questions.
- ☐ I barely understand the concept
- ☐ I have not really an idea what Nature Based Solutions are.

Q2.3 Please judge on the following statements on nature-based solutions:

Nature-Based Solutions and risk reduction - Please tick only one option per line

	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Don't know
Nature Based solutions reduce the risks of extreme weather events						
Nature Based solutions provide good adaptation to climate change						

Nature Based Solutions and Technical Aspects - Please tick only one option per line

	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Don't know
Nature Based solutions have a good cost-benefit ratio						
Nature Based solutions are easy to implement						
Nature Based solutions are very robust						

Social and Economic Aspects of Nature Based Solutions - Please tick only one option per line

	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Don't know
Nature Based solutions create jobs						
Nature Based solutions create business opportunities and local value chains						
Nature Based solutions increase the quality of life						
Nature Based solutions provide possibilities for recreational activities						
Nature Based solutions create identity for a place						
Nature Based solutions make areas attractive						
Nature Based solutions increase property values						

Nature-Based Solutions and Ecology Please tick only one option per line

	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Don't know
Nature-based solutions contribute to cleaner water and better air quality						
Nature-based solutions increase diversity in flora and fauna						
Nature-based solutions allow better discovering and understanding nature						

Q2.4 What is your opinion about the following statements related to concerns on Nature Based solutionss Please tick only one option per line

	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Don't know
Nature Based solutions are not as effective as technical solutions						
Nature Based solutions are less reliable than technical solutions						
Nature Based solutions need too much time until they work						
Nature Based Solutions increase health problems (allergies, etc.)						
Nature Based Solutions lead to an increase of insects and other unwanted animals or plant						
Nature Based Solutions are expensive and/or have a negative cost-benfit ratio						
Nature Based Solutions will not be properly maintained over time						
Nature Based Solutions reduce usability and access of an area						
Nature Based Solutions will increase risk of accidents and injuries to humans						

Q2.4 What might be the main barriers to apply Nature-based solutions according to your opinion? Please tick only one option per line

	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Don't know
Lack of (technical) knowledge						
Lack of good examples for Nature Based solutions						
Uncertainties about potential effects and impacts						
Lack of financial resources						
Lack of available land						
Lack of political will						
Lack of supporting legal framework						
Lack of technical standards for Nature Based Solutions						
Lack of empathy for nature						
Missing of intersectoral collaboration						
Nature-based solutions are not seen as a priority						
Proposed nature-based solutions do not fit or suit for the local conditions						
Lack of long-term maintenance and related funding						

☐ Others, please specify: _____

Part 3: Questions related to further interest in Nature-based Solutions (NBS)

Q3.1 If a nature-based solution was to be implemented, would you like to do any of the following?

☐ Participate in planning and decision-making
☐ Volunteer with advice or expertise
☐ Volunteer with work
☐ Share information or promote the project
☐ No, I would or could not do anything

Q3.2 Do you consider spreading and talking to your contacts about the experiences made with nature-based solutions and the concept of Nature Bases solutions?

☐ Yes
☐ No, I would or could not do anything
☐ No, I think they would not be interested in this topic

Comments: _____

Q3.3 Do you have questions about nature-based solutions that should be addressed in PHUSICOS, in the Living Lab sessions or an upcoming meeting?

☐ Yes: _____
☐ No

Q3.4 Is there anything else you would let us like to know?

_____

Appendix C

Overview of the Living Lab activities at the Demonstrator Sites

Demonstrator Site Gudbrandsdalen

LL description	Date	Assessment
A full LL process is to be followed for developing NBS "from scratch" at a location in the Northern part of the valley (Skjåk).	15/5-19 (kick-off)	Yes
Living lab Skjåk 16.11.21 Group discussions of types of NBS solutions suitable in the area. The idea of Waterways was brought up.	16/11-21	Sent out a summary afterwards, along with the surveys about the evaluation of the Living lab, and their knowledge of NBS.
LL-field trip 17.08.22 Field trip to the old waterways in Skjåk	17/08-22	Written report sent out to all participants Written report
Living lab Skjåk Discussing the old water ways in Skjåk in addition to other NBS solutions.		Written report sent out to all participants Written report includes assessment from the participants
Final conclusions about the LL process	21/02-23	

Demonstrator Site Serchio River Basin

LL description	Date	Assessment
Focus on the willingness of the stakeholders to implement interventions as natural as possible also for the naturalistic value of the area emerged;	12/02-19 (kick-off)	No (questionnaire not yet available)
Characteristics of the NBS have been developed with the stakeholders and technical experts and at Lake Massaciuccoli, a mapping activity was conducted together with stakeholders;	20/02-19 (PHUSICOS and participatory process)	No (questionnaire not yet available)
Technical meeting on analysis of the NBS measures identified southeast of Lake Massaciuccoli;	1/10-19 (mapping)	Yes
Technical meeting on the monitoring system in the NBS areas;	23/05-19	
Technical table: The monitoring system in the NBS areas. Different monitoring tools were evaluated;	31/07-20 20/10-20 (monitoring)	Online survey
Online: Technical aspects analysis of the monitoring system in the NBS works area;	27/01-21	
Online: Dissemination of good agricultural practices for adaptation and mitigation to climate change and sustainable management of natural resources;	18/03-21	Yes

Online: Update on the Phusicos project, explanation of the works carried out and monitoring planning;	26/04-21	Yes
Online: Illustration of the implemented monitoring system, experts will show the technical aspects and what we expect for the monitoring phase;	27/04-21	
Online: about benefits and opportunities linked to the blue and green solutions for the environment;	29/04-21	Yes
Online: The role of NBS in European development strategies and details about Phusicos project and the Serchio Demonstration Case;	22-23/06-21	Yes
Field visit (university students) to show the NBS technical details and works;	25/06-21	
Field visit with local politicians to show NBS works and to promote the role of NBS in agricultural areas;	30/07-21	
Online: Update on the Phusicos project, illustration of the new NBS in progress and first results of the monitoring;	28/03-22	
Green transformation, innovation and territorial synergy;	14/06-22	Yes
Field visit with university students and stakeholders;	14/07-22	
Description of the remote sensing data acquired through the UAV platform for the Serchio demonstration case;	24/11-22	Yes
Discussion about hydrogeological risk prevention and discussion on the Serchio Demonstration Case - Phusicos project;	30/11-22	Yes
Field visit to show the sedimentation basin works	27/03-23	

Demonstrator Sites Pyrenees:

Site 1 – Capet (Municipalities of Barèges and Sers, France)

LL Description	**Date of larger LL meeting**	**Assessment**
Field visit and meeting to introduce NBS and the planned sites for PHUSICOS in the Pyrenees	11/09/2020	Photos Participants' list Presentation
Technical meeting on progress across the demonstrator sites in The Pyrenees	17/11/2021	Agenda Presentations
Technical brainstorming on potential monitoring activities at Pyrenees demonstrator case (part of Consortium meeting extended to technical experts in the different Pyrenees sites)	25/01/2022	Meeting minute Presentations
Coordination meeting with involved stakeholders to present the diagnostic carried out by ONF-RTM and investment plan for Barèges and Sers protection; mention to PHUSICOS contribution to this plan:	21/03/2022	Photos Participants' list Presentation

