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PHUSICOS

According to nature

Deliverable D3.2

Starter Toolbox for Stakeholder Knowledge Mapping to Co-Design Nature-Based Solutions at Case Study Sites

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

Deliverable Work Package Leader:
TUM

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Note about contributors

Lead partner responsible for the deliverable:	TUM
Deliverable prepared by:	Sandra Fohlmeister, Isabel Augenstein, Chelsea Jones, Dayana Ramirez and Gerd Lupp (TUM)
Partner responsible for quality control:	IIASA, NGI
Deliverable reviewed by:	Wei Liu (IIASA)
Other contributors:	JoAnne Bayer and Wei Liu (IIASA) Klaus Pukall (TUM)

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Summary

The overall purpose of this Deliverable D3.2 is to offer a Starter Toolbox for Stakeholder Knowledge Mapping to Co-Design Nature-Based Solutions (NBSs) to the Living Labs at the demonstrator and concept case study sites of PHUSICOS. It intends to support the preparation, co-design, implementation and evaluation of nature-based solutions (NBSs) to reduce hydro-meteorological risks in sensitive European rural and mountainous regions and potentially in some other contexts as well.

With this report, Work Package 3 (WP3) provides a follow-up product to its Guiding Framework for Tailored Living Lab Establishment at Demonstrator and Concept Case Study Sites (D3.1), which comprised the theoretical background and common project terminology for the future Living Lab processes, and gave some principle orientation on key steps of the Living Lab set-up. In its function to be the stepping stone between the preparation and operationalization stages of the Living Labs of PHUSICOS, the present Toolbox builds the bridge towards the practical work of the case site teams with their local stakeholder processes.

More specifically, this Toolbox is meant to accompany the local facilitators of the PHUSICOS case sites in their important task to capture and leverage their local stakeholders' diverse - and possibly also divergent - knowledge in pursuit of co-creating the NBSs of interest throughout their innovation development cycle.

Carrying the title *Starter Toolbox*, it can be interpreted by its users as…

i) …**supporting kit** for the Living Lab set-up stage by containing methods and tools being suited for stakeholder identification and analysis, as well as for the exploration of problems and worldviews on NBSs – all being relevant steps prior to the further co-design work on NBSs;

ii) …a **means of kick-starting** the Living Lab stakeholders' dialogue and to turn it into a worthwhile experience to take part in throughout the further working process. Tools to foster dialogue, prioritize and select NBSs, to co-design and evaluate them shall especially contribute to this purpose; and

iii) …a **living document**. In its fully updated and revised version D3.2 offers a tool selection which has been compiled with the intention to cover a diverse range of needs on the one hand; and to likewise address the case sites' specific demands in a tailored manner on the other hand. Nevertheless, the users of this Toolbox are invited to consider it a *living document*, and to add further tools which deem of importance and may enrich the local Living Lab process work of the PHUSICOS case sites.

This report is part of a series to be developed by WP3 pursuing to support the case sites' stakeholder processes. It will be followed-up by further deliverables guiding the local facilitators in the necessary monitoring and evaluation procedures (D.3.3-3.6 Monitoring & Evaluation scheme) to assess and steer their individual Living Lab's quality management and corresponding stakeholders' satisfaction.

Glossary

KEY CONCEPTS, ABBREVIATIONS AND DEFINITIONS

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

Co-design, co-creation or knowledge co-production can be defined as 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/CS):

Small-scale case study site which serves to test specific challenging aspects of NBSs, 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 (DC/DS):

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

LIVING LAB (LL):

A Living Lab is a physical area and interaction space, in which stakeholders form a quadruple helix innovation network of 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).

NATURE-BASED SOLUTIONS (NBSs):

Nature-based solutions are living solutions inspired by, continuously supported by and using nature. They are designed to address various environmental challenges in a resource efficient and adaptable manner and to provide simultaneously economic, social and environmental benefits (EC 2015).

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).

KEY CONCEPTS, ABBREVIATIONS AND DEFINITIONS (continued)

STAKEHOLDER ANALYSIS / STAKEHOLDER MAPPING:

Process that (1) defines aspects of a social and natural phenomenon affected by a decision or action; (2) identifies individuals, groups and organisations who are affected by or can affect those parts of the phenomenon (this may include non- human and non-living entities and future generations); and (3) prioritises these individuals and groups for involvement in a decision-making process (Reed et al. 2009 cited in Reed & Curzon 2015: 18).

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).

(STAKEHOLDER) KNOWLEDGE INVENTORY/STOCK-TAKING:

Process to identify and locate knowledge assets of a stakeholder group related to an issue of interest. This includes a collection/stock-taking of the explicit and tacit knowledge sources (based on www.PMtips.net/article/knowledge-inventory; accessed 12th March, 2019).

(STAKEHOLDER) KNOWLEDGE ELICITATION/CAPTURE:

Process employed to access a stakeholder's tacit knowledge (experience, expertise) with the goal to obtain a tangible representation of this knowledge (IGI global 2019).

To achieve this goal, a set of elicitation techniques can be applied, typically through some form of direct interaction with the stakeholder of interest (Shadbolt & Smart 2015).

(STAKEHOLDER) KNOWLEDGE MAPPING (SKM):

Stakeholder Knowledge Mapping (SKM) in the strict sense is a set of knowledge representation practices framed in a shared space that translate tacit knowledge into explicit knowledge.

In PHUSICOS, we understand SKM in a wider sense as umbrella concept for the analysis of stakeholder knowledge, including knowledge inventory and stock-taking, knowledge elicitation, knowledge representation and knowledge assessment.

(STAKEHOLDER) KNOWLEDGE REPRESENTATION / VISUALIZATION:

Process that uses the power of visual formats to represent knowledge. It aims at supporting cognitive processes in structuring, sharing, using and generating new knowledge (after Tergan et al. 2006 and Burkhard 2005).

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1 Introduction

1.1 PHUSICOS and its case sites

PHUSICOS, meaning 'According to nature', in Greek φυσικός, is a four-year Innovation Action project that started in May 2018 and is funded by the European Union's Horizon 2020 research and innovation programme (Grant agreement No. 776681). The project consortium comprises 15 organizations from 7 countries (Norway, Germany, Austria, Italy, France, Spain and Andorra) and includes end-user partners from local and regional administrative units.
The main objective of PHUSICOS is to demonstrate that nature-based or nature-inspired solutions (NBSs) for reducing risk from natural hazards induced by extreme weather events in particularly vulnerable areas, such as rural mountain landscapes, are technically viable, cost-effective and implementable at regional scale. PHUSICOS's underlying premise is that nature itself is a source of ideas and solutions for mitigating the risk caused by changing climate. As nature's designs are often effective and frugal, implementing NBSs, including hybrid green/blue/grey infrastructure, can provide ecological, social and economic resilience for society.

Multi-stakeholder participation is an overarching issue of PHUSICOS and, as such, forms a foundation to foster innovation at all levels and at all case study sites. Specifically, Work Package 3 (WP3; Service innovation – Stakeholder participation through Living Labs) is dedicated to employ a Living Lab approach as key mechanism of local stakeholder involvement for the purpose of successfully accompanying the intended NBSs' planning, selection, design, implementation and evaluation.

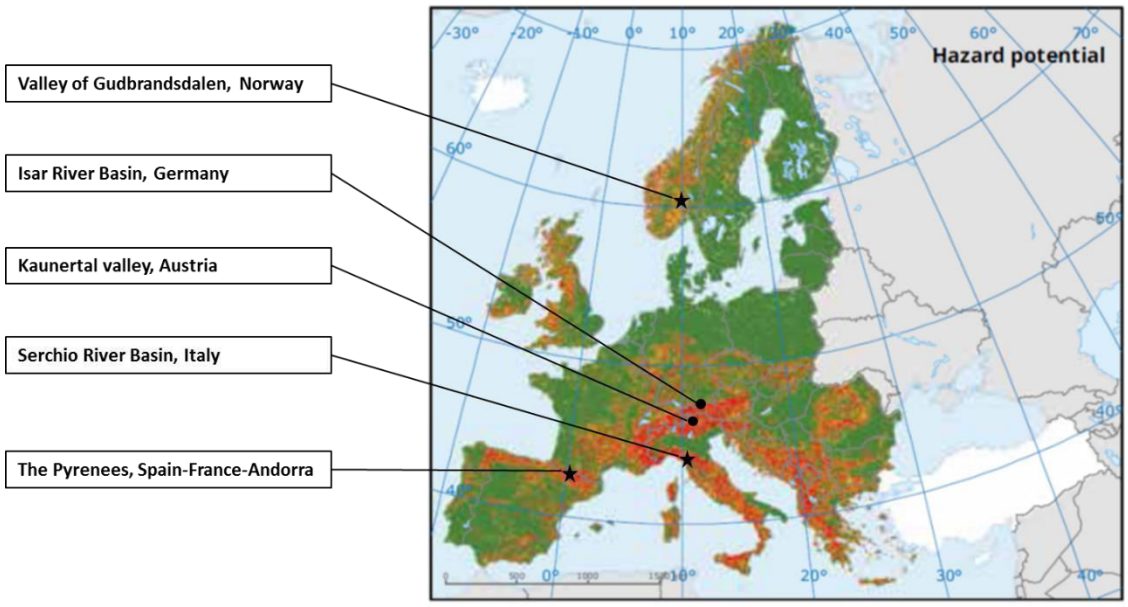

Figure 1. Location of the three large-scale demonstrator case sites (indicated with stars) and supporting concept case sites (indicated with circles) on the European map of hazard potential, with low hazard in green, medium hazard in yellow and high hazard in red (Source: https://phusicos.eu/case-studies/ accessed 23rd February, 2019).

In pursuit of this goal, this report intends to support the initiation of participatory processes, set-up and further work of Living Labs at the project's demonstrator and concept case study sites (Figure 1). It especially aims at the provision of tools to be applied by the local facilitator teams of the Living Labs to capture and leverage stakeholder knowledge for co-designing their NBSs of interest (see Chap. 1.3).

Gudbrandsdalen Valley, Norway (Demonstrator Case Site)

Located in south eastern Norway, the Gudbrandsdalen Valley is one of the longest river valleys in Norway and has experienced frequent flash flood and landslide events over the past decade. The demonstrator site consists of three separate sites within the same valley, each of which faces different disaster risk issues and containing a different relationship among stakeholders. The three sites are located in the southern, central and northern parts of the valley, each with their own unique stakeholder relationships and challenges. The northern section of the valley is the main site for establishing a Living Lab process, as it is there that it is most feasible to implement new NBSs *from scratch* fledged by a full Living Lab process with all stages.

For the southern part of the valley, a clear consensus has already been reached by a solid participatory process which has been ongoing since 2013 among stakeholders regarding the framing of the issue and the type of NBSs to be used. For this location, a levee constructed from natural materials is intended to be implemented inland from the river bank in order to better retain rising water in case of floods. Here, the main focus will be NBS co-design of the selected solution.

In the middle part of the valley, the main issue is excessive gravel sedimentation in the river, increasing flood risk and potential impact. Damage has been sustained to both agricultural land and housing due to this flooding. To date, the traditional solution to flooding has been the outtake of gravel from the riverbed. However, this solution has often proven ineffective and unsustainable. For this reason, possible NBSs are being investigated. Due to the familiarity of the local community with the gravel outtake solution, there is however scepticism to NBS implementation on behalf of some stakeholders, as they would like to continue using gravel outtake for flood prevention. Therefore, the main goal for this location will be to achieve more acceptance of the NBS concept, rather than selecting or co-designing NBSs.

In the northern part of the valley, there is high risk from flash floods, as this site is located at the head of the river at the base of steep slopes down which precipitation flows and feeds into the river. Due to recent flood events[1], the momentum seems appropriate to introduce NBS as an option of disaster risk reduction. Therefore, the current main focus is on NBS selection in the northern valley. The main body responsible for driving the Living Lab process is the Oppland County Authority, who is utilizing their Regional Master Plan to drive innovation and adoption of NBSs over traditional grey infrastructure solutions. Although each location has unique challenges, overall, the

[1] A recent event has been reported from Skjåk, October 2018.

Living Lab process will need to focus on gaining acceptance for NBS over grey infrastructure from the local community and on reaching a consensus (or the least: a compromise[2]) among stakeholders.

Serchio River Basin, Italy (Demonstrator Case Site)

The case study site within the Serchio River Basin is located at Massaciuccoli Lake, an area that suffers from multiple disaster risks, including extreme drought, flooding, seismic activity, and water pollution. Water levels are very low during the dry season of May to September and flooding often occurs in the wetter months of October and November. Additionally, there are subsidence issues due to excessive pumping of water from the basin for agriculture and industry. A diversion channel is planned for construction through funding from the Ministry for Environment, Land and Sea Protection (MATTM). Various NBSs will then be implemented along the diversion channel in order to improve the quality of the water and the local ecosystems. Among the proposed NBSs for this site are vegetation buffer strips, sediment retention basins and reforestation in key erosion prone areas.

The Basin Authority, the main body in charge of the Living Lab process at the site, wants to involve stakeholders in order to better develop planning and maintenance strategies for such ecosystem-based management of the lake. However, several constraints on the stakeholder involvement process already exist. First, the basin is located within a RAMSAR Site and a UNESCO Biosphere Reserve and therefore subject to stringent international and domestic nature conservation regulations, making it difficult to implement NBSs without gaining approval from the necessary intergovernmental bodies. Secondly, the local stakeholders most impacted by the issues within the basin are local farmers, and therefore it is very important that they will be included and heard in the stakeholder process. However, there have already been issues of time constraints due to farmers' work schedules that often do not allot them to participate in planning processes. The current intention of the facilitation team is thus to run a mostly informational inclusion campaign as part of the Living Lab through the use of newsletters, seminars and online questionnaires.

There is still a gap in knowledge on several issues, such as how farmers will respond to efforts to include them as stakeholders, what their reactions to the proposed NBSs will be and what other interested or affected parties exist that should be included in the stakeholder process.

[2] Although reaching a consensus is doubtlessly the preferential outcome of a stakeholder process, in highly contested terrain a compromise might be all what can be achieved. For further reading, see e.g. Scolobig, A., Thompson, M. & J. Linnerooth-Bayer (2016): Compromise not consensus. Designing a participatory process for landslide risk mitigation. Natural Hazards 81 (1): 45-68.

Pyrenees, France-Spain (Demonstrator Case Site)

The Pyrenees demonstrator site is unique within the PHUSICOS project as it is the only one which exists across national boundaries, spanning the border between France and Spain. The demonstrator site intends to realize NBSs at several sites: one proposed intervention site consists of a transboundary road that runs through a mountain valley between Biescas, Spain and Laruns, France. The road experiences frequent incidents of flash floods and rock falls due to the unstable, steep slopes on either side of it. In Biescas, the main challenge is a morraine hillside with unstable sediments that produces frequent rock falls. The angle of the problematic slope is currently 35-40 degrees, and steeper in the very upper part. In fact the shape of the slope is so that the lateral sides already have a lower slope angle, thus the engineered terraces will of most relevance for the central part of the slope (see the preliminary sketch below). The exact slope angle after the measure is implemented is not finally clear.

The equilibrium slope will be sought for the implantation of the vegetation, mainly in carved areas and where the most evident vertical incisions and upward erosion have taken place. Also in these areas, given their unevenness and steep slope, it is proposed to create terraces that minimise the erosive effect of surface runoff until the establishment of stable vegetation by means of staggered mixed terraces. The terraces could be done with a stone base and the rest with wooden gabions or equivalent. Therefore, in areas with steeper slopes, the aim is to reduce the profile to a staggered section, and to try to maintain a balance profile in areas with less slope of the moraine, by maintaining the existing vegetation and other possible stabilisation measures through bioengineering.

In Lauruns, there are two locations that present challenges, one being a forested hillside with falling rocks and another is a ravine that experiences flash floods. One possible NBS for the ravine location is to insert wooden blocks in the river that act as “water jumps” to slow down river flow and encourage the deposit of sediment. For the forested area, the use of wooden tripods in order to prevent movement of snow packs and protect vegetation from snow damage is proposed, thereby maintaining soil stability. However, the implementation of NBSs at both locations in Lauruns is heavily dependent on approval from the National Park of the Pyrenees in which Lauruns is located.

Two proposed NBSs will be implemented in the Bastan Valley of France. The Bastan is a right-bank tributary of Gavarnie’s Gave. It takes its source in the “Néouvielle” massif at an altitude near 3000 m and drains an area of about 110 km² until its confluence with the Gavarnie Gave. Significant flooding was observed on the Bastan in July 1897 and June 2013. They are usually the result of significant snowmelt associated with high orographic precipitation. The June 2013 flood reactivated the historic active band of Bastan, with relatively frequent floods, such as the June 2018 flood (return period close to 10 years), generating a significant material displacement that the PLVG must manage, after the flood, to restore the free flow of water in the affected areas.

The forest of Capet (191 ha) overlooks the village of Barèges, which has been devastated by avalanches several times since the 17th century. Barèges is an important tourist

village (4000 beds), gateway to the ski resort of Grand Tourmalet and the famous pass of the same name. The project consists of analysing areas equipped with civil engineering works, non-equipped areas, and areas suitable for reforestation such as NBS.

Given the location of the proposed NBSs in two different countries, two parallel Living Lab processes will need to be undertaken. On the background of this demanding multi-stakeholder set-up, reaching a consensus and promoting acceptance of the NBS concept are necessary to further drive the related stakeholder processes.