LL Description	Date of larger LL meeting	Assessment
Technical assistance (ONF – RTM x 4), Municipal team (Mayor and Municipal Councilor x 2), Departmental Government (Departmental Sub-Prefect and Assistant x 2), Regional Development section (DDT x 1), Working Community of the Pyrenees – CTP – OPCC (x1)		Meeting minute Tick-box survey - NBS perception
Meeting with demonstration and explanation about field site of Capet to students involved in SPRING SCHOOL, in Lourdes, with Laurent Lespine (ONF – RTM)	07-11/04/2022	Photos Presentations Web new on PHUSICOS website
Meeting aimed to capture comments and suggestions on PHUSICOS platform on NBS, developed by BRGM (FR)	13/04/2022	Meeting minute
Public information meeting (Living Lab) organized together with the Municipality and RTM – ONF – Presence of the population and 3 Municipal authorities	27/09/2022	Photos Participants' list Presentation
IN-DEPTH INTERVIEW (mid round) – Mayor of Barèges	27/09/2022	In-depth interview report (almost complete)
Monitoring visit from NGI in the Pyrenees (Anders Solheim and Hervé Vicari) Field visit and meeting with the Mayors of Barèges and Sers, NGI Technical Experts, Technical Expert for Capet, invited expert from INRAE, Video reporter	10-14/10/2022	Photos Web new on PHUSICOS website
Progress and last steps in the Pyrenees' sites Technical coordination meeting with the PHUSICOS partners in the Pyrenees, Technical experts for each site and the Participatory Expert for Erill, Santa Elena and Artouste	10/02/2023	Agenda Presentations
Training event and Seminar of results of PHUSICOS in the Pyrenees	11 & 12/04/2023	Photos Participants' lists Content presentations Satisfaction survey

Site 2 – Santa Elena (Municipality of Biescas, Aragón, Spain)

LL Description	Date of larger LL meeting	Assessment
Field visit and meeting to introduce NBS and the planned sites for PHUSICOS in the Pyrenees	11/09/2020	Photos, Participants' list Presentation
In-depth interviews (5) from people concerned by interventions in Artouste, Santa Elena	Sept. 2020	In-depth interviews (transcribed and translated)
ARTOUSTE and SANTA ELENA – Formal introduction to NBS to local actors	15/04/2021	Participants' list Presentations Videos
Living Lab (virtual) on the project design	15/10/2021	Questionnaire on LL satisfaction Presentation

LL Description	Date of larger LL meeting	Assessment
Technical meeting on progress across the demonstrator sites in The Pyrenees	17/11/2021	Agenda Presentations
Technical brainstorming on potential monitoring activities at Pyrenees demonstrator case (part of Consortium meeting extended to technical experts in the different Pyrenees sites)	25/01/2022	Meeting minute Presentations
Meeting and field visit with students from SPRING SCHOOL in Laruns and Santa Elena, with Santiago Fábregas Reigosa (EGCT Pirineos – Pyrénées)	07-11/04/2022	Photos Presentations Web new on PHUSICOS website
Meeting aimed to capture comments and suggestions on PHUSICOS platform on NBS, developed by BRGM (ES)	21/04/2022	Meeting minute
Field visit with master students from Polytechnical University of Madrid	22/04/2022	Photos
Field visit with students in vocational training on forestry nursery and landscape gardening in Canfranc	27/07/2022	Web article Photos
In-depth protocol interviews	Sept. 2022	Interview report
Monitoring visit from NGI in the Pyrenees (Anders Solheim and Hervé Vicari) Field visit to Santa Elena with NGI Technical Experts, Technical Expert for Santa Elena Progress and last steps in the Pyrenees' sites	10-14/10/2022	Photos Web new on PHUSICOS website
Technical coordination meeting with the PHUSICOS partners in the Pyrenees, Technical experts for each site and the Participatory Expert for Erill, Santa Elena and Artouste	10/02/2023	Agenda Presentations
Field visit and open-air meeting to see the progress of the works in Santa Elena together with the Mayor of Biescas, the Mayor of Laruns (Artouste site) and their Municipal team, Technical staff from local and departmental governments, PHUSICOS partners, Work company representatives involved in the works, Polytechnical University of Madrid, Technical and Participatory expert of the site, authorities and technicians from neighbouring municipalities	21/03/2023	Agenda Photos Participants' lists Report
Field visit with Regional, Province and Municipal Authorities (Regional Director for Road management and maintenance of Aragon Government)	27/03/2023	Photos
Training event and Seminar of results of PHUSICOS in the Pyrenees	11 & 12/04/2023	Photos Participants' lists Content presentations Satisfaction survey

Site 3 – Artouste (Municipality of Laruns, France)

LL Description	Date	Assessment
Field visit and meeting to introduce NBS and the planned sites for PHUSICOS in the Pyrenees	11/09/2020	Photos Participants' list Presentation
In-depth interviews (5) from people concerned by interventions in Artouste, Santa Elena	Sept. 2020	In-depth interviews (transcribed and translated)

LL Description	Date	Assessment
ARTOUSTE and SANTA ELENA – Formal introduction to NBS to local actors	15/04/2021	Participants' list Presentations Videos
Coordination meeting for defining the project with the Technical expert, Municipal team, Pyrenees National Park, ONF and Departmental technical services	09/09/2021	Participants' list Meeting minute Photos
Technical meeting around Artouste site to gather thoughts on modelling exercises	15/10/2021	Meeting minute
Technical meeting on progress across the demonstrator sites in The Pyrenees	17/11/2021	Agenda Presentations
Coordination meeting to present the progress of the studies for the work in Artouste, the plan for the experimental lab and define joint calendar	19/11/2021	Questionnaire on NBS perception applied (9)
Technical brainstorming on potential monitoring activities at Pyrenees demonstrator case (part of Consortium meeting extended to technical experts in the different Pyrenees sites)	25/01/2022	Meeting minute Presentations
Meeting with Municipality authorities and field visit with students from SPRING SCHOOL in Laruns and Santa Elena, with Santiago Fábregas Reigosa (EGCT Pirineos – Pyrénées)	07-11/04/2022	Photos Presentations Web new on PHUSICOS website
Meeting aimed to capture comments and suggestions on PHUSICOS platform on NBS, developed by BRGM (FR)	13/04/2022	Meeting minute
Meeting with Pyrenees National Park. Start of negotiation on Artouste case with Pyrenees National Park managing staff, Managing staff of CTP technical expert and Éric Leroi	23/05/2022	Meeting minute
Meeting with all stakeholders around Artouste, 7 stakeholders involved in this meeting after many bilateral efforts	29/06/2022	Agenda Participants' list Meeting minute Photos
COORDINATION EXCHANGES for Collaboration protocol elaboration. Emails and call exchanges to agree on protocol content and responsibilities	June to September 2022	Collaboration protocol signed by 7 stakeholders
COORDINATION MEETING / TECHNICAL COMMITTEE 1st meeting. Presentation of work calendar for Artouste site and Lab site and work companies	21/09/2022	Agenda Participants' list Presentation Photos
In-depth interviews	Sept. 2022	In-depth interview report
Field visit to Artouste together with member of Scientific council of Pyrenean National Park and Local authority	07/10/2022	-
Monitoring visit from NGI in the Pyrenees (Anders Solheim and Hervé Vicari) Field visit to Artouste and meeting with Mayor of Laruns and Municipal Team, NGI Technical Experts, Technical Expert for Artouste Progress and last steps in the Pyrenees' sites	10-14/10/2022	Photos Web new on PHUSICOS website
Technical coordination meeting with the PHUSICOS partners in the Pyrenees, Technical experts for each site and the Participatory Expert for Erill, Santa Elena and Artouste	10/02/2023	Agenda Presentations
Technical Committee meeting (according to collaboration protocol signed for authorizing the works)	20/02/2023	Agenda, Photos Meeting minute Participants' lists Presentations
Field visit and open-air meeting to see the progress of the works in Artouste and experimental site in La Peña, together with the Mayor of	21/03/2023	Agenda Photos

LL Description	Date	Assessment
Laruns and his Municipal team, Technical staff from local and departmental governments, Pyrenees National Park representatives, PHUSICOS partners, Work company representatives involved in the works, Polytechnical University of Madrid, Technical and Participatory expert of the site, authorities and technicians from neighbouring municipalities		Participants' lists Report
Field visit to Artouste together with member of Technical Committee members (according to collaboration protocol signed for authorizing the works)	03/04/2023	Photos
Training event and Seminar of results of PHUSICOS in the Pyrenees Visit of Artouste site as part of the Seminar	11 & 12/04/2023	Photos Participants' lists Content presentations Satisfaction survey

Site 4 – Erill la Vall (Municipality of Vall de Boí, Catalonia, Spain)

Type of Living Lab Activity	Date	Assessment
Introduction to NBS and PHUSICOS project, visit to the site together with the Municipality team, regional and local actors	21/07/2021	Participants' list Meeting minute Photos
Coordination meeting between involved stakeholders: Technical assistance, Municipal team, Regional Government of Catalunya (OCCC)	08/09/2021	Participants' list Meeting minute Photos
Living Lab (FtF) session with neighbors from the valley	10/09/2021	Questionnaire on NBS perception applied
Coordination meeting between involved stakeholders: Technical assistance, Municipal team, Regional Government of Catalunya (OCCC)	28/10/2021	Meeting minute
Technical meeting on progress across the demonstrator sites in The Pyrenees	17/11/2021	Agenda Presentations
Coordination meeting between involved stakeholders: Technical assistance, Municipal team, Regional Government of Catalunya (OCCC)	25/11/2021	Meeting minute
Coordination meeting between involved stakeholders: Technical assistance, Municipal team, Regional Government of Catalunya (OCCC)	17/12/2021	Meeting minute
Living Lab with citizens to explain the context and contrast the proposed solution before its implementation	17/12/2021	Participants' list Meeting minute Photos
Technical brainstorming on potential monitoring activities at Pyrenees demonstrator case (part of Consortium meeting extended to technical experts in the different Pyrenees sites)	25/01/2022	Meeting minute Presentations
Coordination meeting between involved stakeholders: Technical assistance, Municipal team, Regional Government of Catalunya (OCCC)	04/03/2021	Meeting minute
Meeting with Municipality authorities and field visit with students from SPRING SCHOOL in Vall de Boi, with Carles Raimat (Kuroba4)	07-11/04/2022	Photos Presentations Web new on PHUSICOS website
Meeting aimed to capture comments and suggestions on PHUSICOS platform on NBS, developed by BRGM (ES)	21/04/2022	Meeting minute
Field visit and public informative session to civil society with authorities	28/07/2022	Poster Photos
In-depth interviews	Sept. 2022	In-depth interview report

Type of Living Lab Activity	Date	Assessment
Monitoring visit from NGI in the Pyrenees (Anders Solheim and Hervé Vicari) Field visit to Erill with NGI Technical Experts, Technical Expert for Erill and Mayor of Vall de Boí	10-14/10/2022	Photos Web new on PHUSICOS website
Field visit and public informative session to civil society with authorities	22/10/2022	Poster Photos
Progress and last steps in the Pyrenees' sites Technical coordination meeting with the PHUSICOS partners in the Pyrenees, Technical experts for each site and the Participatory Expert for Erill, Santa Elena and Artouste	10/02/2023	Agenda Presentations
Coordination meeting between involved stakeholders: Technical assistance, Municipal team, Regional Government of Catalunya (OCCC)	23/03/2023	Meeting minute
Training event and Seminar of results of PHUSICOS in the Pyrenees	11 & 12/04/2023	Photos Participants' lists Content presentations Satisfaction survey
Living Lab with citizens and authorities to see and comment the final progress on the works	22/04/2023	Participants' list Photos

Appendix D

Questions for Site Owners and Facilitators

First Round at the Beginning of the Living Lab Processes

List for Questions for the WP3 Baseline Assessment

Question for Site Owners and Facilitators

Please fill the questionnaire in considering your perception namely your point of view.

Case Study Site:

Q.1 Perceived learning about Nature Based Solutions:

Q.1.1 What is your experience so far with stakeholders and their knowledge on Nature-Based solutions? What was the starting point when stakeholders met with PHUSICOS? Depending on your state of Living Labs – where does knowledge increase and what were the most interesting step stakeholders took since the very beginning?

Q.1.2 How do you try to address and provide opportunities for stakeholders to learn about Nature-Based solutions? Which points or aspects of NBS and/or Living Lab processes are most interesting for stakeholders (Please also consider your "small" exchange formats that are "below the radar" that cannot be captured with the questionnaires provided by the Monitoring and Evaluation scheme)

Q.1.3 From your point of view, how have/can PHUSICOS support stakeholders, their interests and learning process about NBSs (both concept so as measures)?

Q.2 Benefits of, concerns/preoccupations about and barriers for implementing Nature Based solutions

Q.2.1 In your opinion, which are the main benefits of NBS for the stakeholders?

Q.2.2 Which concerns about implementing alternative solutions to grey solutions do you observed? Do you think that this concern(s) can be easily addressed within the Living Labs?

Q.2.3 Which barriers in the planning/implementation/monitoring process have been identified by the stakeholder as barriers? Did these barriers congestioned or delay the process? Could they be solved or adressed in the Living Lab processes?

Q.3 Living Labs

Q.3.1a What are your impressions about the benefits of Living Labs so far?

Q.3.1b Which concerns do you have about the Living Lab approach?

Q.3.1c Which might be the barriers for working with Living Lab approaches to co-design/implement/monitor NBS?

Do these barrier are related to the Living Lab process, to the solution targeted or related to other reasons?

Q.3.1d Which meeting formats have been implemented before the COVID-19 pandemic and which ones were the most fruitful ones? (Site visits, small group meeting, large group meeting, face-to-face meeting, phone call, phone conference, informal meetings?

Q.3.1e Which meeting formats do you try to implement during COVID-19 pandemic? Which were a success and which not? Why?

Q.3.1f Do you have recommendations on how to document Living Lab activities (even small meetings, 1:1 exchanges, and site visits) so they could serve for the M&E reporting tasks?

Q.3.2 What would you like to see as outcomes of the PHUSICOS Living Labs from a Facilitator Perspective?

Q.3.3 What would be your lessons learned so far on Living Labs so far? Any recommendations already for Living Labs?