Kaunertal Valley, Austria (Concept Case Site)

The Kaunertal Valley in Austria faces increased erosion due to the rapidly receding Gepatschferner glacier and a lack of stabilizing vegetation on the exposed slopes. This displacement of sediments damages roads, settlements and water bodies in the surrounding area of the glacier. The Kaunertal site has been chosen as a concept case in order to develop an NBS concept for erosion prevention in high-elevation areas that are rapidly changing under climate change. The NBS concept aims at developing elevation-adapted seed mixtures, which are combined with by native microbes (bacterial and fungi) for slope stability measures and erosion protection. The microbes serve to promoting vegetation traits, such as length and density of the roots that best enhance slope stability. Within the framework of PHUSICOS, site specific plants and microbes are identified and selected and the newly developed plant-microbe seed mixtures are applied to selected test plots on unconsolidated proglacial sediments and high erosion patches. The seed mixture will be applied using standard techniques of hydro-seeding using spray solutions.

For this reason, one of the main stakeholders that is be included in the participatory process includes local companies that apply the hydro seeding method, as they can assist process implementation and seed mixture production. Important additional stakeholders include the local authorities and local farmers, shepherds and, as they are instrumental in gaining acceptance for the establishment of test plots and can likely contribute local knowledge regarding local species that may work best for hydro seeding.

Due to the highly technical nature and the focus on NBS development, a full co-design process regarding the NBS design is not possible with all stakeholders. A co-design process is however taking place in activities of outreach and education within the local communities. These tasks include stakeholder participation by regional authorities, natural reserve personal and a local climate change adaptation initiative. Along these paths the perception and acceptance of NBS implementation will be studied.

Isar River Basin, Germany (Concept Case Site)

The Isar River originates in the Alps and runs through heavily populated areas of southern Germany, ending at its link to the Danube River. It therefore presents an interesting opportunity for a concept case, as it runs directly through the city of Munich and hydro-morphological restoration have become an instrument of integrative flood mitigation strategy with the Isar-Plan since the year 2000. Historically, grey infrastructure such as dams were built in order to maintain hydraulic regulation and limit the risk to major population centres. However, the implementation of such grey solutions led to additional problems, such as river incision, local ecosystem damages and decrease of the recreational and cultural value. Therefore, the goal of NBS implementation at the Isar River was to work alongside the existing grey infrastructure in order to restore ecological and cultural integrity.

One of the main NBS was a morphological river restoration and consisted of a set of measures such as bank flattening to increase the retention area and habitat diversity and building honeycomb structures to enable fish migration. With the starting point of both citizens and nature conservation demanded to improve the ecological value and recreation quality at the Isar, NBSs were chosen as the most accepted solution to fulfill the multiple demands in the best way.

As the NBSs here have already been selected and implemented, the main goal of the concept case is to serve as a learning example for the remaining case sites and to engage stakeholders for the evaluation of the NBS performance, eventually leading to upscaling the undertaken measures to other affected sites.

1.2 Connection between D3.1 and D3.2

Deliverable D3.2 is a follow-up product to D3.1 Guiding Framework for Tailored Living Lab Establishment at Demonstrator and Concept Case Study Sites, which was elaborated to be the conceptual point of departure for the initialization of local participatory processes of PHUSICOS. While D3.1 provided the theoretical background and common project terminology for the future Living Lab processes, as well as case study examples with valuable insights and a practical guidance on important steps to be taken to establish the Living Labs, D3.2 is meant to be the stepping stone from Living Lab preparation towards implementation.

As Figure 2 illustrates, the core intention of D3.2 Starter Toolbox for Stakeholder Knowledge Mapping to Co-Design NBSs is hereby to support the Living Labs' co-creation processes of the NBSs of interest. Titled as *Starter* Toolbox, it however also contains tools to be still useful in the Living Labs' set-up stage, being of possible help in conducting relevant tasks such as the identification and analysis of stakeholders, the necessary problem and solution framing as well as the exploration of different worldviews and conflicting perspectives amongst stakeholder groups at the local sites.

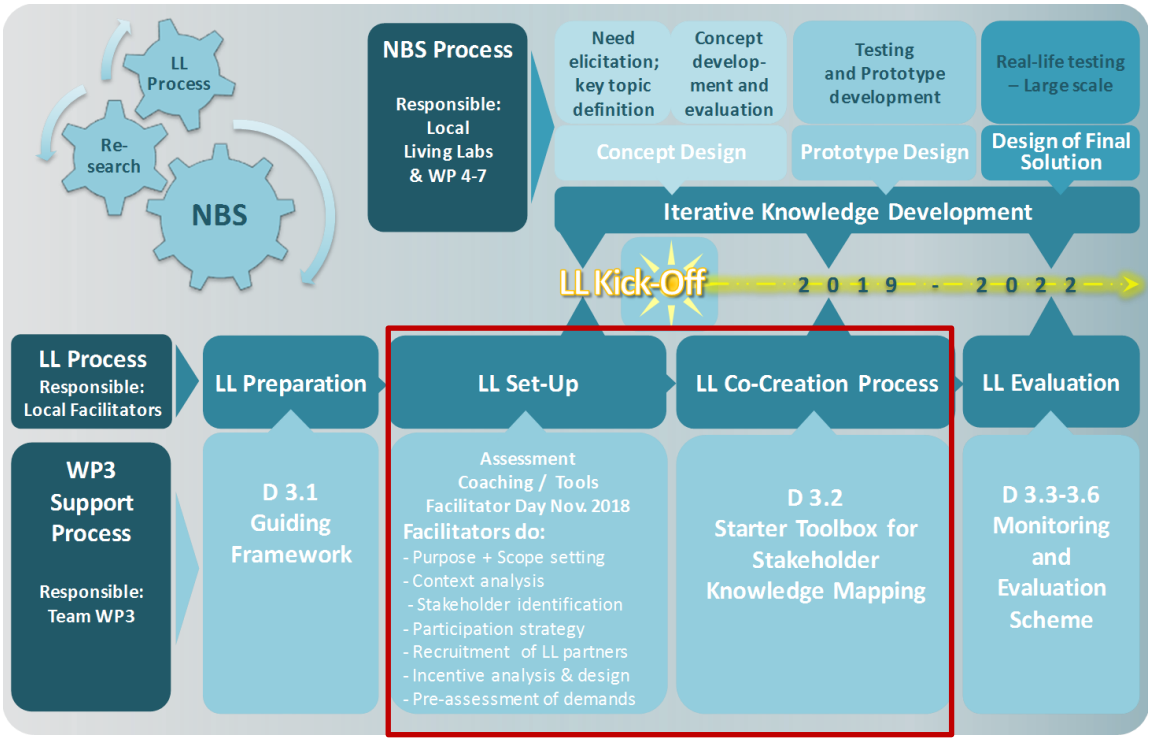

Figure 2. Overview to the PHUSICOS Living Lab process in its contextual embedding of NBS development (top), Local facilitators' tasks (middle and below) and WP3 support services (below). D3.2 Starter Toolbox for Stakeholder Knowledge Mapping to Co-Design NBSs is intended to support both the Living Lab Set-Up and the further Living Lab Co-Creation Process, here highlighted by a red framework. (Graph from: Fohlmeister et al. 2018, Design: C. Smida)

In the pursuit to serve both purposes of supporting the PHUSICOS Living Labs in their set-up and operationalization processes in an appropriate and useful manner, the present deliverable D3.2 was conceptualized in a step-wise process and iterative approach:

i) In a first step, a draft version of D3.2 was elaborated in October 2018. It presented some theoretical background considerations on the importance of a stakeholder-centred approach – more specifically of observing stakeholders' roles and appropriately analysing their knowledge – for co-designing NBSs. It furthermore explained the conceptual roots of the term *Stakeholder Knowledge Mapping* and provided a working definition of this concept as an orientation for all project partners in PHUSICOS. Furthermore, it contained a first tool selection to operationalize Stakeholder Knowledge Mapping, focussing on the Living Labs' set-up stage in preparation of their kick-off and working processes.

ii) In a second step, the draft version was further elaborated into a more extended and likewise tailored tool collection covering all phases of the NBS innovation process, ranging from Exploration to NBS Selection, over NBS Co-design to NBS Evaluation. This fully revised version of D3.2 has been especially orientated by substantial inputs from three directions: on the one hand, more in-deep research was undertaken concerning contemporary tool practice in PHUSICOS-alike contexts and with focus on Stakeholder Knowledge Mapping and NBS co-design. On the other hand, the individual tool interests and demands of the local facilitators being in charge of the related Living Lab processes were assessed during the PHUSICOS Facilitator Orientation Day and Consortium meeting in Naples, Italy (13th-15th November, 2018), bringing forward important insights concerning the usefulness and applicability of the intended tool collection, which could then be taken into consideration for the final toolbox design. Furthermore, expert consultation contributed to confirming and further fine-tuning the tool selection, and to formulating additional important hints on its operationalization.

It is hoped that this revised and updated version of D3.2 is a means of inspiration and useful companion for the PHUSICOS local case sites to efficiently kick-start and steer their local Living Lab processes towards a continued and fruitful dialogue in capturing and leveraging local stakeholders' knowledge to co-design the NBSs of interest in an iterative manner throughout the lifetime of PHUSICOS.

1.3 Purpose and outline of this deliverable

The overall purpose of this Deliverable D3.2 is to provide a Starter Toolbox for Stakeholder Knowledge Mapping (SKM) to Co-Design Nature-Based Solutions to the Living Labs at the demonstrator and concept case study sites of PHUSICOS. It intends to support the implementation of NBSs to reduce hydro-meteorological risks in sensitive European rural and mountainous regions in a collaborative approach by providing a set of carefully selected tools. These tools shall serve the local case site teams to get relevant stakeholders engaged in their local participatory processes, capture their demands, interests, and worldviews related to NBSs, and leverage the existing knowledge for the realization of the intended solutions.

The report targets to address especially four groups in their work on NBSs:

- The facilitators of the PHUSICOS Living Labs who will steer and manage the stakeholder involvement processes at the demonstrator and concept case sites;
- local scientific and end-user partners as well as other Living Lab participants of the case study sites who will select, co-design and evaluate the NBSs;
- PHUSICOS project partners, such as Work Package (WP) leaders and their collaborating teams, to achieve a coherent understanding and implementation of key concepts; and finally
- 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, and wishing to employ Living Lab approaches to find innovative ways of developing and implementing solutions inspired by nature.

The report consists of two main parts (**A&B**), comprising a total of seven chapters.

The present chapter shortly describes the background idea of this deliverable and introduces the reader to its purpose and outline. It further builds the bridge back to D3.1 Guiding Framework for Tailored Living Lab Establishment at Demonstrator and Concept Case Sites, and explains the connection between the two reports.

Chapter 2 sheds light on the methodology of how this deliverable was developed.

PART A, comprising Chapters 3 to 5, outlines relevant background considerations to the Toolbox, which offer the interested reader a solid theoretical foundation to the tools' application.

Chapter 3 starts with underscoring the importance of a stakeholder-centred approach for the implementation of nature-based solutions in PHUSICOS, carving out its benefits and giving answers to the questions of why stakeholder knowledge matters, and what we understand by co-design in PHUSICOS.

Chapter 4 is dedicated to the concept of Stakeholder Knowledge Mapping (SKM) and its evolvement over time. It also presents a working definition for the further operationalization of Stakeholder Knowledge Mapping in PHUSICOS.

Chapter 5 gives more in-depth insights to the considerations which stand behind the presented content, structure and systematization of the Toolbox. More specifically, it informs on the Toolbox' intended targets, boundaries, content and structure, and makes transparent the results of the demand assessments which were undertaken with the facilitator group during the Consortium meeting in Naples (November 2018). Furthermore, it outlines the Toolbox' concept at a glance.

The quick reader may directly step into **PART B**, which presents the core of this deliverable: the Toolbox.

Next to an orientating overview table to the full tool collection, Chapter 6 offers guidance on how to put Stakeholder Knowledge Mapping for co-designing NBSs into practice by providing a set of tools that have been described on behalf of informative tool portraits and divided by their use for

i) the Living Lab set-up stage (see Chap. 6.2) and

ii) the Living Lab working process (see Chap. 6.3).

A connected Toolbox library enables further reading upon demand (see Chap. 6.4).

To conclude, Chapter 7 gives a short outlook to the steps ahead, especially with regard to the further evolvement of the Living Lab processes at the case sites as well as to follow-up deliverables of this Work Package.

2 Methodology

The methodology applied for elaborating the revised version of D3.2 Starter Toolbox for Stakeholder Knowledge Mapping to Co-Design Nature-Based Solutions at Case Study Sites was a stepwise procedure building on knowledge from both science and practice in order to identify and assemble a tool collection being of best possible use to the Toolbox' target groups (see Chap. 1.3).

The point of departure for the research undertaken was a set of research questions deduced from the titling of the product to be elaborated:

- What is Stakeholder Knowledge Mapping (SKM)?
- Which tools are commonly applied in contexts similar to PHUSICOS for SKM and co-design purposes?
- Which tools should be part of the Toolbox given the varying objectives, situations, and tool demands of the demonstrator and concept case sites?

In order to address these questions, two parallel strands were pursued (see Figure 3):

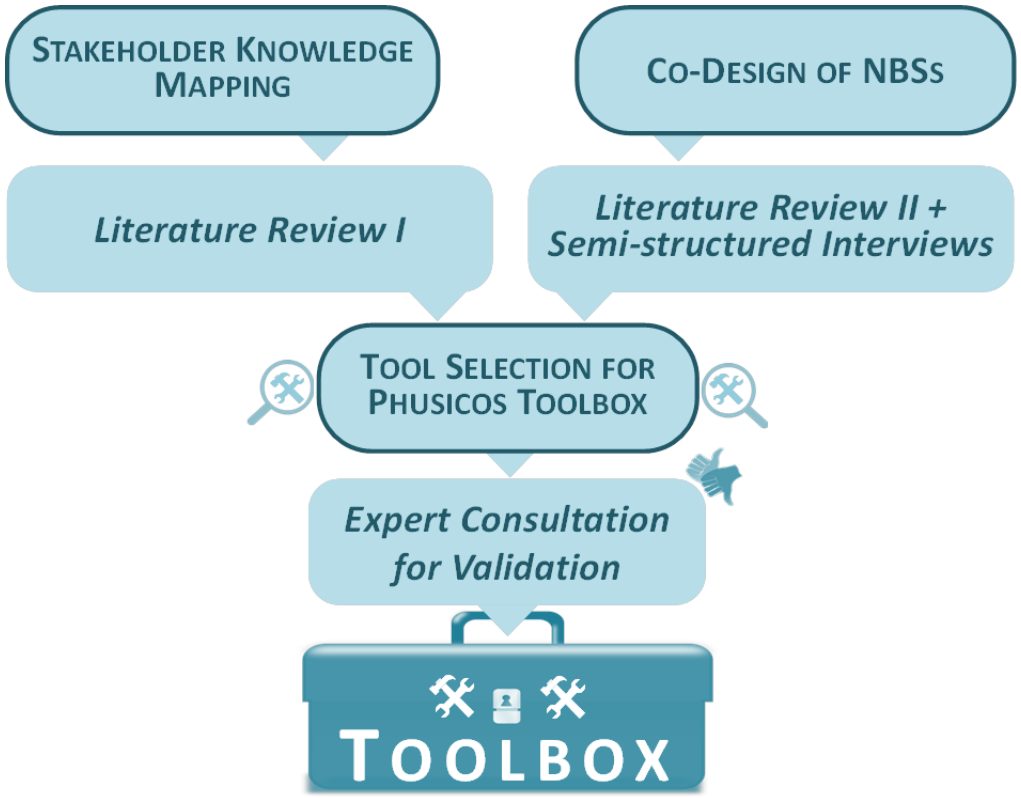

Figure 3. Methodology for the elaboration of D3.2 Starter Toolbox for Stakeholder Knowledge Mapping to Co-Design NBSs (revised version) at a glance. Design: C. Smida 2019

On the one hand, an in-depth literature review and analysis (I) was executed on the term *Stakeholder Knowledge Mapping*. This served to shed light on the concept and its roots, to clarify the terminology for coming up with a working definition for the PHUSICOS context, and to identify relevant mapping tools for use by the case site facilitators to capture, elicit and leverage local stakeholder knowledge.

On the other hand, the term *Co-Design of Nature-based solutions* was further investigated, putting a focus on contemporary tool practice in PHUSICOS-related fields, such as landscape planning, participatory planning, innovation management, disaster risk management, climate change adaptation, and natural resource management. While the related literature review (II) contributed to establish a sound knowledge base for tool selection, semi-structured interviews with facilitators and experts from PHUSICOS were employed to make transparent given tool demands and verify the intended tool set's usefulness from the target group's perspective *ex-ante*. To the same end, an interactive *Tool Corner* exercise was conducted with the facilitator group of PHUSICOS in the framework of the Consortium meeting in Naples (November 2018).

To validate the preliminary tool collection, as a final step another expert consultation was performed. Making use of professional social science expertise from outside of PHUSICOS contributed especially to detect possibly inappropriate tools, and gaps to fill. Furthermore, valuable hints on the systematization of the Toolbox could be derived in this way.

In the following paragraphs, the individual steps of the methodology are further outlined, focusing especially on the conducted literature reviews and interview design.

Research on Stakeholder Knowledge Mapping (SKM): Literature Review I

To trace the origins of the term *Stakeholder Knowledge Mapping*, three databases were selected to conduct the literature review: Web of Science (WoS), Scopus, and Google Scholar. The exact expression *stakeholder knowledge mapping* was searched in these databases yielding no results, except in Google Scholar. In this database, three sources were found. SKM thus appeared to be a concept-less term in the academia. Consequently, it was necessary to use additional research criteria for conducting this literature review. New research criteria were selected by considering both SKM's semantics and the intended role of it in PHUSICOS. This search was executed in three steps (see Table 1). In the first step, the search criteria contained the characters *stakeholder knowledge* AND *knowledge mapping*. WoS and Scopus yielded no results, but Google Scholar showed 40 sources. Therefore, search criteria were modified for a second filtering as follows:

("Stakeholder Knowledge" OR "Knowledge of stakeholders" OR "Stakeholder analysis" OR "Stakeholder Learn*" OR "Stakeholder perception" OR "Organizational learning" OR "stakeholders' knowledge" OR "Stakeholder awareness" OR "Local knowledge" OR "Local ecological knowledge" OR "Organizational knowledge" OR "public perception" OR "stakeholder perspective") AND ("Knowledge mapping" OR "Cognitive mapping" OR "knowledge capturing" OR "Mapping of knowledge" OR "Knowledge mapping method").