Q.3.4 Is there anything else you would like to share with us or is there something important for you that we have not asked about?

Thank you very much for taking your time!

Appendix E

Tick Box Survey outcomes from Living Lab Participants

Evaluation of Living Lab session performance

(mainly linked to assessment of 4 events)

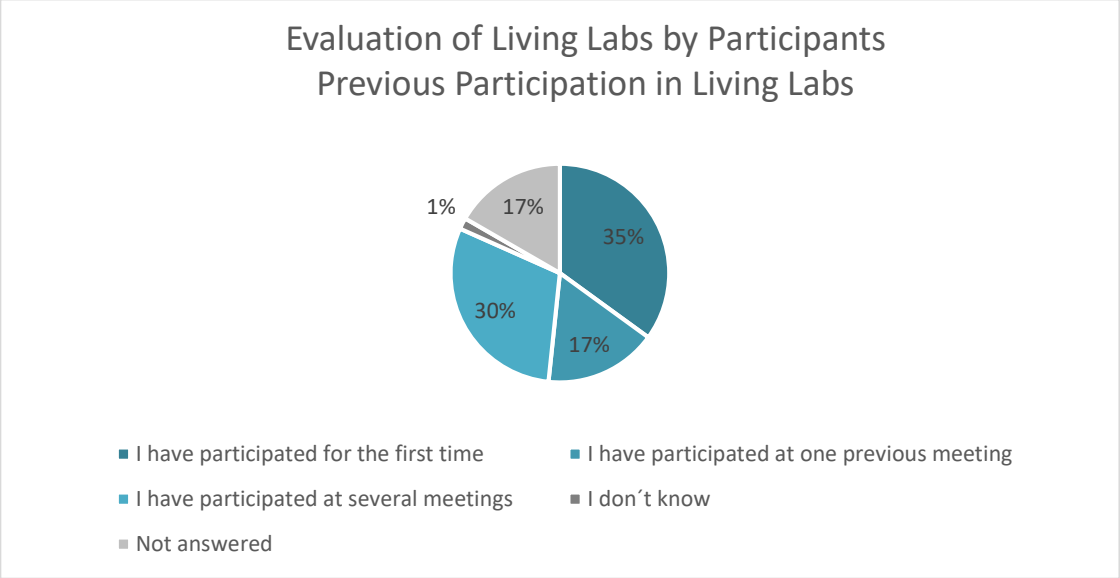

Figure 1: Living Lab participation (mainly responses from early stages of PHUSICOS, n=88)

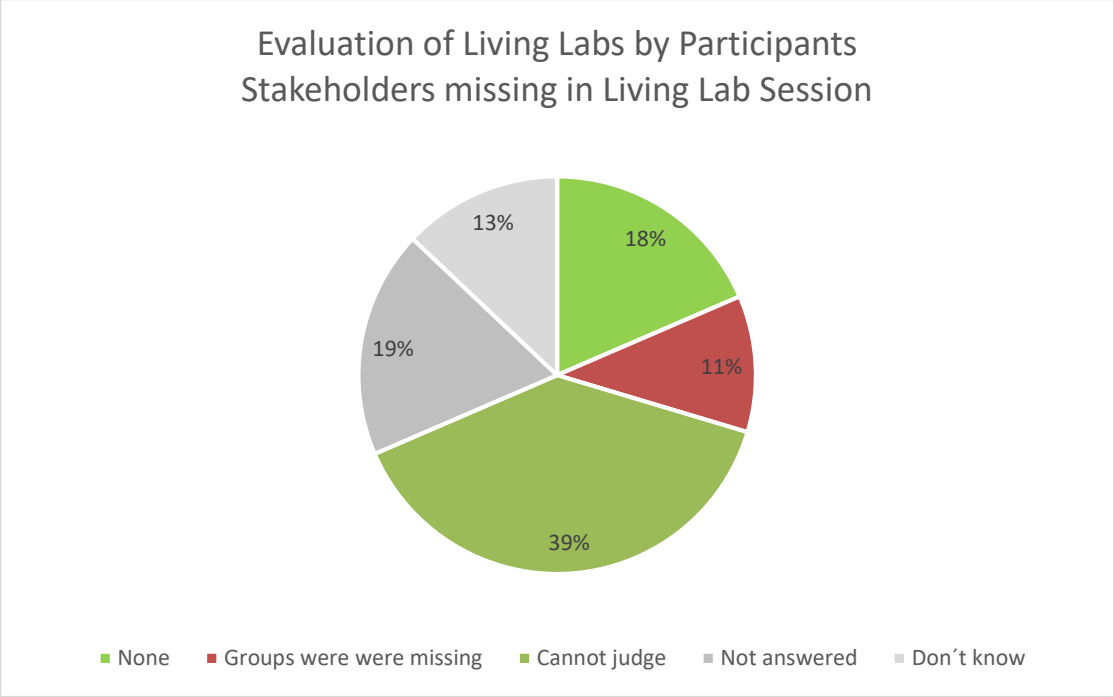

Figure 2: Missing Stakeholders (mainly responses from early stages of PHUSICOS, n=88)

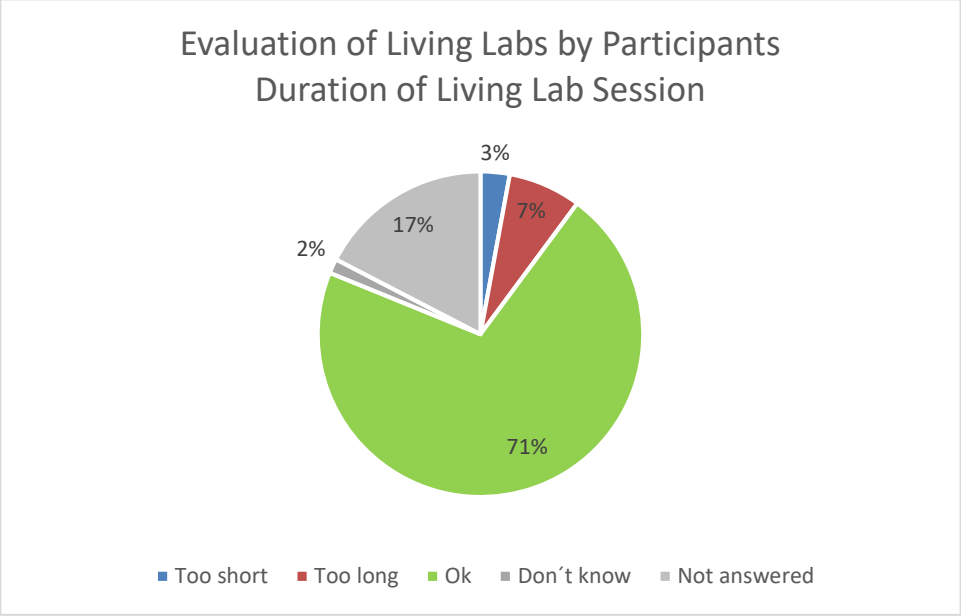

Figure 3: Facilitation of Living Lab - Organization (mainly responses from early stages of PHUSICOS, n=88)