The second filter yielded 426 results[3]. Fourty-two overlaps were found, reducing the number of results to 384 sources. Given the large number of findings, research terms were redefined in a third filtering step. Search terms were modified by considering key words found during the second filter i.e., cognitive mapping, fuzzy cognitive mapping, mental mapping, sketch mapping, causal mapping, and participatory mapping; and PHUSICOS' targeted stakeholders i.e., local users of NBSs in European mountainous rural areas. Research criteria were narrowed down as described below for a third filter

("Local knowledge" OR "community perception") AND ("knowledge mapping" OR "mapping of knowledge" OR "cognitive mapping" OR "fuzzy cognitive mapping" OR "sketch mapping" OR "causal mapping" OR "participatory mapping").

In comparison to the second filter, the third filter reduced the number of sources in Scopus from 85 to 25 but increased the number of findings in WoS from 51 to 54 documents and in Google Scholar from 248 to 6240 documents. Given the frame of the present work, the sources of the first filter were chosen for Google Scholar, and the sources of the third filter were selected for WoS and Scopus. This represents a total of 119 initial sources for conducting the literature review (see Table 1).

Table 1. Initial sources obtained per database – Literature Review I

Databases	Filter 1		Filter 2		Filter 3	
	Initial	Overlap-free	Initial	Overlap-free	Initial	Overlap-free
WoS	0	NA	51	0	**54***	0
Scopus	0	NA	121	85	66	**25***
Google Scholar	**40***	NA	254	248	6240	NA

- Overlap-free: refers to the number of new documents identified in the database taking WoS as reference point, e.g., in the third filter 66 documents were found in Scopus, of those, 41 documents were already included in the findings of WoS, then Scopus provided 25 new documents to the review.
- *Initial sources included in the literature review to be screened.
- NA: Does not apply

The filtered literature was assessed in two steps, a practical screening step and a methodological screening step, namely. When the sources succeeded on the practical screening step, the methodological screening took place thereafter. To do so, a set of questions was applied that allowed checking the quality of the databases' results. This aimed to make sure that the sources considered in this review had similar high methodological quality by including texts that met a minimum score among an ideal set of methodological parameters. Quality parameters were derived from Fink (2014).

Built on the literature screenings, a literature analysis was conducted for tracing the conceptual roots of knowledge-mapping-related concepts and investigating their relationships. Drawn on this, the SKM concept was developed (Shoemaker et al. 2003) and a working definition subsequently formulated for PHUSICOS. SKM tools were

[3] Until July 2018.

identified and described on the basis of the sources obtained. To fill knowledge gaps, additional scientific and grey literature was researched and consulted.

Research on Co-Design of NBSs: Literature Review II

With regard to the research conducted on Co-Design of NBSs, in a first step a review of relevant scientific and grey literature was undertaken to identify common practice methods from the following fields: landscape planning, participatory planning, innovation management, disaster risk management, climate change adaptation, and natural resource management. These fields were chosen as focus areas for literature review as they best relate to the PHUSICOS context, in the sense that they are focused on participatory, environmentally sustainable processes that address risk and natural resources. Specifically regarding grey literature and practitioners' manuals, literature in the fields of participatory planning and innovation management was reviewed from Living Labs in the European context, in order to gain broad background on general Living Lab methodology and components that allow Living Labs to run efficiently regardless of their domain.

The initial literature review was conducted across several databases, including Web of Science (WoS), Scopus, and Google Scholar, as well as within practitioner databases of Living Lab consortia, such as the European Network of Living Labs (ENoLL). Within databases of scientific literature, the search strategy focused on terminology relevant not only to Living Labs and co-creation, but also to the fields of disaster risk management, landscape planning, climate change adaptation, and natural resource management (see Table 2 for search terms).

Table 2. Search terms applied for Literature Review II on Co-Design of NBSs

Main Search Terms	**Living Labs**	**Co-Design**	**Nature-Based Solutions**	**Hydro meteorological Disasters**
Related Terms	Participatory Planning	Co-Creation	Ecosystem-based Adaptation	Flood Risk
	Stakeholder Knowledge Mapping	Knowledge Co-Production	Landscape Planning	Catchment Management
	Stakeholder Dialogue	Social Innovation	Climate Change Adaptation	Disaster Risk Management
			Natural Resource Management	

A total of 171 sources were collected for review, comprised of both scientific and grey literature. From the review and by snowball sampling via searches through grey literature and practitioners' websites in the field of Living Labs, social innovation, participatory planning, NBS, and climate change adaptation, 18 toolboxes in total were identified for further analysis (see Chap. 6.4, Table 4). Many of the collected toolboxes originated from past consortia or publicly funded projects in the mentioned fields. The

toolboxes selected were chosen based on their focus on using participatory processes and tools that facilitate the active inclusion of stakeholders in planning or design of solutions. Existing toolboxes were analysed for similarities and differences in their approaches to the structural organization and inclusion or exclusion of tools.

From both the scientific and grey literature, two categories of useful information were extracted. First, the potentially useful tools were collected; including their descriptions, application requirements and the purposes they may serve in a participatory planning context. Secondly, the characteristics and criteria used by past toolboxes and tool application scenarios for the selection of appropriate tools were extracted as possible characterization criteria for the PHUSICOS context.

Research on Co-Design of NBSs: Expert & Facilitator Interviews, Tool Corner

In addition to the review of literature on tools to co-design NBSs, interviews were conducted with both experts in related disciplines and the Living Lab facilitators indicated for each case study site under the PHUSICOS project. While the review of literature served as a means of collecting the *ideal* set of tools that would be useful for the Living Labs, the interviews with project related experts and facilitators served to collect the *realistic* expectations and viewpoints of those who had prior experiences implementing participatory tools in contexts similar to that of the PHUSICOS project (experts) and of those who will be responsible for implementing and guiding the use of the tools within the case study sites (facilitators). Semi-structured interviews were therefore conducted during the PHUSICOS Consortium meeting held in Naples, Italy (November 2018). Interviewees were asked questions orally, with the guidance of a questionnaire sheet provided during the interviews, also to overcome potential language barriers. Questions consisted of both open-ended questions and Likert-scale rated questions (for interview design, see Annex A; for results, see Chap. 5.2).

In addition to the interviews conducted, an interactive exercise was undertaken at the PHUSICOS Consortium Meeting in which facilitators could rate a list of preliminarily compiled stakeholder involvement and co-design tools by dot-voting, based on their existing familiarity with each tool and/or their desire to learn more about any of these tools. This exercise, named the *Tool Corner*, was conducted displaying printed lists of identified tools with adjacent columns on pin boards, with three columns corresponding to a level of familiarity and the final column indicating the desire for more information regarding a tool. In order to select tools to be listed as part of the Tool Corner exercise, an initial shortlist developed by analysing available literature was further narrowed down by utilizing those tools which were deemed most likely to be suited for the needs of the facilitators and which represented the broadest range of tools from simple to complex and from low to high technological demands. While the main focus of the Tool Corner tools was set on the NBS Co-Design Phase, every effort was made to include tools for each of the Living Lab phases, in order to allow facilitators to comment on and indicate which tools they needed most for their future work (for Tool Corner outline, see Annex B).

By analysing and combining the results of the expert and facilitator interviews as well as Tool Corner outcomes, a portrait of the *realistic* needs of the case study sites for tools

and guidance was constructed. Consequently, it was juxtaposed against the *ideal* set of tools derived from literature to assemble the final set of tools for the Toolbox.

PART A:

BACKGROUND CONSIDERATIONS TO THE TOOLBOX

3 Why does Stakeholder Knowledge matter to NBS implementation?

3.1 Who is a stakeholder and should be on board?

Stakeholders can be defined as "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).

A closer look at scientific literature suggests, however, that a range of stakeholder definitions exist (Schiller et al. 2013). For example, Friedman & Miles (2006) identify 55 different attempts to describe the term *stakeholder*. Definitions can vary significantly depending on theoretical foundations of the respective work and controversies led in literature (e.g. Mitchell et al. 1997), whether certain groups have the status and legitimacy or not. This discussion also includes the aspect of nature, i.e., whether nature can be a stakeholder itself or not and who might be the appropriate advocates or spokespersons for nature's needs (Steurer 2006).

Important aspects can also be dependency and influence on an issue, resources and strategies that persons or groups use to accomplish their claims, and their ensuing level of success (Steurer 2006). Putting them in the centre of the perspective, a managerial logic can be a useful way to address stakeholders compared to more theoretical approaches of stakeholder identification (Frooman 1999).

According to the quadruple helix concept, stakeholders to participate in Living Labs are users and beneficiaries, private and public actors as well as knowledge institutions (Nyström et al. 2014; Fohlmeister et al. 2018). Stakeholders may vary in their interests, power, responsibility and problem-framing with regard to the particular issue at stake (O´Brien et al. 2013). As stakeholders' interests do often stem from values and worldviews, the consideration thereof is of critical importance and should not be neglected. They also assume different roles, sometimes even one stakeholder can play several roles at the same time, or roles can change. Furthermore, they produce and are informed by different modes of knowledge (Davies & White 2012).

In the PHUSICOS context, relevant stakeholders to be on board of the local demonstrator and concept case sites' Living Lab processes embrace them contributing local know-how to the NBS co-design process. This can include i) public bodies such as water authorities, administrative bodies responsible for disaster risk management and flood control, forest and land use management, national park entities; ii) private sector partners such as ski resorts and hydro-seeding companies; iii) civil societies such as landowners, herders and shepherds, farmers' associations, environmental NGOs; as well as iv) local research entities and experts. To identify the stakeholder landscape being of importance to the NBS co-design process at the individual case site, a sound stakeholder identification and analysis is an important pre-condition to ensure the necessary representativeness, continuity, legitimacy and power of the Living Lab (Reed et al. 2009; see also D3.1 Chap. 4.3 and in this deliverable Chap. 6.2 on further guidance).

Central aspects for working with stakeholders are their importance, relative power, influence and interests to a specific initiative or project (Aligica 2006). Natural resource managers are often confronted with different, conflicting interests since various groups use the same resources for different purposes. Stakeholders also may define problems differently, and thus envisage different solutions. In here, stakeholder analysis helps to identify the stakeholders, their attributes, knowledge, sources of information and roles in the action arena. This knowledge can provide a good basis for the success of a project (Brugha & Varvasovszky 2000), avoid pitfalls or failures due to problems with stakeholder representation or participatory process design (Reed & Curzon 2015) or at least contribute to describe and better understand different attitudes and views in contested terrain.

Understanding stakeholders is being considered one of the most critical parts of participatory processes (Murray-Webster & Simon 2006). The identification of stakeholder roles is an option to gain insight in the way stakeholders may act in Living Labs. A role can be played by an individual but also by a group of organizations. Sometimes, role distribution can change over time. Two or more roles may be held by one person or institution at one time. Such reflection on stakeholder roles thus can be supportive to Living Lab facilitators in better preparing and steering the related processes and interactions between the participants.

Nyström et al. (2014: 491-492) identified a number of role-related tasks for Living Lab actors. The most important are:

- The “webber”, initiating network connections and deciding whom to contact;
- the “instigator”, trying to influence decision-making processes of actors;
- the “gatekeeper”, possessing relevant resources or knowledge, being able to influence decisions by providing them or not;
- the “advocate”, spreading positive information;
- the “entrant”, focussing on protecting his perspective by interfering; and
- the “compromiser”, trying to balance out for avoiding conflicts.

Murray-Webster & Simon (2006) suggest three basic but important dimensions to identify stakeholder roles:

1. Power or ability to influence, e.g. position, power over resources, credibility;
2. interest in the topic or issue; and
3. positive or negative attitude towards the project or issue, i.e. the extent of supporting or blocking potential work in a Living Lab or possible outcomes thereof.

To better understand the role a stakeholder or stakeholder group may play in a Living Lab process, Murray-Webster & Simon (2006) describe a total of eight labels for the possible way of action, and arrange the identified agents in a three-dimensional grid (see Figure 4).

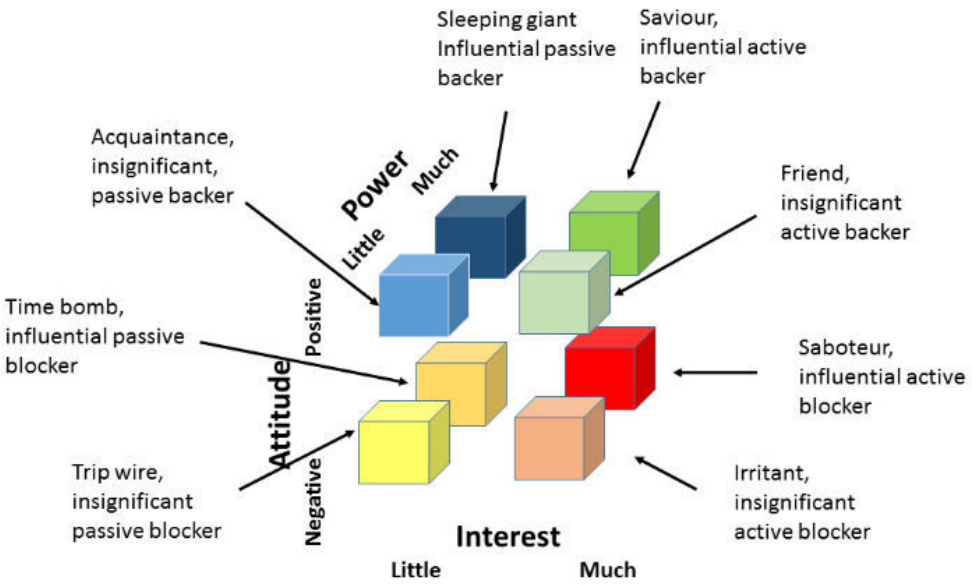

Figure 4. "Better know your sleeping giants, trip wires and time bombs in Living Labs!" Eight different types of stakeholders, based on Murray-Webster & Simon (2006: 2), modified by G. Lupp 2018

One of the core issues frequently mentioned in literature is stakeholder representation, their legitimacy, participation, power, and knowledge that influence and is influenced by other attributes. Important questions for setting up participatory processes like Living Labs are (according to Reed et al. 2009):

- Are different and diverse stakeholders adequately represented?
- How to take the different relative interests and influences of stakeholders and stakeholder groups into account?
- If issues define stakeholders, how are the issues defined? Also it should be considered, that it can be a challenge, when only a small core group defines issues to be considered or a few stakeholders dominate problem definitions (Moura & Teixeira 2002).

This reiterates the key function of a stakeholder analysis as foundation of a Living Lab process. It originates from business management, is often applied in policy, development and natural resource management, and has become increasingly popular in different fields. With this variety and flexible adaptation to needs and contexts, as an outcome, a wide understanding of stakeholder analysis exists and what this concept might be. For this reason, there are several suggestions, how, when and why stakeholder analysis might be most effective. Nonetheless, a broad range of methods for stakeholder analysis exists in different disciplines (Reed et al. 2009).

Stakeholder analysis is also used to understand the diverse range of potentially conflicting stakeholder interests (Friedman & Miles 2006). However, if attempting to carry out such work, one should be aware that already this task might generate or exacerbate conflicts, and sometimes hidden agendas might influence the results of the assessments. Also there is the question of objectivity, since persons or institutions conducting a stakeholder analysis do it from a particular perspective and often with a particular outcome in mind (Reed et al. 2009). Other potential problems can be the lack of knowledge, skills, resources, or that the analyses may be biased. Finally, also ethical concerns about representing the views of other people should be mentioned (Bryson et al. 2002).

Numerous attempts exist to classify the different approaches to stakeholder analysis (Friedman & Miles 2006). For example, management science distinguishes three dimensions: descriptive, instrumental, and normative. The most significant differences are between normative and instrumental approaches. Although these theoretical approaches are frequently used by scientists, it is difficult for practitioners to adopt a single theoretical stakeholder approach and do not differentiate between them in practice (Antonacopoulou & Meric 2005).

While descriptive approaches mainly make transparent how persons think and act, instrumental stakeholder approaches are more pragmatic and often related to understand how organisations, project and policy makers can identify, explain and manage other stakeholders to achieve desired outcomes.

Normative approaches emphasize the legitimacy of stakeholder involvement and empowerment in decision-making processes. They often have been adopted in policy, development and natural resource management. Decisions made have a stronger legitimacy or are morally more responsible by involving key or representative actors (Reed et al. 2009). The normative approach suggests that stakeholders should be involved in decision-making processes. The aim of this approach is that persons and groups involved might feel at least some level of ownership of these processes. Stakeholder analysis can therefore provide a basis to build the transformation of relationships and the development of trust and understanding between participants and thus contribute to create new, innovative solutions. Although the process of assessing stakeholders and their knowledge may not necessarily provide a start to changes in attitudes and behaviour, it may enable diverse groups of potentially conflicting stakeholders to appreciate the legitimacy of each other's views and provides a common ground for collaboration (Reed et al. 2009).

In most of the stakeholder analysis literature, there is no description of how stakeholders actually are recruited. Stakeholders seem to be self-evident and self-construed. However, before work actually can be done, it is necessary to identify who might hold a stake in a specific issue. This needs a clear understanding of the issue, so that the boundaries of the social and ecological phenomena can be set (Reed et al. 2009).