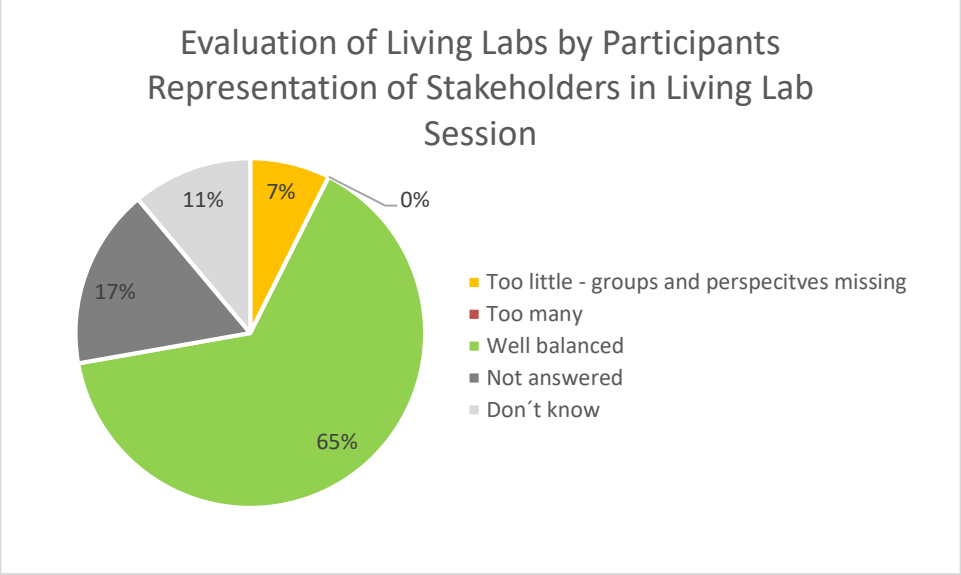

Figure 4: Perceived stakeholder representation in Living Lab (mainly responses from early stages of PHUSICOS, n=88)

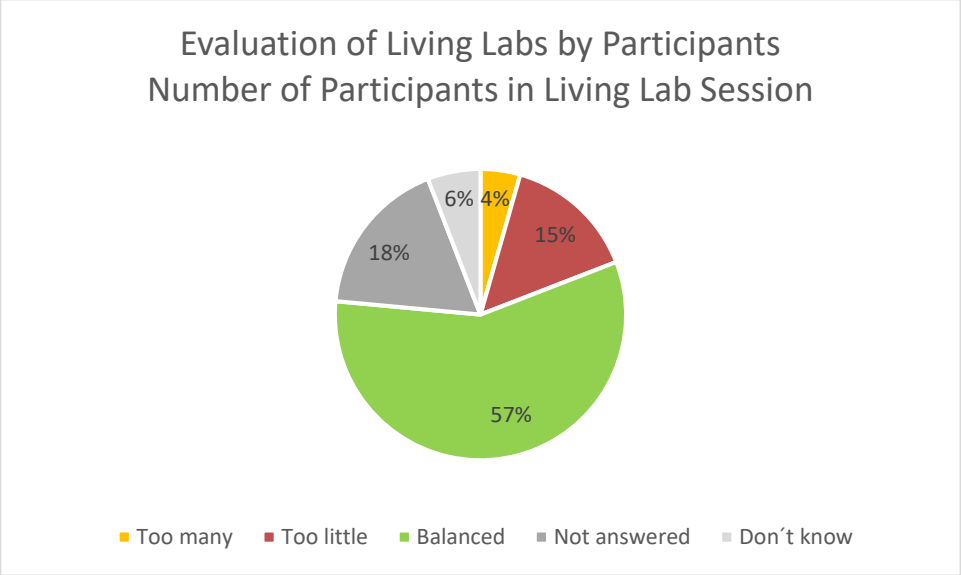

Figure 5: Perceived Number of Participants in the Living Lab Session (mainly responses from early stages of PHUSICOS, n=88)

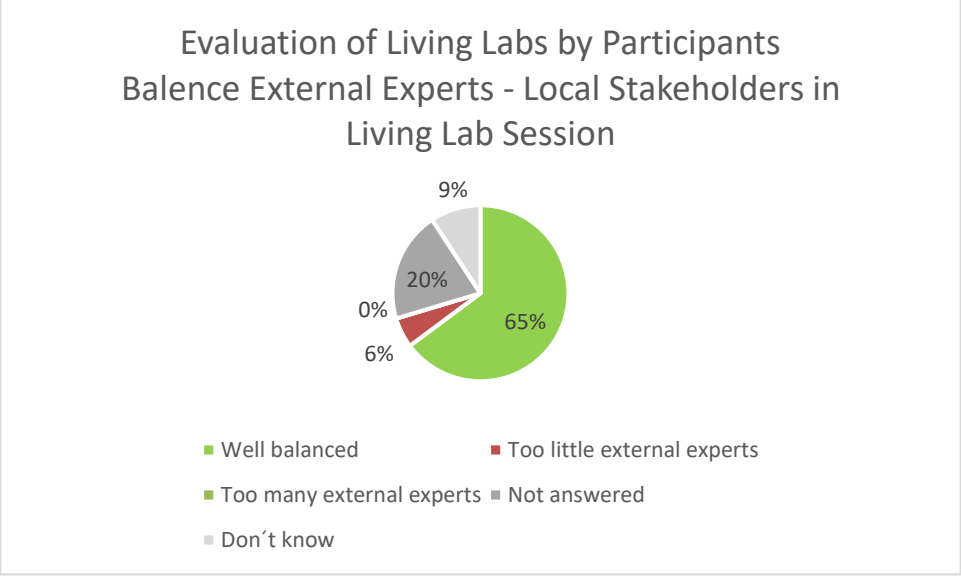

Figure 6: Perceived Balance between external experts and local stakeholders in the Living Lab Session (mainly responses from early stages of PHUSICOS, n=88)

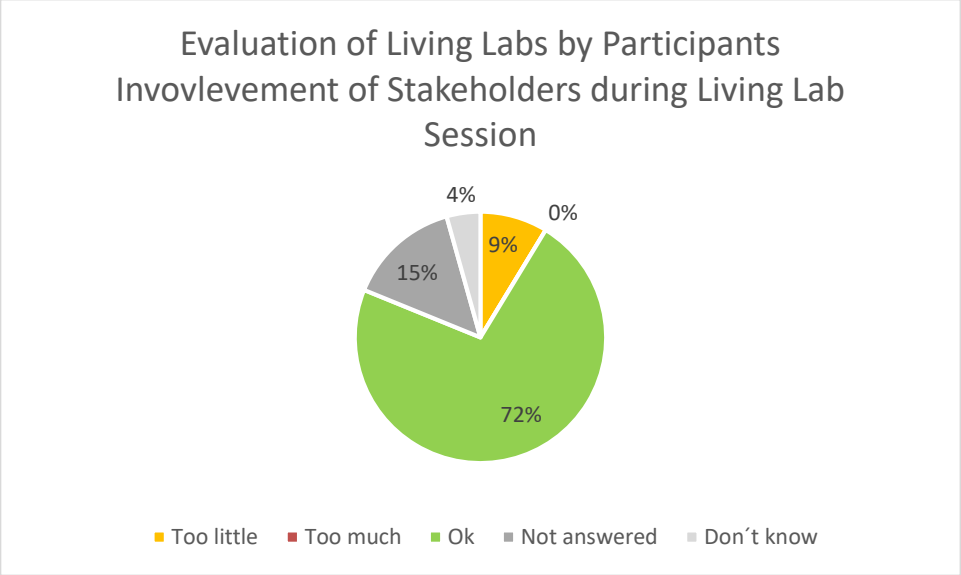

Figure 7: Involvement of Stakeholders in the Living Lab Session (mainly responses from early stages of PHUSICOS, n=88)