3.2 Stakeholder involvement for NBS application: a justification

Stakeholder involvement matters for NBS application for several reasons. One key aspect of NBS projects emphasized by the EU is the importance of incorporating multi-stakeholder engagement into NBS implementation strategies that is interdisciplinary across the realms of "design, implementation, finance, and policy-making" (Faivre et al. 2017: 511). Engagement with stakeholders across multiple disciplines is necessary in order to build up an evidence base within the European scientific community regarding the use and purpose of NBSs, and to better facilitate their acceptance and uptake among different stakeholder communities (Faivre et al. 2017). Such knowledge dissemination is especially due within the general public, as research has shown that within this stakeholder group the concept of NBS is still too abstract and not fully understood to garner substantial support for NBS initiatives (Faivre et al. 2017; Nesshöver et al. 2017). In fact, Nesshöver et al. (2017) indicate that ensuring the involvement of multiple stakeholders is one of the key factors for making the NBS concept fully integrated and operational as a sustainable development policy option.

It is on this very background that the International Union for Conservation of Nature (IUCN) is currently working on a global standard for NBS, which will be launched in the framework of the World Conservation Congress in Marseille in 2020, pursuing to achieve a clear definition and related benchmarks to efficiently foster the NBS transfer from pilot and project-scales towards significantly larger scales. Among the set of criteria of the draft standard, the transparent and stakeholder-inclusive design of NBSs is a strong component and demand to be addressed, which clearly underpins the relevance of stakeholder involvement in NBS design (IUCN 2019).

More specifically, including stakeholders in the design and application of NBSs can better the NBS planning process by contributing stakeholder knowledge and perspectives on related issues; it can increase acceptance among stakeholders by promoting understanding and visibility of the concept while bringing additional normative benefits by improving the democratic nature of the process and therefore its acceptance among those consulted (Nesshöver et al. 2017; Schultz & Duit 2011).

Specific examples from past efforts to include stakeholders in hydrological disaster risk reduction have confirmed these findings. In a stakeholder involvement project aimed at reducing flood risk in the UK, Bracken et al. (2016: 237) showed that "local people who have no professional responsibility for flood management have excellent understandings of flooding including location, extent and duration and in turn have excellent ideas about possible management interventions to reduce risk".

Engaging stakeholders in the PHUSICOS Living Lab processes to co-design NBSs can thus help to find new and innovative solutions, to achieve the set environmental goals more efficiently and effectively, to better cope with or even resolve conflicts, and to build trust and provide learning. Therefore, the involved agents are more likely willing to support policy and implementation decisions in the long term (Reed 2008).

3.3 What means to co-design a NBS?

The concept of *co-design* is both fundamental to the Living Lab concept and to the development of the present Toolbox. Throughout the literature on the concept, various other terms can be found in place of *co-design*, including *co-creation* and *knowledge co-production*. These terms are most often used in an interchangeable manner for the same collaborative and democratic design concept, with little distinction made between them (Almirall et al. 2012; Calleja & Marantz 2015; Ståhlbröst & Holst 2012). Therefore, for the purpose of this deliverable, the three terms will be used synonymously and interchangeably.

Co-design, co-creation or co-production of knowledge can be defined as 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). In fact, the earliest definition of co-design identified such active involvement of end-users as the primary characteristic of co-design (Voorberg et al. 2014). The term *end-user* and the means by which this stakeholder group is involved differ according to the discipline in which the work is being undertaken and whether it exists within the private or public sphere. The private sector often uses the term *co-design* to signify the inclusion of consumers when producing goods to ensure that the added value invested meets the consumer demand (Calleja & Marantz 2015). In the public sphere, *co-design* focuses on the end-user as the recipient of a public service, usually a citizen, and therefore co-design intends to include them in the designing process of the "purpose of that public service" (Calleja & Marantz 2015: 5). The importance of this concept for Living Labs cannot be understated, as it is this process that gives the Living Lab concept unprecedented strength and flexibility in developing innovation.

The design of NBSs does not precisely fall within the category of either a consumer product or a typical public service. Instead, it is rather a multi-disciplinary output that produces varied co-benefits for different sectors of both the public and private spheres.

The meaning of co-design for the PHUSICOS context can thus be derived from similar applications of participatory design with stakeholders from related disciplines, such as climate change adaptation and integrated water resources management projects. It is important to keep in mind that in these disciplines and others related broadly to environmental planning and disaster risk management, stakeholders can be included in co-design not only for technical design purposes, such as designing the dimensions and components of complex barrier systems or other engineering solutions, but also in a broader sense of the word *design*, such as planning and implementation procedures of the chosen technical components for the NBS (Brink & Wamsler 2018; Wamsler 2017). As contributions to these planning and implementation aspects, stakeholders can use the co-design process to "develop and explore plausible futures, and define the relevance of process results, which intensifie[s] the inclusion of stakeholders' perspectives and, by extension, their engagement with the results" (Gramberger et al. 2014: 205).

In fact, a recognized need for related sustainability concepts, such as ecosystem-based adaptation (EbA), is the need to better incorporate the social and economic aspects of their implementation and evaluation, in addition to environmental considerations (Scarano 2017). Co-design with local stakeholders who can offer direct experiences related to social and economic effects will be key to help fill this void in NBS design. An example of stakeholder co-design of NBS planning and implementation aspects may include cooperatively deciding on possible locations for NBS implementation, evaluating the socio-economic viability of a solution, identifying positive or negative perceptions among the community or dialogue on the potential secondary effects that the NBS may have on the landscape and biodiversity (Hernandez-Morcillo et al. 2018). Therefore, the concept of NBS co-design with stakeholders is not limited to strictly traditional engineering aspects of the design, but rather aims at a more holistic means of design.

Co-designing alongside stakeholders can further address the issue of maintaining stakeholder interest in a participatory process (Gramberger et al. 2014). Literature has found that giving creative agency to stakeholders can help to resolve many challenges of traditional innovation processes, such as "clarifying ambiguity and add[ing] legitimacy to the scientific inquiry process" by making clear the inherent value assumptions being made by each stakeholder when considering solutions and ideas and assisting with the negotiation of goals among stakeholders (Coleman et al. 2017: 120). Furthermore, considering knowledge from a variety of stakeholders, including those at the base of a multi-level governance system, has been found to expand the adaptive capacity of the overall system through the addition of outside creativity by encouraging all stakeholders to better understand the needs present and the challenges to overcome (Coleman et al. 2017; Peterson et al. 1997; Lam et al. 2017).

Therefore, utilizing co-design in the design of NBSs can not only make use of stakeholders' local knowledge regarding technical components such as land-use, economic effects and social implications of proposed designs, but can also help facilitate acceptance among the community by ensuring their voices being heard and hopefully being responded to as well.

4 On the road to Stakeholder Knowledge Mapping (SKM)

The systematic literature review on the exact expression *Stakeholder Knowledge Mapping* generated no results in the databases consulted with the exception of three hits in Google Scholar. None of these three sources provided a definition for the term. In the attempt to capture the notion of the apparently undefined term of SKM in academia, literature was reviewed for potential origins and related concepts.

4.1 SKM: conceptual roots

When tracing potential origins of Stakeholder Knowledge Mapping (SKM) in literature, it was found that **cognitive mapping** is presumably the earliest related concept. The term *cognitive map* was introduced by Tolman (1948) when working with rats on his theory on purposeful spatial behaviour. He suggested that animals and men acquire mental representations of their physical environment and called these mental models "cognitive maps" (Tolman 1948: 189). Departing from Tolman's work, the neuroscientists O'Keefe and Nadel (1978) proposed a formal theory on cognitive maps as psychological and neural representations of physical space with the hippocampus providing the neural basis of cognitive mapping (Eichenbaum 2015). Initially, research to understand how humans acquire, process and use spatial information about their external reality, and how the individual's cognitive map is reflected in their spatial behaviour, was predominantly driven and conducted by disciplines of geography and psychology (e.g. Downs & Stea 1975; Moore & Golledge 1976; Kitchin & Freundschuh 2002). Summarising research contributions, Montello (2009) states that the cognitive map in the head consists of multiple, selective representations of varied abstractness containing spatial and non-spatial information, omitting irrelevant information and highlighting relevant, and distorting and schematizing spatial and non-spatial properties depending on contexts and tasks, thus allowing the integration of new "information from different sources, modalities, and occasions" (Mark et al. 1999: 757). The intrinsic geometry of perceptual space does not seem to be Euclidean (Fernandez & Farell 2009). Instead, mental space of navigation is represented qualitatively, in terms of elements (e.g. landmarks, buildings) being represented in relation to one another and relative to a reference frame (Tversky 1993). The dynamic information-processing process and the internal representation allows spatial orientation, navigation and wayfinding and enables to communicate spatial knowledge to others (Golledge et al. 2000).

According to Eichenbaum (2015: 9), already "Tolman emphasized that cognitive maps provide insights into human cognition broadly, including human social behavior" which is substantiated by recent studies (e.g. Tavares et al. 2015). The environmental psychologists Kearney and Kaplan (1997: 583) point out that many fundamental human cognitive processes such as predicting, planning and decision-making would be impossible without the ability to represent physical and conceptual aspects of the external world internally. It is also interesting that Kearney and Kaplan (1997) use the terms *cognitive map, cognitive structure* and *knowledge structure* interchangeably in their article.

The impossibility of directly investigating mental models which exist only in minds (Jones et al. 2011), made it necessary for researchers to find means to elicit internal cognitive maps and capture them in external representations such as text, maps, diagrams or computer models. Swan (1997) points out that a distinction has to be made between the internal cognitive map and its external representation revealed by elicitation techniques, since the output is always shaped by the elicitation method, like the output of any other research technique. However, in literature the term *cognitive map* can be found for the internal cognitive representation as well as for the tangible output generated by elicitation methods, as will be encountered in the following paragraphs.

The study of human spatial cognition spread towards the field of urban studies when Kevin Lynch (1960) established a theory on urban planning with his seminal book *The Image of the City*. Lynch studied how residents of Boston, Jersey City and Los Angeles perceive and understand the structural outlay of their home towns by asking them to draw a freehand sketch map of a certain city district from memory as well as an imaginary trip through the city. According to Kitchin (2015), Lynch was pioneer in the use of **sketch mapping** as an analytical tool to externalize cognitive maps of individuals, aggregating those to produce a composite map of shared spatial knowledge and determining the salience of environmental elements depicted in the sketch maps. Lynch's work was an inspiration not only for urban planners. Sketch maps became a widespread technique to capture participants' mental models of the physical environment (see e.g., Applegard 1970; Pocock, 1976; Milgram & Jodelet 1976).

In the book *Mental Maps* known to a wider audience, the geographers Peter Gould and Rodney White (1974) examined where people would prefer to live given the choice. Based on the responses, Gould and White (1974) generated isolinear maps showing revealed preference surfaces which they called **mental maps**. Since these maps present surveyed opinion data in cartographic form (Golledge 2008), they are not mental maps in the sense of internal representations described above.

In the 1970s, approaches to externally represent abstract non-spatial mental concepts and visualize reasoning processes gained momentum in the social sciences. O'Neill et al. (2015: 1575) describes this branch as creating *models of understanding* to separate them from studies containing a spatial element such as those related to spatial cognition, spatial behaviour and geographic knowledge. The *models of understanding* approaches aim to capture subjects' knowledge and depict complex relationships among concepts. Concepts are, as Margolis & Laurence (2014) note, the constituents of thoughts, enabling the human mind to categorise, infer, memorise, learn and decide.
Robert Axelrod introduced the approach into political sciences. In the collection of essays *Structure of Decision: The Cognitive Maps of Political Elites*, Axelrod (1976) presents a set of empirical techniques for determining the cognitive representations of the external world held by key political leaders and used to structure their reasoning in respect to decision-making. He defines a cognitive map as a graphic representation intended to capture the content and structure of a person's assertions and stated beliefs about a particular issue where the "concepts a person uses are represented as *points*, and the causal links between these concepts are represented as *arrows* between these points.

This gives a pictorial representation of causal assertions of a person as a graph of points and arrows" (Axelrod 1976: 5). A cognitive map is understood as a particular mathematical model of a person's belief system. Taken from one of Axelrod's empirical studies is the following explanation:

> 'Causal assertions are regarded as relating variables to each other, as in the assertion that "the amount of security in Persia augments the ability of the Persian government to maintain order". Here the causal variable is "the amount of security in Persia" and the effect variable is "the (degree of) the ability of the Persian government to maintain order". The relationship between the two variables is indicated by the word "augment". A word such as "augments" indicates a positive causal relationship between the causal and the effect variable. This means that an increase in the amount of security will cause an increase in the ability of the Persian government to maintain order' (Axelrod 1976: 59).

In Axelrod's directed graphs the causal relationships between the concepts variables can be either positive (change occurs in the same direction) or negative (change of inverse dependency), which he computationally analysed with the help of adjacency matrices. Preferring unobtrusive methods, Axelrod (1976: 7) derived his cognitive maps mainly from documented material such as verbatim transcripts of policy meetings but also from questionnaires sent to a knowledgeable "panel of judges" or interviews with the politicians themselves. Visualisations like Axelrodian cognitive maps showing how entities are interconnected through the use of points and arrows are also termed *vertices-arcs maps* (e.g. in geometry) or more commonly as *node-link diagrams.*

Various types of relations among concepts are known. Swan (1997: 188) lists proximity (A is close to B), similarity (A is similar to B), cause–effect (A causes B), category (A is a subset of B) and contiguity (A follows B). Predominant types among conceptual maps are those representing causal links between concepts, assumingly because "causality is conceptually and instrumentally the most potent of all relations" (Gray et al. 1985, cited in Mohammed et al. 2000: 132).

Aiming for analysing individual and group cognition in organisations, the study of Bougon et al. (1977) on the Utrecht Jazz Orchestra introduced the analysis of cognitive maps, which they called **cause** (means-end) **maps**, into management research. The notion to study knowledge structures merged with the already established discipline of knowledge management, broadly used in the field of business administration. In this field, **knowledge mapping** is understood as developing a graphical representation of the knowledge allocation and sharing process in an organization (Driessen et al. 2007; Krbalek & Vacek 2012). For Wexler (2001: 250) a knowledge map is a consciously designed communication medium using graphical representation of information in organisational contexts.

For better representing the "hazy degrees" of causal reasoning, Bart Kosko (1986: 65) suggested to apply fuzzy logic to Axelrod's cognitive maps. He fuzzified Axelrod's concept variables and the binary causal connections by applying fuzzy causal functions

with real numbers ranging from minus one to plus one to the connections (Özesmi & Özesmi 2004: 45). For this kind of fuzzy-graph structure Kosko coined the term "fuzzy cognitive map" (Kosko 1986: 65). Fuzzy logic allows a more appropriate handling of data that is "qualitative, uncertain or incomplete and the relationship among parameters can be described through a set of rules" (Rajaram & Das 2010: 1735). From the article by Özesmi and Özesmi (2004) can be inferred that **Fuzzy Cognitive Mapping** (FCM) has been applied in at least eight fields including health, technology, politics, administration, economics and ecology by that time. Interested in modelling and analysing complex social-ecological systems and environmental problems considering people's knowledge, perceptions and values, Özesmi and Özesmi (2004: 44) understand and use a cognitive map as a "qualitative model of how a given system operates". Therefore, individual persons such as experts, decision-makers but also local stakeholders are invited to draw fuzzy cognitive maps consisting of the system variables they find important (e.g. wetland, water pollution) and the causal relationships among these variables (e.g. water pollution affects wetland). With arrows the participants indicate the direction, and with a number between −1 and 1 they indicate the relative strength among these variables (ibid.). To form group cognitive maps, cognitive maps of individuals can be aggregated. Özesmi and Özesmi (2004: 47), document four ways to derive the cognitive maps forming the base for FCM analysis: from questionnaires, by extraction and coding from written texts, by drawing them from data that shows causal relationships, and by interviewing people who draw them directly. The focus of FCM is rather on analysing mapped knowledge than on knowledge elicitation and mapping in itself.

In a parallel line of work to Axelrod's dating back to 1972, Joseph Novak established **concept maps** as a means to study children's ability to acquire science concepts by visualising the relationships between concepts in form of a map and observe the effect on memorability, learning and understanding (Novak & Canãs 2006). Concept maps are hierarchical node-link diagrams with superordinate concepts at the top. The nodes contain the concepts usually described by one or two words and links are usually displayed as simple lines with meaningful labels capturing the interrelationships between the concepts (ibid.). In the traditional form of concept maps, the links are directed one-way or non-directional. By learning new concepts, the existing cognitive structure of the learner develops, thus gradually deepening and expanding understanding of the particular subject matter and the brain's ability to retrieve and process information. When learning or research is practiced by drawing a concept map, the identification of new crosslinks between concepts "may sometimes lead to a creative insight" (Novak & Canãs 2006: 177). Originally suggested as a technique to facilitate teaching and learning (Novak & Gowin 1984), concepts maps have been used to create, transform, elicit, capture, manage, transfer and assess knowledge and expanded into fields such as business management and accounting, computer science and software development, engineering, medicine and nursing (Daley et al. 2010; Davies 2011). Mayor drawbacks of concept maps are the rigid rules used for identifying concepts and their relationships making it hard for novices to learn the process and that the linear map structure make them inadequate to capture more complex relationships (Davies 2011: 285).

The node-link structure to represent internal mental concepts is shared by **mind maps**, which have been propagated by the psychologist Tony Buzan as a device to stimulate creativity and memory in the 1970s (Buzan & Buzan 2000). In its traditional form, a mind map is a hand-drawn rich picture around a central topic not depending on a strict formal structure to organise thought. Radiating from the central idea, individuals or groups are free to add concepts in the form they prefer, e.g. as keywords, images, symbols or pictures. The connecting lines between them are usually unlabelled (Davies 2011). Main aim of mind mapping is the exploration of creative associations between themes to encourage brainstorming and spontaneous, creative thinking (Dixon & Lammi 2014). Mind maps are used in many professions (see Davies 2011). Like concept maps, their popularity is arguably aided by the variety of software packages available for map creation and analysis (Eppler 2006). Constraints of mind maps are seen in the absence of clear links between depicted concepts; they are often difficult to decipher and understand for others than the authors; cannot deal with complex relationships between concepts; are inconsistent in terms of level of detail; can become convoluted and messy (Eppler 2006; Davies 2011; Dixon & Lammi 2014).

Curtis (2016) documents that space-related knowledge and perception mapping witnessed a renewed uptake in scientific studies since the 2000s covering a spectrum of topics such as the investigation of crime perception (Curtis 2012), wild fire management (Cacciapaglia & Yung 2013) mobility (Hall & Smith 2014), natural hazard risk perception (O'Neill et al. 2015) and the formation of informal settlements (Pe 2017). She argues that the growing adoption of the approach has been driven by the technical improvement of spatial analytical tools such as Geographic Information Systems (GIS) but also by a shift in scientific interest towards learning from local people how they use places and their resources and how they perceive, appreciate and feel about places (Curtis 2016).

The increasing availability of powerful GIS technology and the urge to incorporate local knowledge especially in natural resource management and all facets of spatial, environmental and community planning (e.g. Chambers 2006; Dunn 2007), triggered the development of participatory forms of GIS. Rall (2018) differentiates three major approaches for using GIS in a participatory way: **Participatory GIS** (PGIS) developed from non-profit and scientific work in rural areas of developing countries with the primary focus on promoting the perspectives and concerns of local people and their empowerment through the mapmaking process and by communicating on par with other stakeholders. Predominantly used by urban and regional government agencies in the developed world to enhance public involvement in spatial planning is **Public Participation GIS** (PPGIS) which "integrates geospatial technologies with public knowledge in a geo-survey format to support collaborative planning processes and spatial decision-making" (Rall 2018: 20). More recently emerged **Volunteered Geographic Information** (VGI) which refers to place-related information voluntarily created and gathered by private citizens using smartphones and technologies like social media and web-based mapping (Haworth et al. 2016). The main emphasis of VGI is to build collective intelligence and engage "citizens as sensors", e.g. for data inventory or

reporting problems encountered in the city, thus contributing to an improved and more publically accessible spatial information base (Rall 2018: 20).

In research, studies and processes are commonly entitled as **participatory** when they integrate local people's knowledge and socio-perceptual input (see examples above). Such an integration does not necessary imply that a direct communication and interaction takes place between researches and local stakeholders. In the framework of international cooperation and rural development schemes, practice and methods to facilitate peer-to-peer dialogue and enable local stakeholder to share, enhance and analyse their knowledge was conceptualized particularly by Chambers (1983, 1994a, 1997, 2002). Although early initiatives root back to 1968, when Paulo Freire published the book *Pedagogy of The Oppressed*, wherein he stated that poor and exploited people should be allowed to conduct analysis about their own reality (Chambers 1994b). It was the Conference on Rapid Rural Appraisal (RRA) in 1985 at the University of Khon Kaen, Thailand, which meant a landmark for the use of the adjective *participatory* related to stakeholder knowledge integration (ibid.). At the same time, it was the starting point for the further evolution of a set of participatory knowledge elicitation techniques bundled under the umbrella terms of Participatory Rural Appraisal (PRA), Participatory Action Research (PAR) and Vulnerability and Capacity Assessment (VCA), which were prominently applied in international development during the up-following decades. Several tools of these collections, such as the social and resource map, transect map, mobility map and flow diagram, have a long history in practical application and can be called stakeholder knowledge mapping techniques in the strict sense. Numerous publications provide guidance on stakeholder-centred methods of development, including but not limited to participatory mapping tools (e.g. Narayanasamy 2009; Schwedes & Werner 2015; Dearden et al. 2003; Chambers 2002).

With regards to the PHUSICOS project, the following **conclusions** can be drawn:

Several streams of thinking and research to capture individual knowledge (thoughts about how the world is) and beliefs (preferences, values; in general, thoughts about how the world should be) using graphical representations of these mental constructs were traced in literature, which was helpful for approaching SKM conceptualisation. In the following, the term *knowledge* is used as umbrella term for both mental constructs of knowledge and belief. *Knowledge capture* is understood as the combination of *knowledge elicitation* (get access to what is held in the mind) and *knowledge representation* (generating a tangible output of the mental knowledge and belief structures). Without the externalisation of knowledge, the transfer of knowledge from one person to another person, group of persons or to society is impossible, and therefore lays the basis for the further development of knowledge (*knowledge transformation*).

The scientific fields studying brain functions, cognition and human spatial behaviour use the term *cognitive map* for the mental representations the human mind acquires to make sense of the outside physical world, and maybe also of the social environment. Originally, *cognitive mapping* was defined as the internal dynamic process to generate these mental models. Since then, it became appealing for many disciplines to capture

mental constructs held by the human mind. With the spreading of the idea to make thoughts and beliefs explicit by graphic representations into a broad variety of professions, the term *cognitive mapping* has gradually become loaded with different meanings and a multitude of related concepts and approaches emerged. To avoid misconceptions, it seems advisable to use the term *cognitive mapping* in its original meaning. From this line of basic research, which is otherwise somewhat out of the scope relevant for the PHUSICOS project, an interesting insight is to be gained. Considering that cognitive maps might apply to both physical and non-physical spaces as new studies in neuroscience suggest (Epstein et al. 2017), displaying information within spatially structured representations (e.g., maps, node-link diagrams) might be an effective way to express and transfer knowledge.

More significant insight for the PHUSICOS Living Lab approach provide the two streams of research that focus on generating tangible representations of knowledge held in the human mind. The space-related models try to capture a person's place-related knowledge within maps whose potential usefulness for the PHUSICOS context is easily apparent (see Chap. 6.3, and here portraits of mapping tools in Part B of this report). The other branch creates models of understanding using node-link diagrams to visualise abstract, non-spatial concepts and relationships between them. Axelrodian cognitive maps, Fuzzy Cognitive Maps and Novakian concept maps have been successfully applied to represent and assess cognitive structures. Their major strength unfolds when used as quantitative mechanism to thoroughly analyse the visualised causal relationships and mathematically compare cognitive structures. Since applying these tools as measurement techniques is complex, time-consuming and demands considerable conceptual and procedural know-how (Mohammed et al. 2000; Gray, Zanre & Gray 2014), they assumingly are of less relevance for the PHUSICOS Living Labs (see Chap. 5.2 for tool demands expressed by PHUSICOS Living Lab facilitators). However, applied in the framework of an interactive participatory event or group discussion, structured node-link diagrams can be powerful tools to visualise e.g. a problem's roots and consequences for group-based planning, to explore and explain complex subject matter, and enabling dialogue and mutual learning among participants, whereas mind maps can be used for brainstorming ideas and as visual medium to capture the essence of discussions. It is said that a picture is worth a thousand words. This might hold even truer for structured forms of graphic representation to capture tacit knowledge.

4.2 SKM: a working definition for PHUSICOS

The literature review employed for this deliverable yielded several concepts connected to the goal of mapping stakeholders' knowledge as described in the previous paragraph. These concepts have in common that their practitioners use them to capture knowledge visually using two types of maps: cartographic maps and node-link maps.

In the strict sense and drawn upon related-concepts' literature, Stakeholder Knowledge Mapping (SKM) can thus be understood as a set of knowledge representation practices framed in a shared space that translate tacit knowledge into explicit knowledge.

The very value of SKM lies in its function to make transparent informal personal insights (tacit knowledge) that stem from a stakeholder's experiences related to daily activities and are influenced by the socio-cultural context, using explicit symbols (words, numbers, pictures, etc.) (Lam 2000; Polanyi 1962; Keller & Tergan 2005). These symbols can be represented as abstract semantic relations among concepts (conceptual knowledge); processes (procedural knowledge); or cartographical perceptions of reality (episodic knowledge). Explicit conceptual, procedural and episodic knowledge allow summarizing and comparing complex relationships.
The SKM practitioner, e.g. the Living Lab facilitator, elicits valuable knowledge in a shared space. This is an area within which ideas and/or things move (Oxford University Press 2018), and it can be physical and virtual. While the former is attached to a territorial delimitation such as cities, towns, watersheds, national parks or neighbourhoods; the latter is related to a set of goals, values or ideas shared among the individuals who transmit ideas, e.g. companies, internet communities, political parties.

For the demands of the PHUSICOS context, the SKM concept needs to be further operationalized. Taking especially into consideration the multiple purposes which the present Toolbox is expected to deliver to the Living Labs (see Chap. 1 and 5), it is recommendable to interpret the notion of Stakeholder Knowledge Mapping in a wider sense. The corresponding working definition can thus be formulated as follows:

In PHUSICOS, Stakeholder Knowledge Mapping (SKM) is defined as an umbrella term and concept for the analysis of stakeholder knowledge, including knowledge inventory and stock-taking, knowledge elicitation, knowledge representation and knowledge assessment. As important pillar of stakeholder analysis, it is preceded by a sound stakeholder identification, and targets to leverage local stakeholders' knowledge towards a successful co-creation of NBSs.

This understanding of SKM (see Figure 5) allows for further methods and tools going beyond mapping techniques, but still being useful for the Living Labs at the demonstrator and concept case sites of PHUSICOS.

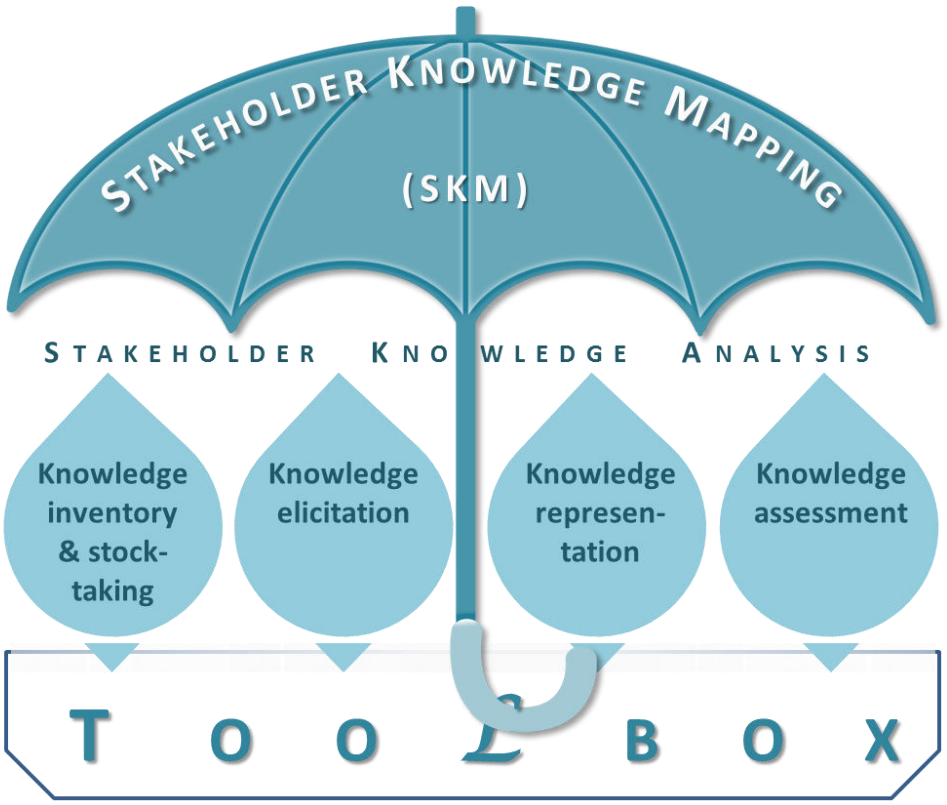

Figure 5. Stakeholder Knowledge Mapping (SKM) as an umbrella concept in PHUSICOS – a working definition. Design: C. Smida & S. Fohlmeister

As it is one of the objectives of PHUSICOS to engage a diverse range of stakeholders, scientists and practitioners through the Living Lab approach and lead to innovative ways of co-developing and co-designing NBSs for achieving sustainable hazard and risk management, a key question is: How can such a new way look like? Knowledge visualization is seen as promising approach that can help individuals and groups from different social, cultural and professional backgrounds with the co-creation of innovative solutions and to cope with the increasing complexity of tasks (Tergan & Keller 2005).

Visual representations are used with the goal to improve the transfer of knowledge and to catalyse new knowledge in collaborative settings (Burkhard 2005). Thus, knowledge visualization builds upon the powerful innate human abilities to process visual information. Ware (2005: 29) postulates that "the power of visualization comes from the fact that it is possible to have a far more complex concept structure represented externally in a visual display than can be held in visual and verbal working memories".

The following sub-chapter thus introduces the *Knowledge Visualization Framework* by Burkhard (2005) as a possible guidance to put SKM into practice.

4.3 Key questions to operationalize SKM

Based on the work by Gupta and Govindarajan (2000), Burkhard (2005: 240) determines five elements as decisive for a successful knowledge transfer: "(1) the perceived value of the sender's knowledge, (2) the motivation and willingness of the sender to share his knowledge, (3) the existence and richness of transmission channels, (4) the motivation of the recipient to acquire knowledge from the sender, and (5) the absorptive capacity of the recipient, i.e., the ability not only to acquire but also to use knowledge."

These factors show that a good part of a successful knowledge elicitation and visualization process depends on the *outsiders* or the party which applies SKM, what underscores the meaning of a sound preparation to such a process on this behalf.

A proper means to do so can be the Knowledge Visualization Framework (KVF) suggested by Burkhard (2005), offering four perspectives and key questions for outlining the path from intention to practice:

- The **function** perspective asks **why knowledge should be visualized** (aim);
- The **knowledge type** perspective questions **what type of knowledge** needs to be visualized (content);
- The **recipient type** perspective asks **who is being addressed,** i.e. who is the target group and what is the audience's background (recipient). This perspective is the base to define the last perspective, the visualization type perspective.
- The **visualization type** perspective asks **which method is the best to visualize this knowledge** (medium), e.g. architects use a sketch, diagram, image, map, object, interactive visualization or story.

The function perspective: Why should knowledge be visualized?

According to Burkhard (2005), the function perspective distinguishes six functions of knowledge visualization, which can easily be memorized by the so-called CARMEN-acronym. Following this, it may…

…support to coordinate individuals in a communication process (**C**oordination);

…allow getting and keeping attention, e.g. by identifying patterns (**A**ttention);

…ease remembrance and recall (e.g. conceptual diagrams) (**R**ecall);

…motivate and activate participating actors (e.g. knowledge maps) (**M**otivation);

…promote knowledge co-production in teams (e.g. scenario discussion) (**E**laboration);

…lead to the creation of new insights (**N**ew Insights).

In PHUSICOS, Stakeholder Knowledge Mapping can potentially be a fruitful contribution especially for its function to guide the Living Lab participant groups through their communication processes in a structured and coordinating manner. Moreover, corresponding tools may motivate and activate the Living Lab participants to co-create knowledge being valuable to the intended NBSs' implementation, which can also lead to new, innovative insights.

The knowledge type perspective: What type of knowledge needs to be visualized?

Using the knowledge type lens can ease the identification of the type of knowledge that is meaningful in a knowledge mapping process. For his framework, Burkhard (2005: 245) differentiates five knowledge types: Know-what (declarative knowledge, e.g. facts); Know-how (procedural knowledge, e.g. processes), Know-why (experimental knowledge; e.g. causes); Know-where (orientational knowledge; e.g. knowledge sources) and Know-who (individual knowledge, e.g. experts).

In the PHUSICOS context, all of the mentioned knowledge types can be of importance to the further development of the intended NBSs at the demonstrator and concept case study sites. For the local facilitators it will be likewise of relevance to explore the Living Lab participants' declarative knowledge on NBSs as well as possible knowledge gaps, so that valuable contributions can be made by the remaining Work Packages to fill them, e.g. by means of tailored trainings in NBS awareness building or distinct technical contents.
Furthermore, local stakeholders' individual and orientational knowledge can be decisive to detect further stakeholders and potential knowledge sources being *invisible*, but key to the process. Experimental knowledge seems also worthwhile to be explored, e.g. on the background of assessing the perception on NBSs, potentially existing barriers and their underlying causes as well as the search for ways to overcome them. Last but not least it should be noted that some knowledge types might be useful inputs to construct others.

The recipient type perspective: Who is being addressed?

To consider the recipient type perspective is meaningful for detecting the target group and context of the knowledge mapping's recipients, which might be individuals, a team or even network of people (Burkhard 2005). SKM practitioners should be familiar with and well-informed about the context and cognitive background of the stakeholders whose knowledge they intend to capture and leverage, as this is decisive for the choice of suitable knowledge analysis methods and tools (see Part B, Chap. 6).

In PHUSICOS, local facilitators should carefully decide upon the stakeholder set-up they are in need of for working on a distinct issue (e.g. problem identification and exploration; NBS selection; NBS co-design; NBS evaluation), and systematically employ stakeholder identification and analysis tools for this purpose (see D3.1 Guiding Framework or this deliverable, Chap. 6.2.2 for Stakeholder identification and analysis tools).

The visualization type perspective: Which method is the best to visualize this knowledge?

Based on the previous steps, methods and tools can be chosen accordingly for the SKM exercise of interest. For doing the right selection amongst a multitude of existing tools, it is advisable to take into consideration available resources (e.g. time, skills, and financial resources), necessary pre-conditions (e.g. logistical setting, material, and computer-aided support), tools' individual strengths and weaknesses, and further intended proceedings with the gained results.
SKM methods might be quantitative (e.g. sketch maps drawn manually, scanned and processed with GIS tools) or qualitative (e.g. resource mapping, flowchart diagrams, semi-structured interviews with node-link map outputs). Both quantitative and qualitative methods are complementary strategies to obtain reliable and valid data. As practice indicates, the sequential application of several tools with a small number of key participants was found to increase effectiveness in eliciting local knowledge due to the large amount of details provided by them (Isaac et al. 2009; Kiptot 2007).