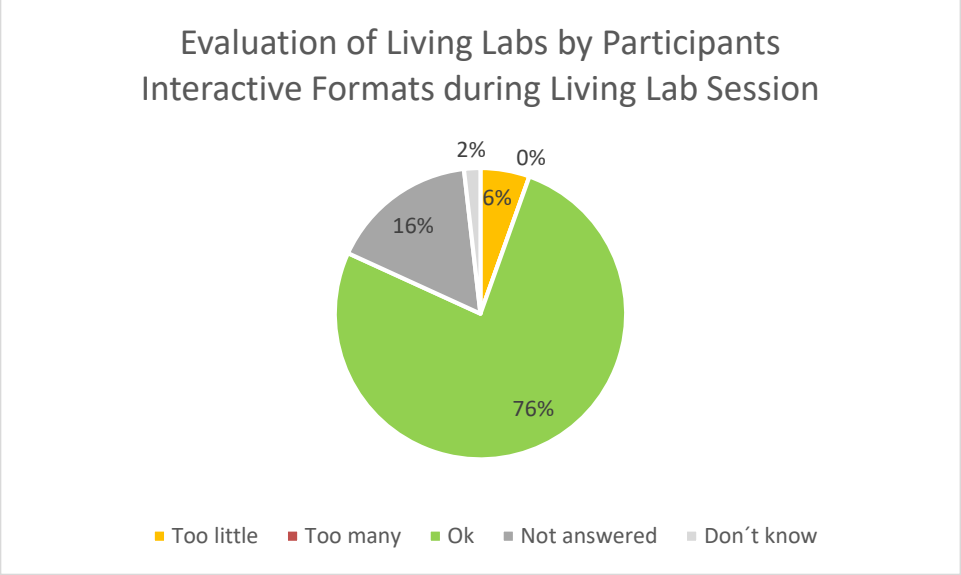

Figure 8: Interactive formats provided in the Living Lab Session (mainly responses from early stages of PHUSICOS, n=88)

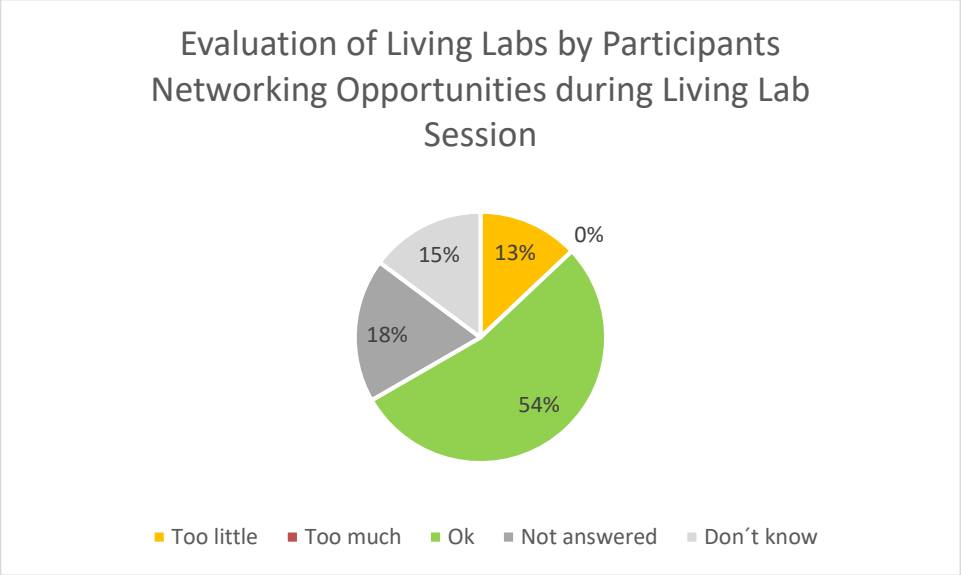

Figure 9: Provided networking opportunities in the Living Lab Session (mainly responses from early stages of PHUSICOS, n=88)

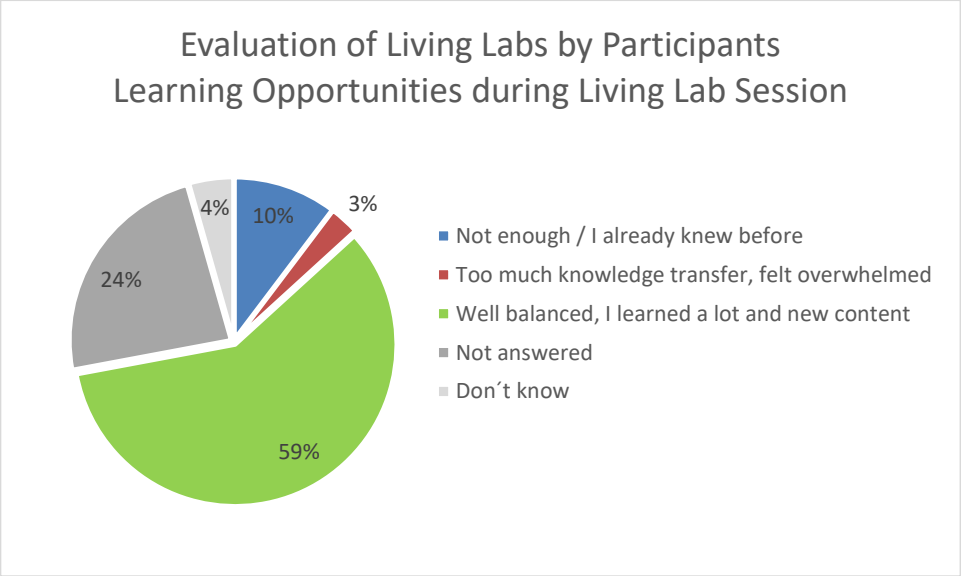

Figure 10: Provided Learning Opportunities in the Living Lab Session (mainly responses from early stages of PHUSICOS, n=88)