With regard to the PHUSICOS context, a variety of methods and tools can be applied for a diverse set of purposes of the intended Living Labs, such as the exploration of problems and possible solutions; the identification of priorities, conflictive worldviews and the potential for consensus-building among stakeholders; the comparison and selection of NBS, the NBS co-design and NBS evaluation (see Figure 6).

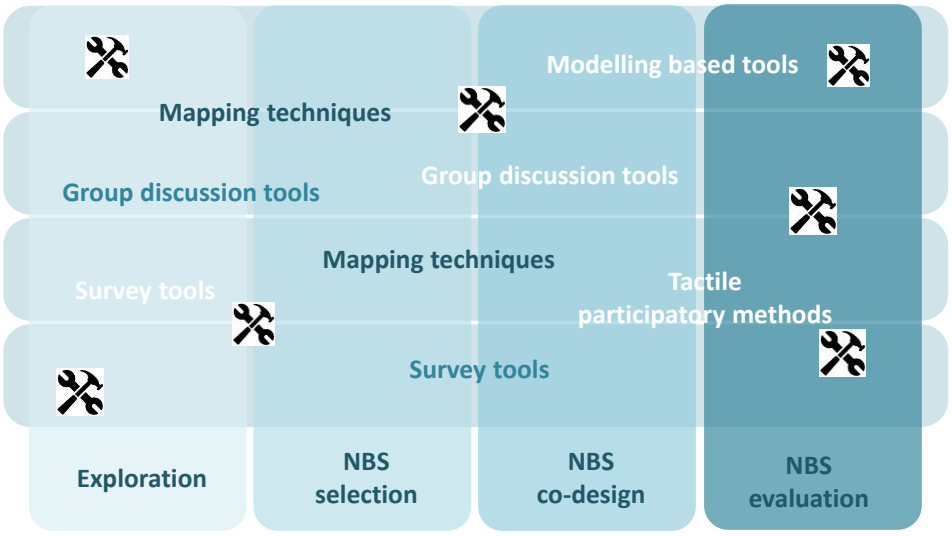

Figure 6. Methods and tools to capture and leverage stakeholder knowledge may vary depending on purposes and NBS innovation stages. Design: C. Smida & S. Fohlmeister

The up-following chapter (Chap. 5) sheds light on the background deliberations undertaken to equip the present Toolbox with methods and tools deemed useful for the PHUSICOS context. More specifically, it informs on the Toolbox' intended targets, boundaries, structure and content, and makes transparent the results of the demand assessment done with the facilitator group during the Consortium meeting in Naples 2018. Furthermore, it outlines the Toolbox' concept at a glance, and explains the systematization of the subsequent tool portraits assembled in Part B of this report.

5 Designing a Toolbox for SKM to Co-design NBSs

5.1 The frame: Targets, boundaries, structure and content of the Toolbox

The present deliverable D3.2 *Starter Toolbox for Stakeholder Knowledge Mapping to Co-Design Nature-Based Solutions at Case Study Sites* is a WP3 product that facilitators of the Living Labs may use to foster local participatory processes for the intended NBS implementation at their case sites (see Chap. 1.2 & 1.3). The Toolbox contains a variety of participatory design and communication tools from PHUSICOS-alike areas, and shall serve the following purposes:

- Eliciting stakeholder demands, concerns, interests, and existing knowledge for co-creating the intended NBSs at the PHUSICOS case sites;
- fostering dialogue among stakeholders towards a successful NBS implementation;
- assisting in priority setting and creating a common vision among participating stakeholders; and
- enabling to tailor stakeholder involvement during the NBS realization process to the individual local needs.

Based on these **targets**, the Toolbox has been conceptualized as a multi-disciplinary means of facilitating the local NBS co-design processes among many different stakeholders participating at each Living Lab site. The recommended tool set shall ultimately assist in eliciting and combining knowledge of hydro-meteorological risks, mitigation strategies, and value systems from various groups, such as researchers, civil society groups, and the private and public sectors, to bring forward NBSs which are suitable solutions in combatting disaster risk and likewise rest on common agreements by all involved parties.

On this background, the Toolbox' design had to find a suitable balance between i) narrowly focus on those resources, methods and procedures that would be the most efficient and relevant for the Toolbox' objectives; and ii) to be flexible and broad enough to cover a diversity of needs, given the Living Lab sites' widespread geography throughout the countries of Northern and Western Europe as well as their different stages of development, such as NBS exploration, selection, prototype development, or implementation.

That said, the present Toolbox does not pursue to come up with individual tool recommendations for each case site; instead, it offers a selection of 25 tools deemed relevant to the PHUSICOS context, from which the facilitators may flexibly choose according to their individual needs, skills and planned next steps in their Living Lab processes. It is likely that nuances will have to be made according to the given local setting, and that facilitators will need to customize tools for their specific contexts and stakeholder circles.

As for the Toolbox' **boundaries**, tools were pooled from fields closely related to the PHUSICOS context, such as landscape planning, participatory planning, innovation management, disaster risk management, climate change adaptation, and natural resource management (see Chap. 2). However, given the vast amount of tools available from these fields, additional filtering criteria were necessary to focus on those tools best suited to the PHUSICOS objectives connected to Stakeholder Knowledge Mapping and NBS Co-Design (see Chap. 3 & 4).
The following criteria were thus applied in order to efficiently narrow down a set of tools deemed relevant and useful to the Living Labs' future work:

Creative autonomy of stakeholders: Being considered a key principle of a Living Lab, the tools should above all serve the purpose of co-design, adequate to setting priorities and designing concrete solutions rather than solely conceptualizing the problem. They should therefore feature an inherent **creative aspect in which stakeholders have autonomy to bring forward ideas of their own**, rather than solely be focused on review or feedback mechanisms. This lies at the core of the definition of co-design, as previously outlined in Chap. 3.3 (Calleja & Marantz 2015; Chisholm 2015; Lam et al. 2017; Voorberg et al. 2014).

Participatory nature: The tools should be **participatory,** indicating their ability to enhance stakeholder interaction with the facilitator, but also, and perhaps more importantly, with each other. Horelli (2002: 11) identified some aspects of what constitutes "participatory" tools, also referred to as "enabling" tools. Enabling tools can be distinguished by their ability to:

- boost interaction and communication among participating stakeholders;
- strengthen knowledge creation; and
- uphold communication between stakeholders and the broader sociocultural environment of the Living Lab.

Integration of values, interests, worldviews and opinions: While knowledge creation, knowledge integration, and participation are all key components of co-design, another - often overlooked - component is that of combining values among stakeholders, also termed *worldviews, interests, opinions or epistemologies.* This is an idea which has precedence in scientific literature from both co-creation methodologies and participatory planning (McDonald et al. 2009; Hegger et al. 2012; Evans et al. 2017). For example, Hegger et al. (2012: 54) identified the different "knowledge interests" that stakeholders may have apart from the knowledge they possess. These knowledge interests correspond to the criteria they use to define what is relevant or important knowledge to produce. Hegger et al. (2012) uses the example of a transdisciplinary team of scientists working on a climate change project, where the regional governments of affected areas will be most interested in the safety of the areas under their responsibility, while scientists may be most interested in producing knowledge related to the development of new flood models. In their toolbox on group discussion-based research integration methods for transdisciplinary research, McDonald et al. (2009: 89-91) use the **integration of**

"visions, worldviews, interests and values" as one of the two primary categories for tools. They further define visions as "aspirations about dealing with a problem", worldviews or values as "assumptions that each of these hold about how the world works in relation to the problem under consideration" and interests as "motivations for getting involved in the understanding of the problem" (McDonald et al. 2009: 89-90). In this sense, visions, worldviews, interests and values exist as auxiliary factors to the knowledge that stakeholders hold and are capable of producing, and will have an effect on the way they communicate and share that knowledge in a participatory setting. It is therefore necessary to integrate such visions, worldviews, interests and values in order to reach a shared understanding on which knowledge integration or co-production can take place. In fact, within the co-creation and Living Lab literature itself, the importance of "value-mapping" among stakeholders is recognized. In their Living Lab methodology handbook, Evans et al. (2017: 20) state that "the aim of the co-create step is to develop several conceptual ideas that answer the needs and values represented in the [stakeholders]". Given the widely recognized significance of integrating values and priorities among stakeholders, this is a component which had to be addressed by the resulting tool set.

Accessibility to facilitators: Another important aspect for inclusion to the present Toolbox was the **accessibility** to the Living Lab facilitators. For this purpose, tools which are open source, publicly available and do not require payment to access were considered ideal for inclusion. While tools which are copyrighted or acquired through a paid consulting service were not automatically excluded from consideration, efforts were made to emphasize those tools which require the least budgetary demand from the case study sites' facilitation teams. The aspect of accessibility was not only deemed relevant related to budgetary items, but also in terms of complexity levels. Tools of a low to medium level of complexity were considered to be preferential for inclusion in the Toolbox, as the cost-benefit ratio of using highly technical, computer-based or overly complex tools[4] might interfere with implementation. Nevertheless, facilitators having a special interest in tools of higher complexity levels shall feel encouraged to apply them in their Living Lab processes.

Concerning the **structure** of the presented Toolbox, it was built on several background considerations. On the one hand, the sequence of a Living Lab process – and herein especially the division into Living Lab set-up (see Chap. 6.2) and Living Lab working process (see Chap. 6.3) – was considered a useful structuring element for a later tool selection on behalf of the PHUSICOS facilitator group. On the other hand, the structure was inspired by a sound screening of other toolboxes and toolkits (see Chap. 2 and Chap. 6.4), which enabled to come up with ideas on the tool portrait template design (see Chap. 5.3) as well as on relevant traits and display options. This very toolbox and toolkits' screening process served not only to orientate the Toolbox' structure, but also as a step to compile further reading material and an informative overview table to the current toolkit landscape in PHUSICOS-related contexts (see Chap. 6.4, Table 4).

4 For this reason, powerful and useful tools of high complexity levels, such as Robust Decision Making (RDM), Participatory Dynamic Systems Modelling or serious games, were not included in the presented Toolbox.

Furthermore, the Toolbox' structure was aided by expert consultation within and outside the PHUSICOS context (see Chap. 2). This contributed especially to identify commonalities and differences between the proposed tools, which consequently led to their systematization into suitable clusters (see Chap. 6). Within these clusters, an alphabetical order of the tools was applied for better orientation.

Apart from the previously outlined background considerations, the Toolbox' **content** was conceptualized with the intention to best possibly address the tool demands articulated by its users, the facilitator teams of the local demonstrator and concept case sites of PHUSICOS (see Chap. 5.2). Nevertheless, it is important to note that, while the feedback gained from expert consultation, facilitator interviews and the Tool Corner exercise (see Chap. 2) were undoubtedly useful for developing the Toolbox, the feedback given therein reflects only the state of affairs at the time which it was gathered, and does not preclude the possibility of changes to the needs and demands of case site facilitators in future stages of the PHUSICOS project.
Therefore, the resulting set of tools was assembled with the *current picture* in mind, but likewise with *enough room* to adapt to the needs of facilitators in the future.

5.2 The demand: Tool demands of PHUSICOS case sites

To make transparent the tool demands of the PHUSICOS case sites, two main perspectives were captured, elicited and taken into consideration for the Toolbox design: on the one hand, and most importantly, the facilitators' perspective on own tool demands was thoroughly assessed on behalf of semi-structured interviews, and results analysed in order to identify preferences, desired information on the tools' application and special aspects being relevant for the Toolbox' operationalization.
On the other hand, tool demands were also judged from the perspective of experts being familiar with the PHUSICOS context, thus enabling to compare and synthesize both viewpoints into a joint picture (see Chap. 2 and Annex A for interview design).

To gain sufficient insight into the planned stakeholder processes and application parameters involved, a total of eight semi-structured interviews were conducted, two with experts in the field of disaster risk management and six with case study site facilitators (one for each case study site except for two with each facilitation partner of the Pyrenees case study site). From the responses given on both open questions and Likert-scale rated questions, the conclusions outlined in the following paragraphs were drawn.

5.2.1 Tool demands from Experts' perspective

The two experts interviewed offered insights into the main factors that can contribute to a successful stakeholder involvement process, socio-cultural factors that play a role in disaster risk reduction (DRR) practices, and on their past experience utilizing participatory planning tools. Both experts have extensive experience working in participatory planning, especially in developing countries, with one expert having

considerable experience conducting participatory planning practices in relation to flood and landslide risk in Asia. Experts were first asked what insights they could contribute from these past experiences. One significant aspect that was brought up is the importance of proper communication with stakeholders when conducting DRR planning, as many stakeholders are not fully knowledgeable of the level of risk and probability of hazard occurrence (e.g., landslide or floods). Some stakeholders may not be able to place terms such as *50-year flood event* or *100-year flood event* into the context of their daily lives. For this reason gaps in knowledge among stakeholders need to be properly addressed so that a stakeholder involvement process can take place with everyone at a common understanding.

Secondly, the experts highlighted the need to approach all participatory planning and design practices with cultural sensitivity, as the definition of what constitutes a truly *participatory* process and what level of participation is acceptable may differ among cultures at each case site. For cultures that are used to strict hierarchical structures or high levels of bureaucratic authority, a lower level of participation during the project's limited lifespan may need to be accepted, whereas cultures with a strong legacy of fully democratic decision-making and open fora will be better equipped to handle full co-design and even give stakeholders full ownership of the planning practices. Both experts highlighted the central role that differing worldviews and value systems among stakeholders play in their interactions and in the outcome of the stakeholder involvement process. One such example is the dichotomy between consequential/individualistic worldviews compared to egalitarian or moralistic worldviews. Based on differing value systems, different communities will frame a problem differently. For example, when answering the questions "What is the main problem resulting from a landslide?" or "What caused this landslide?", different stakeholders will answer differently based on their particular worldview and set of values. When facing contested issues, without recognizing all the major worldviews present, a complete solution will be difficult to co-design among the stakeholders, as not all groups will feel that their particular views, shaped by their value systems, are being heard, responded to, and/or addressed. The importance of discovering the *worldview narratives* of different stakeholders in the early stages of the stakeholder involvement process was emphasized, in order to both identify potential conflicts as well as to make stakeholders aware of each other's different value sets, thereby facilitating dialogue.

Other factors that were identified potentially affecting the stakeholder involvement processes either positively or negatively, were the semi-rural nature and the importance of the agricultural sector at each case site. The semi-rural nature may present a benefit to the project work, as the local communities are more closely linked to local ecosystems than communities in an urban setting, and therefore the concept and attributes of NBSs may be better integrated as a solution. The strong agriculture presence at most case sites, however, was indicated as potentially resistant, given that the income of each community is strongly linked to the land and therefore any change to the land as a result of proposed NBSs will be under intense scrutiny. Furthermore, additional barriers to landscape change from NBSs may arise due to environmental regulations such as wildlife and habitat protection present at some case sites. Such regulations must be respected during

the NBS co-design process, highlighting the need of tools that can effectively and concisely communicate the environmental limits of NBS design during stakeholder involvement in co-design.

The experts also recommended specific tools that would be most applicable in the PHUSICOS context, based on their past experiences applying tools in other participatory processes. They identified the most important purposes for the PHUSICOS toolbox as identifying relevant stakeholders, exploring opinions and worldviews among stakeholders, eliciting local knowledge contributions for the realization of NBSs and making decisions in complex multi-stakeholder settings. The goal of fostering group cooperation was seen as not being fully achievable by the toolbox, as this depends in large part on the soft skills of the facilitator leading the process. Measuring the efficiency of NBSs is more of a technical aspect to be done after the participatory work, whereas the toolbox should be focused on working with people and ideas. When specifying tools, the experts identified snowball sampling and the Interest-Influence Matrix as especially useful for identifying stakeholders and discourse analysis, focus group interviews and World Café style group discussions when exploring value systems held by stakeholders. Other tools that were indicated by experts as being particularly useful in similar stakeholder processes they had participated were the Delphi Technique, Participatory GIS, Participatory Scenario Planning, and serious games. In general, the experts suggested that tools with a low to medium level of complexity should be emphasized for inclusion in the final toolbox.

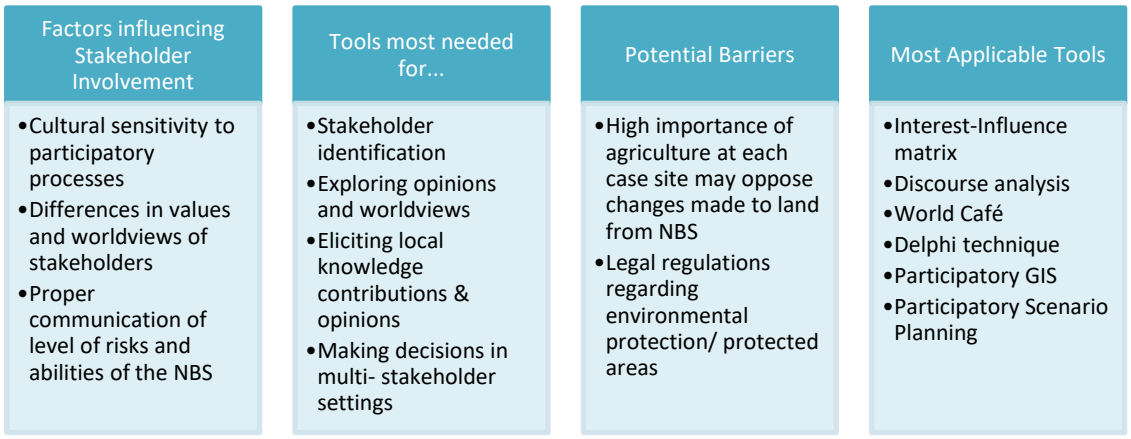

Figure 7. Expert consultation findings summary. Design: C. Jones 2019

5.2.2 Tool demands from Facilitators' perspective

Gudbrandsdalen Valley, Norway (Demonstrator Case Site)

The facilitation team of the Gudbrandsdalen case site indicated that their aim for the stakeholder involvement process was to engage stakeholders to the maximum extent possible, including a full co-design process and creating a sense of ownership among the stakeholders. Given the multiple locations of the Gudbrandsdalen demonstrator case,

each site differs slightly in its needs and planning of stakeholder processes (see Chap. 1.1). For the southern part of the river valley, there is already a long-existing stakeholder process in place from which possible NBS measures have been selected. Therefore, this part of the valley is now ready for the implementation of NBS measures. There is a clear consensus present on the types of NBSs desired and how implementation should proceed.