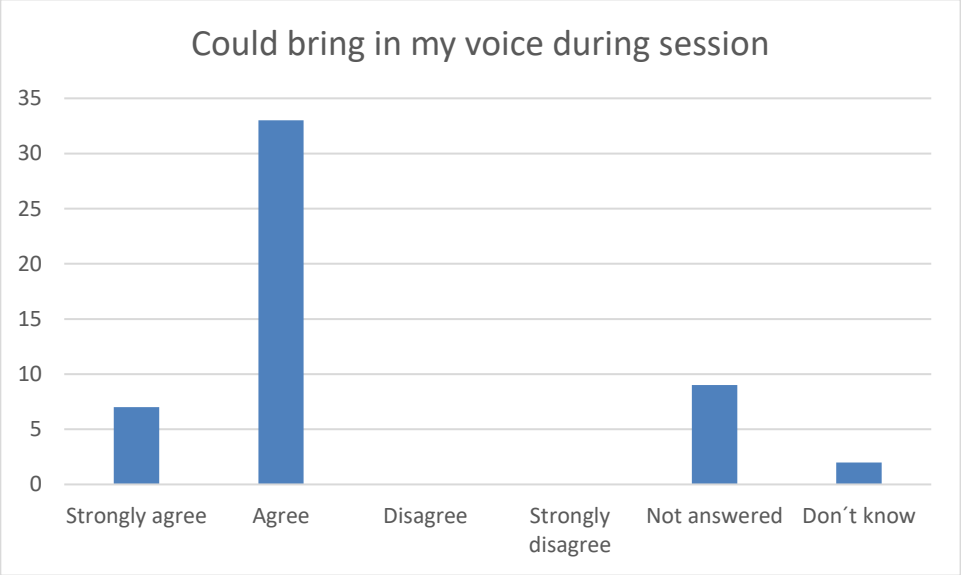

Figure 11: Perceived opportunities to engage during the Living Lab Session (mainly responses from early stages of PHUSICOS, n=88)

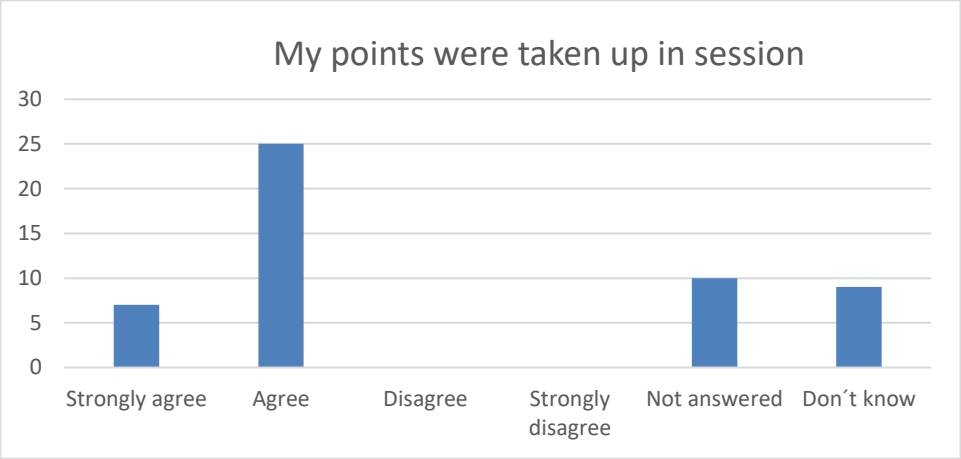

Figure 12: Perceived uptake of own points during the Living Lab Session (mainly responses from early stages of PHUSICOS, n=88)

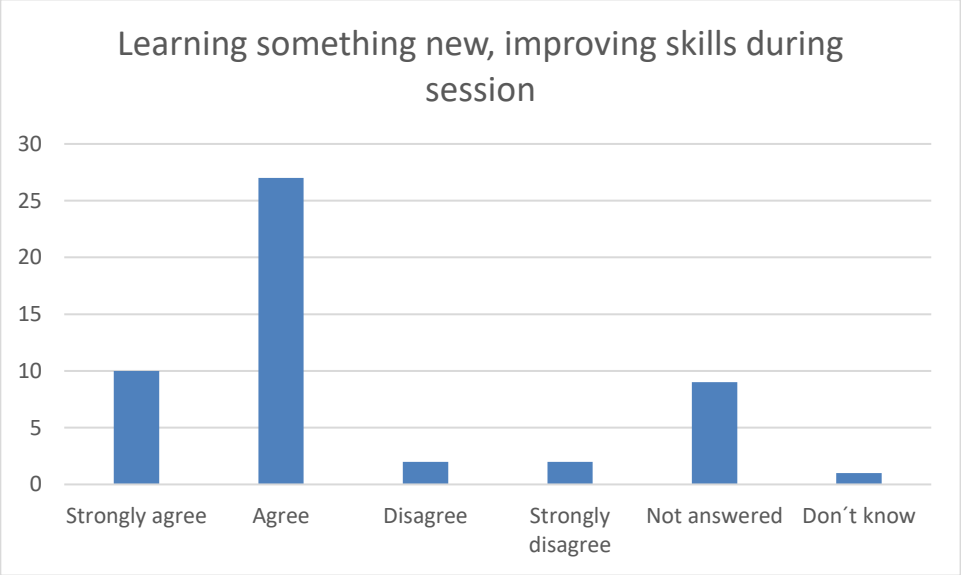

Figure 13 Perceived new learning and improving skills during the Living Lab Session (mainly responses from early stages of PHUSICOS, n=88)

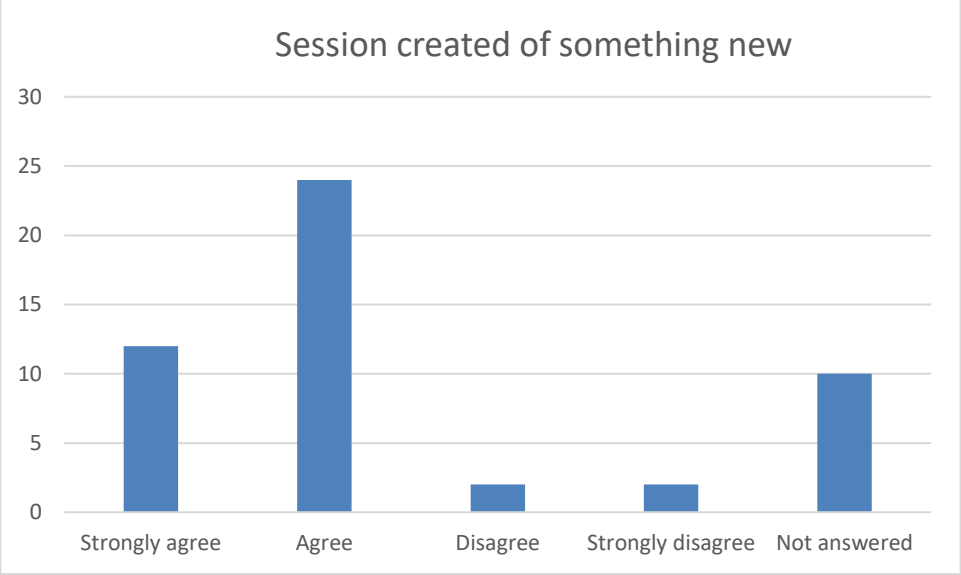

Figure 14: Perceived innovation ("Creating something new") during the Living Lab Session (mainly responses from early stages of PHUSICOS, n=88)