In the central valley, there is a preference of traditional grey solutions. This might be an obstacle to further progress on stakeholder involvement. Specifically, the outtake of gravel from the river bed is viewed as viable solution due to past use of this technique in the valley and economic and political support for the measure. It is likely that this situation will require mediation expertise to resolve, and therefore may not be handled within the scope of the PHUSICOS project. However, it is in this part of the valley where tools for consensus-building and conflict resolution would be the most needed tool types.

A full Living Lab process is intended to be conducted in the northern part of the valley, where the greatest potential exists for having a full stakeholder involvement process. It is also in this part of the case study site where the PHUSICOS toolbox will be most useful, and to which the majority of the feedback from the facilitation team was directed. Currently, there is already an existing consensus regarding the need for flood prevention, and the problems at stake in the community from prior flood prevention legislation and participatory processes focused on the issue. However, an agreement must still be reached regarding the concept of NBS and the selection of appropriate NBS types for the area. Therefore, tools are most needed for the northern valley related to the Exploration & NBS Selection phases.

The main toolbox purposes which need to be met for the Gudbrandsdalen facilitation team are thus tools for exploring the opinions and worldviews of stakeholders, eliciting local knowledge contributions and making decisions in multi-stakeholder settings. The team indicated a special interest in using tools from the categories of modelling & scenario analysis as well as group discussion tools. The Gudbrandsdalen facilitation team possesses already experience in implementing tools such as World Café, focus groups and participatory scenario analysis through the use of hydrological models. However, it was emphasized that simple tools that could be applied in an informal manner with low material input were of primary importance for the site, as tools which were overly academic or relied heavily on technology might intimidate non-technical stakeholders and inhibit the beginning stakeholder involvement process in the northern valley. The team also indicated that tools which could overcome uneven power dynamics within groups, such as anonymous survey techniques, would be useful for their case site. Regarding the set up and format of the resulting toolbox, the Gudbrandsdalen facilitation team emphasized the importance of including case studies that illustrated past examples of how the tools had been applied in situations similar to the PHUSICOS project, as this would greatly assist in planning their own application procedures for the tools.

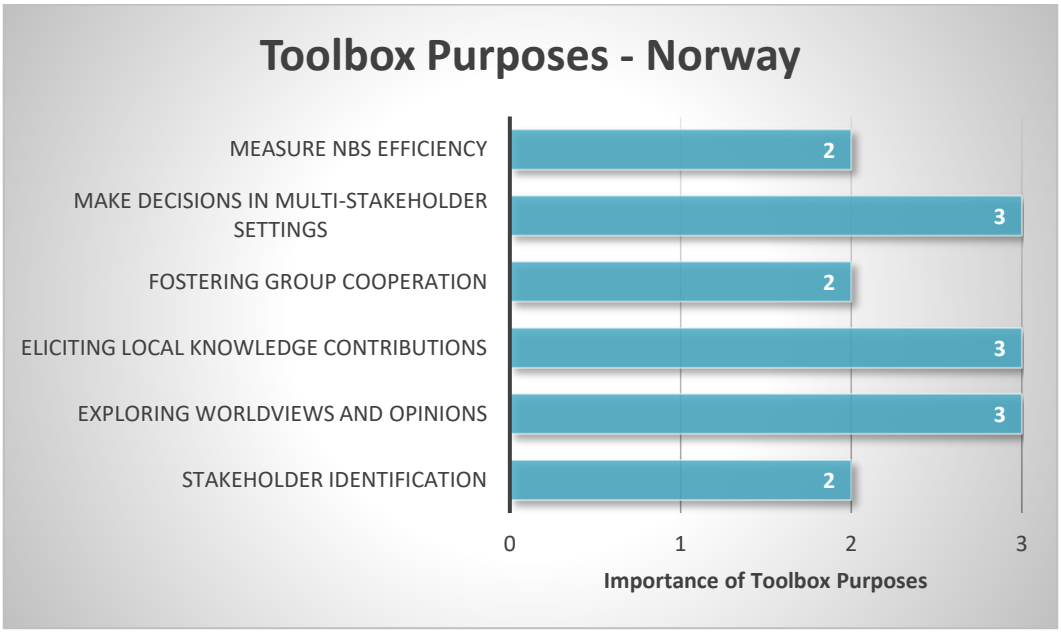

Chart 1. Gudbrandsdalen Likert question "Toolbox Purposes" responses. Questions were answered on a Likert scale of 0= not intended, 1= not important, 2= somewhat important, 3= very important. Design: C. Jones 2019

Current and Intended Stakeholder Involvement	Tools needed for...	Potential Barriers	Tool Category Preferences
•Full Living Lab process only at northern section of case site •Emphasis on Exploration & NBS Selection •Strong legacy of participatory processes in the area	•Explore opinions and worldviews •Elicit local knowledge contributions • Conflict resolution • Equalize power dynamics	•Skepticism regarding effectiveness of NBS •Potential resistance from agriculture & hydropower industries	•Group discussion tools •Modelling & scenario analysis tools •Suitable for use by non-technical stakeholders

Figure 8. Gudbrandsdalen interview findings summary. Design: C. Jones 2019

Serchio River Basin, Italy (Demonstrator Case Site)

For the Serchio River Basin facilitation team, the main aim of the stakeholder involvement process is to decide upon both the type of NBSs to be utilized and the location of the NBSs selected. For this reason, the stakeholder involvement process is primarily focused on the NBS Selection phase. The majority of stakeholder groups have already been identified and a generalized understanding of the problem at hand has already been reached among current stakeholders. For this reason, stakeholder identification and analysis tools are not regarded as necessary for the Serchio River case site. The integration of NBSs within existing agro-ecological systems and planning for the maintenance of the selected NBSs are also secondary concerns of the Serchio River Basin facilitation team to be addressed within the stakeholder involvement process. Full involvement of stakeholders at an active cooperation/co-design level is still uncertain, as the ability of all stakeholder segments to participate in co-design is questioned due to the varying technical expertise among stakeholders. Stakeholders are, however, intended to be involved in all further stages (e.g. implementation, assessment), but these are currently of a secondary priority level.

Regarding potential conflicts among stakeholders, most sensitive groups are farmers and other agricultural stakeholders as well as conservation NGOs and representatives of the protected area located within the site's boundaries. Efforts for communication have been partly unanswered, indicating a demand of better addressing the specific concerns, expectations and availability of the agricultural and ecological protection stakeholder groups. Tools specifically designed to encourage the farmers' participation are needed, as this is a very influential and important stakeholder group in the case site area and their cooperation will probably contribute to greater success of the planned interventions. Additionally, the main toolbox purposes for the Serchio River Basin case site are exploring worldviews and opinions and eliciting knowledge contributions from these local stakeholders.

To achieve these purposes, the main tool categories that the Serchio River Basin facilitation team feels would be useful are group discussion tools and mapping & geo-design tools. These tool categories were emphasized over categories such as opinion-gathering/survey techniques because they focus on *real* participation, rather than simply gathering feedback from stakeholders. Hands-on and scenario analysis tools were identified as being of secondary importance for the site's tool needs. The Serchio River Basin facilitation team underpinned the need for the toolbox to differentiate between which tools are useful for which kinds of stakeholders, by including some guidance regarding which tools would be most suitable for non-technical and technical stakeholders. The team also indicated that including past use cases of tools as examples within the toolbox would be useful guides for how the tools can be applied in similar contexts.

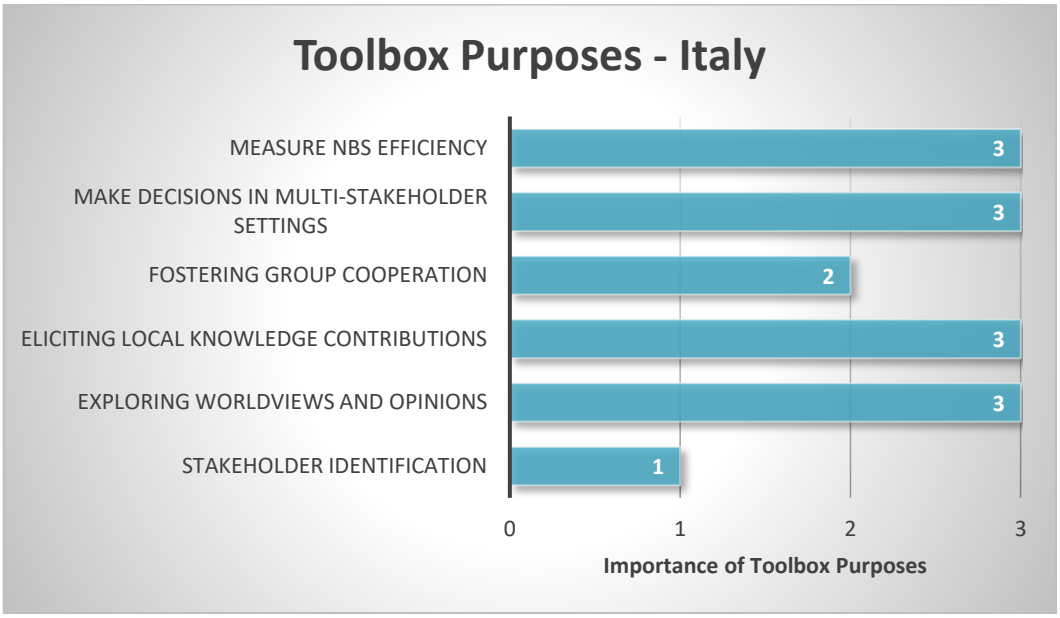

Chart 2. Serchio River Basin Likert question "Toolbox Purposes" responses. Questions were answered on a Likert scale of 0= not intended, 1= not important, 2= somewhat important, 3= very important. Design: C. Jones 2019

Current and Intended Stakeholder Involvement	Tools needed for...	Potential Barriers	Tool Category Preferences
•Mainly involve stakeholders on a consultative level •Main focus is on the NBS Selection phase	•Conflict resolution (especially for agriculture sector) •Eliciting local knowledge contributions •Exploring worldviews and opinions	•Likely sensitivity on behalf of farmers and NGOs representing the interests of the wildlife protected area (RAMSAR site)	•Group discussion tools •Mapping & geo-design tools •Simple tools for non-technical stakeholders

Figure 9. Serchio River Basin interview findings summary. Design: C. Jones 2019

Pyrenees, France-Spain (Demonstrator Case Site)

Given the special transboundary nature of the Pyrenees case study site, the facilitators from both countries were interviewed separately, in order to gain a better insight into the particular concerns of stakeholders and local conditions. One important note when considering tool recommendations for the Pyrenees case study site is that the site selection for NBS interventions is still ongoing, as several potential sites exist, with one crossing the boundary between France and Spain and another one existing entirely in the French part of the case site (see Chap. 1.1). For this reason, a consensus on where the stakeholder involvement processes will be carried out and what is needed is still not complete[5]. Despite this, a common goal for the stakeholder involvement processes that was echoed by both representatives of the facilitation team was to create a joint vision and objective for the selection, design and implementation of NBSs.

In order to reach it, a mostly informational campaign is intended to be used to target stakeholders and involve them in a later Living Lab process. The main reason for this choice is the need for awareness-raising regarding the importance of NBSs and to achieve more security of the local communities. While the potential for a full co-design process certainly exists, such a possibility will largely depend on the stakeholders which end up being involved in the final process. It is most likely that such a process will only be undertaken among technical stakeholders involved and not with the full range of stakeholders. As this case study site is still in the initial Living Lab stages, the phases of Exploration and NBS Selection were indicated to be the primary focus for the stakeholder involvement process, with Exploration being the most important phase at the moment. The main stakeholders thus far identified include the Parc National des Pyrenees, the municipal administration of Laruns (France) and Biescas (Spain) and the environmental administration of the region of Aragón (Spain). Planning bodies from these administrative units in the fields of geology and disaster risk reduction, as well as the cooperation consortium, the European Groupe of Territorial Cooperation (EGTC), called “Espacio Portalet” composed by the regional government of Aragon, Spain and the Pyrénées-Atlantique Department of France, have also been identified as important stakeholders. The facilities provided by the EGTC on the Portalet side of the border will act as the main meeting point for stakeholders and facilitators.

The facilitation team indicated that there is a possibility that conflicting views may arise among stakeholders; this is very much due to the difference in bureaucratic organization and governance structures between the two countries, calling for a sound coordination between multiple national institutions. Additionally, it is anticipated that certain economic sectors within the region would have a strong voice and influence over the stakeholder process. Winter tourism is extremely important for the local economy in the form of ski resorts, and therefore any stakeholder processes planned would need to be able to cater to the needs of these stakeholders. Agriculture was also identified, in the French side, as sensitive sector that may influence the process, as the planned NBS measures at hotspot areas along the mountain road will likely impact farmland. For this reason, an outreach including private stakeholders in the tourism and agriculture

[5] According to available information to WP3 as of March, 2019.

industry will be necessary in order to reach a full consensus on any planned measures to be undertaken.

Regarding the most important objectives to be fulfilled by the toolbox, the facilitators indicated that exploring opinions and worldviews, eliciting local knowledge contributions and measuring the efficiency of NBSs were for them the most relevant purposes for the application of tools. In terms of prior tool familiarity, the facilitators already have experience in participatory scenario planning, survey techniques such as online surveys, questionnaires and group discussion techniques such as World Café. They also indicated past experience with serious games, however, they felt that the execution of this particular tool was too complex and time consuming for the current stakeholder process. In regard to needed tool categories, the French facilitators specifically indicated the importance of having access to combinations of visualization tools and group discussion techniques to better display and record the results of the discussions, while the facilitator of the Spanish part of the case study site indicated a preference for combining group discussion and opinion-gathering methods. Both facilitators felt that mapping & geo-design tools would be imperative for inclusion and proper co-design. In closing, the facilitators stated that their highest priority for the toolbox was that the tools included be simple to apply with the widest possible variety of stakeholders. They further indicated that guidance provided for each tool should include a list of their strengths and weaknesses, as this would be useful in order to better relate its potential applicability to their local context

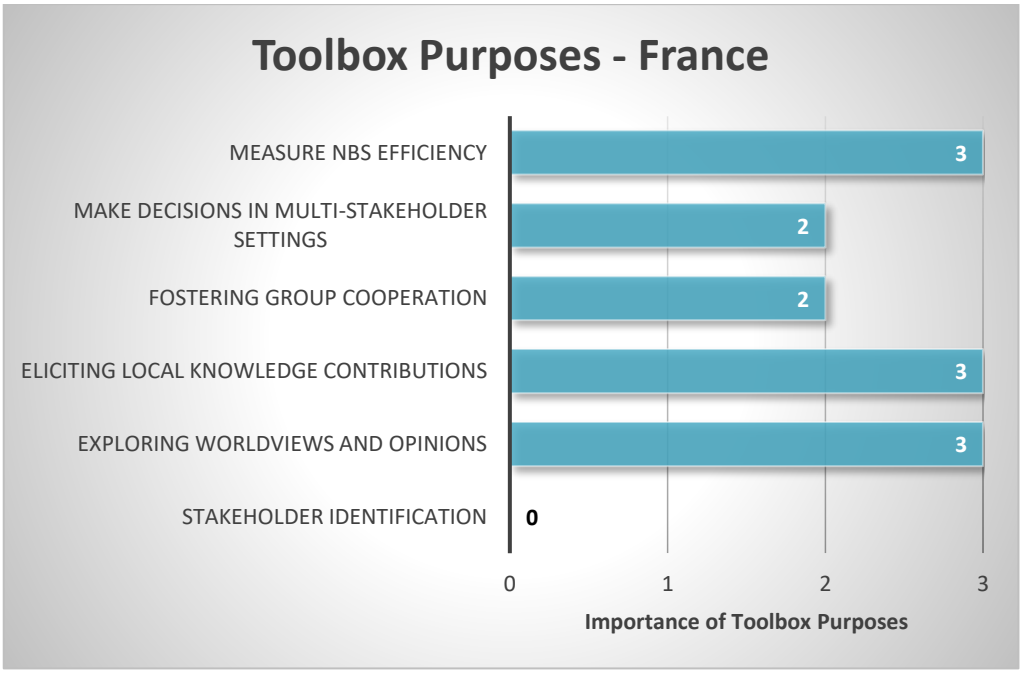

Chart 3. Pyrenees - French side Likert question "Toolbox Purposes" responses. Questions were answered on a Likert scale of 0= not intended, 1= not important, 2= somewhat important, 3= very important. Design: C. Jones 2019