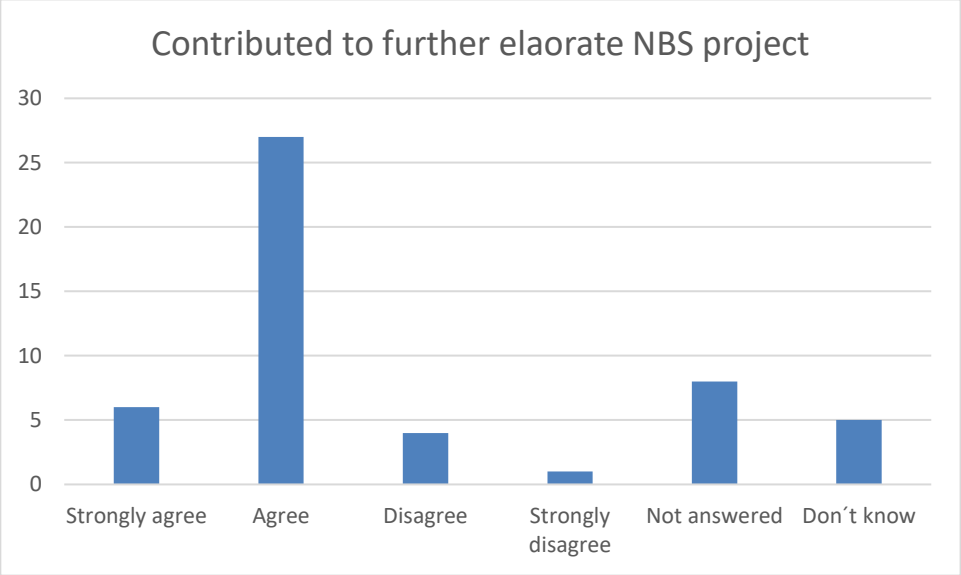

Figure 15: Perceived progress during the Living Lab Session towards co-creation of NBS (mainly responses from early stages of PHUSICOS, n=88)

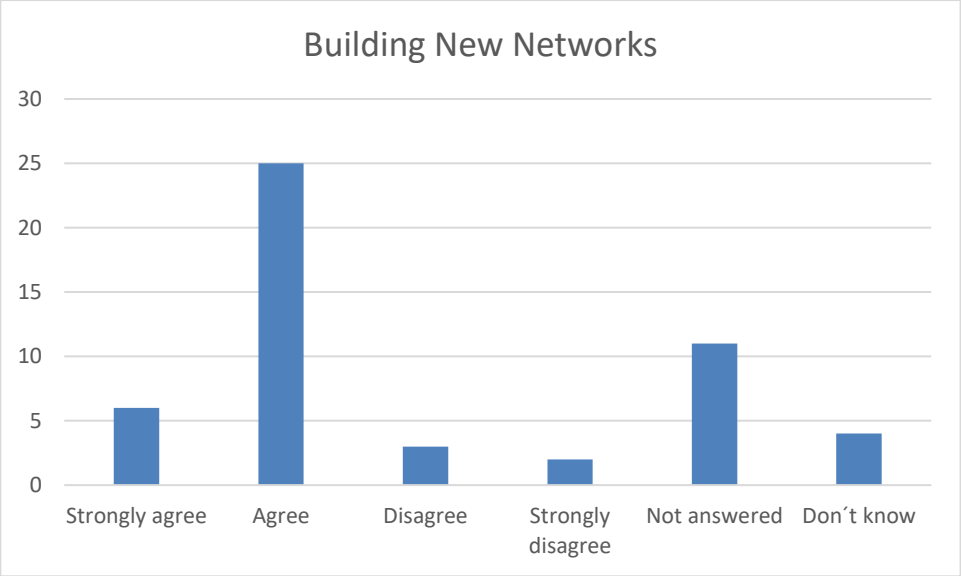

Figure 16: Perceived network building the Living Lab Session (mainly responses from early stages of PHUSICOS, n=88)

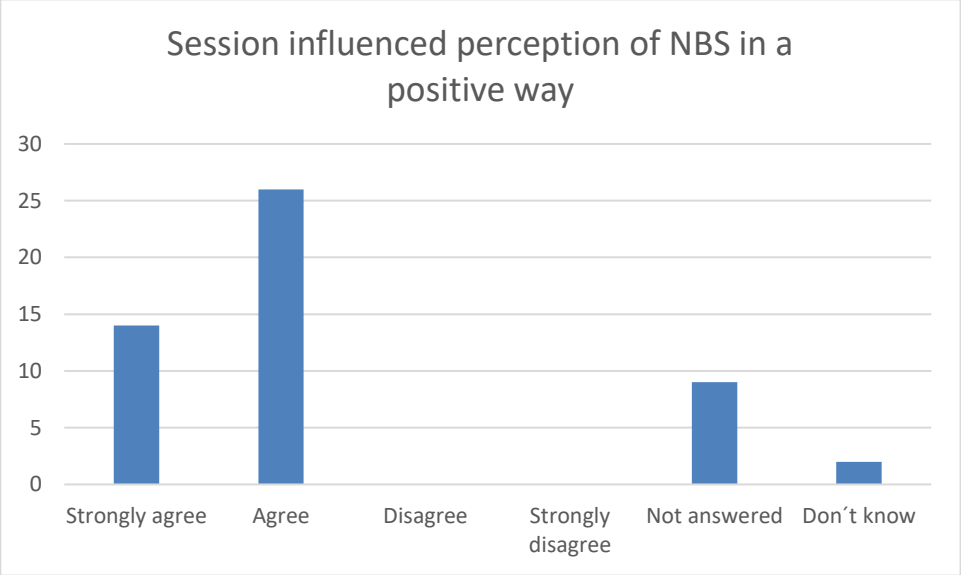

Figure 17: Perceived uptake of NBS idea during the Living Lab Session (mainly responses from early stages of PHUSICOS,n =88)

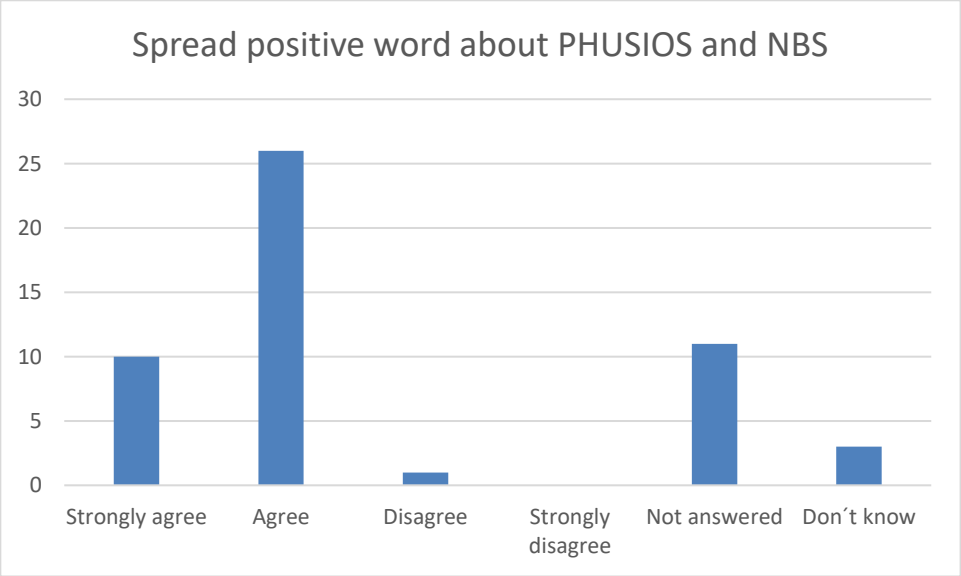

Figure 18: Expressed willingness to disseminate and advocate for NBS (mainly responses from early stages of PHUSICOS, n=88)