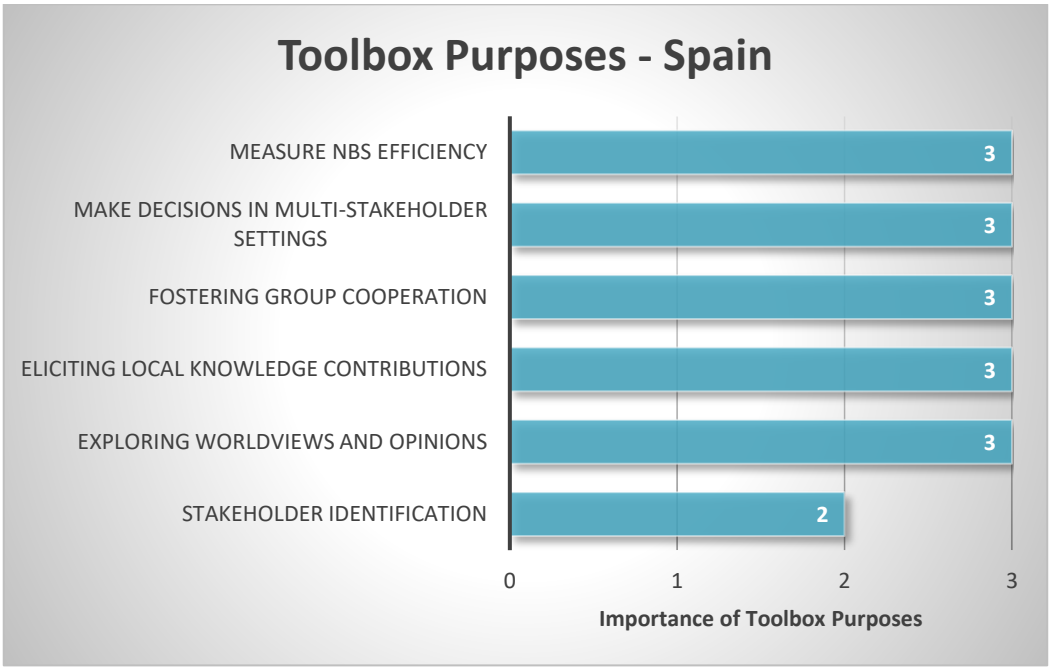

Chart 4. Pyrenees-Spanish side Likert question "Toolbox Purposes" responses. Questions were answered on a Likert scale of 0= not intended, 1= not important, 2= somewhat important, 3= very important. Design: C. Jones 2019

Current and Intended Stakeholder Involvement	Tools needed for...	Potential Barriers	Tool Category Preferences
•Main administrative, political, and planning bodies already identified •Potential to include private stakeholders (tourism & agriculture), but still need to be identified •Main focus is on NBS Selection phase	•Exploring opinions and worldviews •Measuring efficiency of NBS •Eliciting local knowledge contributions •Foster long term commitment to the project from stakeholders	•Potential sensitivity of winter tourism and agriculture sectors •Bureacratic and governance differences between countries may slow down the process and demand sound coordination	•Group discussion tools •Visualization tools (both simple & technical options) •Opinion-gathering tools (to be used as complements to group discussion) •Emphasis on simple tools that can be understood by a wide range of stakeholders

Figure 10. Pyrenees interview findings summary. Design: C. Jones 2019

Kaunertal Valley, Austria (Concept Case Site)

At the Kaunertal Valley case site, the intention for the stakeholder involvement process is to include stakeholders on active cooperation and co-design levels, with eventual advancement to complete stakeholder ownership of the stakeholder process where possible. The primary goals of stakeholder involvement are to improve the acceptance of the already selected NBS measure in the community, and to raise awareness regarding the potential of NBSs for disaster risk reduction in the Kaunertal Valley and other similarly affected regions of Austria. Hereby, it is important to note that the facilitator team feels that including stakeholders in co-design will strongly depend on the type of stakeholder, as for the initial stages of the planning process (e.g. Exploration and NBS Selection) local inputs and knowledge have been the most important (e.g. local land use and location-based knowledge and permissions for actions), while for later stages (e.g. NBS Co-Design and Assessment) technical and expert stakeholders will be meaningful in addition to local stakeholders (e.g. site selection, technology implementation).
The primary phases of importance for the inclusion of stakeholders at the Kaunertal site are thus the co-design, implementation, evaluation and upscaling stages. While the stakeholders for the initial stages (Exploration & NBS Selection) have already been identified, stakeholder identification for co-design and implementation phases is still ongoing. Overall, the Kaunertal stakeholder involvement process benefits from having stakeholders that are clearly willing and enthusiastic about participating in the process, with no identified conflicts among the current stakeholders being in place. Additionally, given the rural nature and small size of the community surrounding the site, many of the local stakeholders are closely connected to each other. This benefits cooperation, but also requires a high degree of authenticity, engagement and clear objectives throughout the stakeholder process. One important point regarding conducting the stakeholder involvement process at the Kaunertal site is that past participatory planning processes involving stakeholders at the location have resulted in negative experiences, and therefore an especially high level of engagement with stakeholder concerns is necessary to counteract any bias towards the process that stakeholders may have.

The main purposes of the toolbox for the Kaunertal site are to explore the worldviews and opinions of the stakeholders, elicit local knowledge contributions, and to assist with decision making in a multi-stakeholder setting. Fostering group cooperation and measuring the efficiency of selected NBS measures are considered of secondary importance, and are foreseen to be particularly useful in the future transfer and up-scaling of technology outside of the Kaunertal Valley to other related projects and sites. To this end, group discussion and opinion-gathering tools are of primary importance, with hands-on visualization tools playing a supporting role. Tools which support the documentation of decisions and of the consensus reached are also needed, especially within largely oral or informal tools where mechanisms for the review and synthesis of decisions would be needed. The Kaunertal facilitation team emphasized the need for easy-to-use tools which are not too academic in nature in order to be suitable for the wide range of non-expert stakeholders currently involved at the case site. Simplicity of use and of structure in tools is important due to the desire of the Kaunertal team to utilize informal group discussion techniques and events, such as outdoor gatherings (e.g.

barbecues) with stakeholders, as a way to better engage with the already closely-knit community and benefit from the existing social networks.

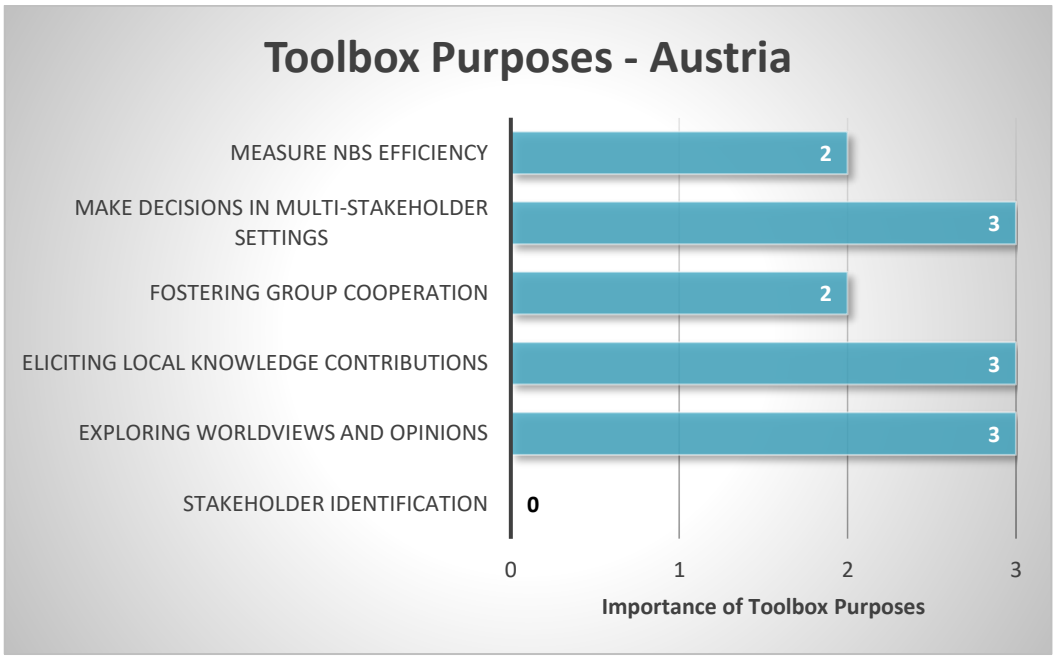

Chart 5. Kaunertal Valley Likert question "Toolbox Purposes" responses. Questions were answered on a Likert scale of 0= not intended, 1= not important, 2= somewhat important, 3= very important. Design: C. Jones 2019

Current and Intended Stakeholder Involvement	Tools needed for...	Potential Barriers	Tool Category Preferences
•Improve acceptance of already selected NBS measure •Raise awareness on NBS potential •Primary involvement in the NBS Co-Design, Implementation and Evaluation phases	•Exploring opinions and worldviews •Eliciting local knowledge contributions & opinions •Upscaling and handing over ownership of the process to local stakeholders	•Past negative experiences from stakeholder processes in the area •Highly interlinked local stakeholders, resulting in high expectations regarding results and engagement	•Opinion-gathering & survey techniques •Group discussion tools •Tools for documentation of decisions taken and consensus reached

Figure 11. Kaunertal Valley interview findings summary. Design: C. Jones 2019

Isar River Basin, Germany (Concept Case Site)

The main role of the Isar River Basin case for PHUSICOS will be to provide learning examples to gain insights regarding NBS implementation, processes to find solutions and upscaling. With already active involvement of local citizens and NGOs and on-going public participation processes, stakeholder involvement for PHUSICOS aim primarily at retrospective evaluations of the most suitable NBSs for the case site, with a special focus on the upscaling potential of the selected NBSs to other areas of the Isar River Valley and beyond. Therefore, work with stakeholders targets primarily on informational and consultative levels. The local need analysis showed that the most important stages for the current stakeholder process at the Isar are the Exploration and the NBS Selection stages6, with the co-design phase remaining of secondary importance.

Regarding the existence of potential barriers to the stakeholder process, the main concern identified by the facilitator is the presence of key economic sectors which have vested interests in the continuity of the Isar river and maintenance of water volume.. Furthermore, landowners in the vicinity of the river are considered sensitive groups, as changes to the river system from NBS implementation could increase pressure on very limited available land in a fast growing metropolitan area. For these reasons, the most needed purposes for the toolbox, as identified by the facilitator, are eliciting knowledge contributions of local stakeholders, fostering group cooperation, using tools to assist with making decisions and comparison of NBS options in multi-stakeholder settings. Focusing on these purposes would assist the Isar site's stakeholder process to better utilize the existing knowledge base and support of its largest stakeholder group as "local experts", while also fostering better inclusion of as yet uninvolved stakeholders.

In regards to the content of the resulting toolbox, the Isar site facilitator indicated that an emphasis should be placed on practical tools which could be easily implemented in group settings with a wide range of stakeholders, rather than tools which focused on discussing or working with abstract concepts and methods. Tools which emphasize focus group discussion on specific, identifiable issues or which work with concrete data would fit better with the existing organic and highly self-organized nature of the stakeholder involvement process. This is especially important given that the largest stakeholder group at the Isar site is that of local citizens and NGOs, and therefore an emphasis needs to be placed on tools which are easily accessible and usable by non-expert stakeholders. The most interesting tools mentioned by the facilitator were those for up-scaling purposes such as mapping & geo-design tools, modelling & scenario analysis methods and other, simpler types of visualization tools.

Group discussion and opinion gathering methods were not deemed as important, as the case site has already conducted successful group discussions and hearings and therefore maintains a strong dialogue among the stakeholders.

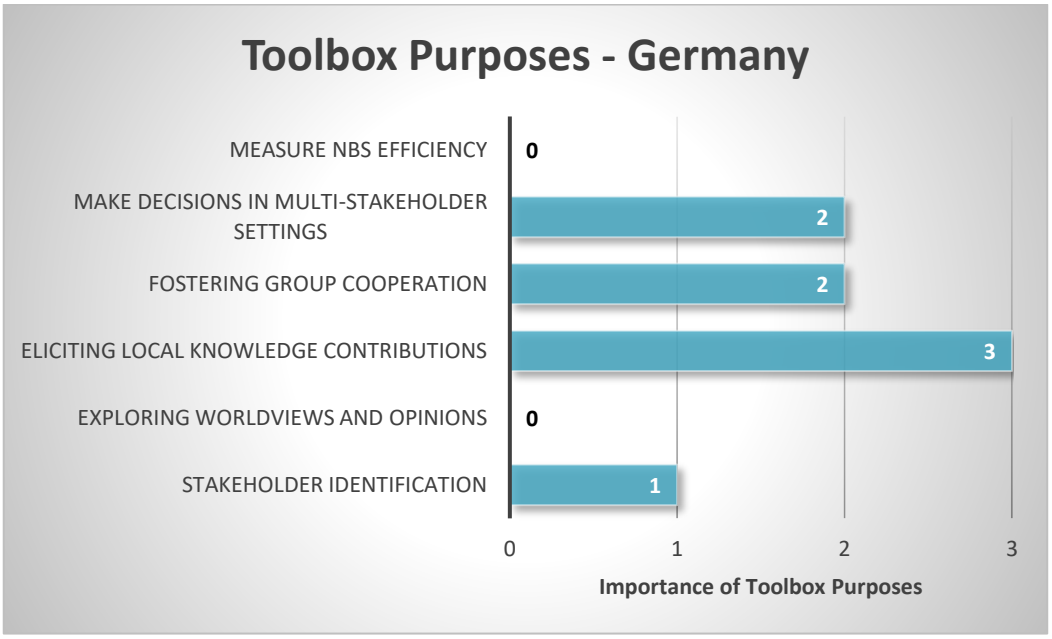

Chart 6. Isar River Basin Likert question "Toolbox Purposes" responses. Questions were answered on a Likert scale of 0= not intended, 1= not important, 2= somewhat important, 3= very important. Design: C. Jones 2019

Current and Intended Stakeholder Involvement	Tools most needed for...	Potential Barriers	Tool Category Preferences
•Mostly informational/ consultative intentions •Largest stakeholder group comprised of NGOs •More Governmental & private sector involvement in current stakeholder process would be desirable	•Eliciting knowledge contributions •Fostering group cooperation •Making decisions in multi-stakeholder settings	•Private economic sectors (e.g. hydropower industry) •Landowners •Existing infrastructures	•Mapping & geo-design •Modelling & scenario analysis •Visualization & hands-on

Figure 12. Isar River Basin interview findings summary. Design: C. Jones 2019

5.2.3 Conclusions from Feedback

From the completed interviews and the Tool Corner exercise with facilitators, important insights were gained regarding facilitators' needs and prior experience applying participatory planning tools. A count was collected of both toolbox purposes and tool categories that were rated at the highest level of importance by each facilitation team in interviews. In this way, a better idea could be built on what the facilitators expected from the final PHUSICOS toolbox and what their plans were for stakeholder involvement at their case sites.

One relevant aspect of analysis was to identify which Living Lab phases were considered the most important for stakeholder involvement among all the case study sites. From the interviews findings, the Exploration and NBS Selection phases had the highest priorities for involving stakeholders among the case study sites, with NBS Co-Design and Assessment/Upscaling being regarded as secondary foci for stakeholder involvement to the current point of time (see Chart 7).

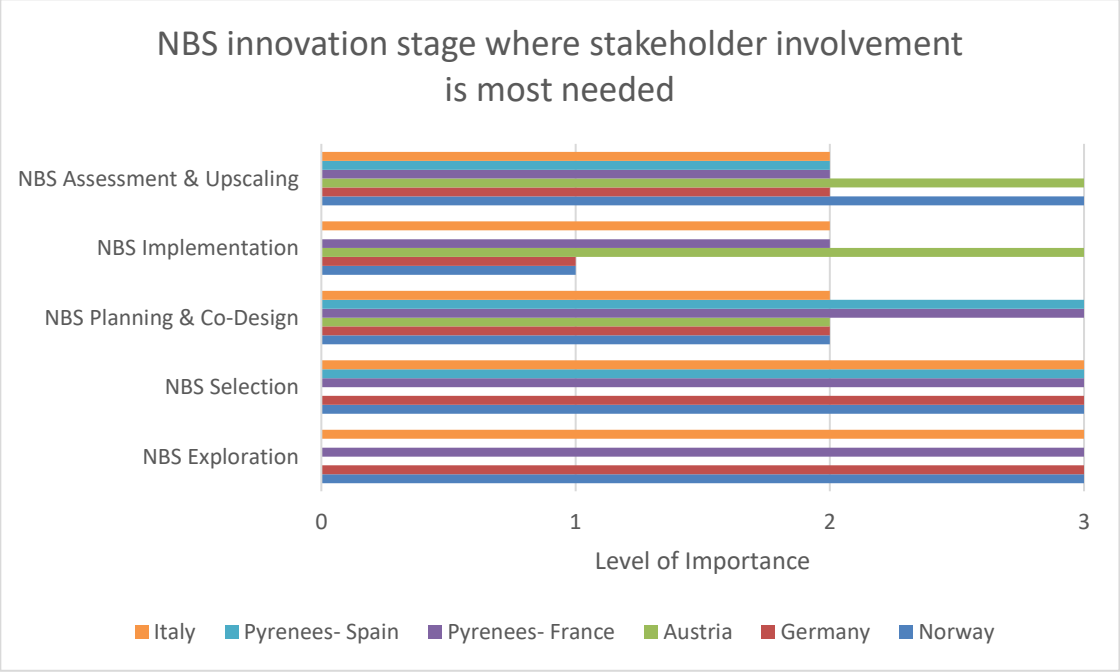

Chart 7. Overall findings among all case sites regarding stakeholder involvement in each Living Lab stage. Questions were answered on a Likert scale of 0= not intended, 1= not very necessary, 2= somewhat necessary, 3= very necessary. Design: C. Jones 2019

The most important purposes that facilitation teams would like to fulfil through the use of the toolbox were eliciting local knowledge contributions and exploring worldviews and opinions (see Chart 8). Conflict resolution, a purpose which was not included in the questionnaire, was also mentioned frequently as an important, although secondary, objective to be achieved.

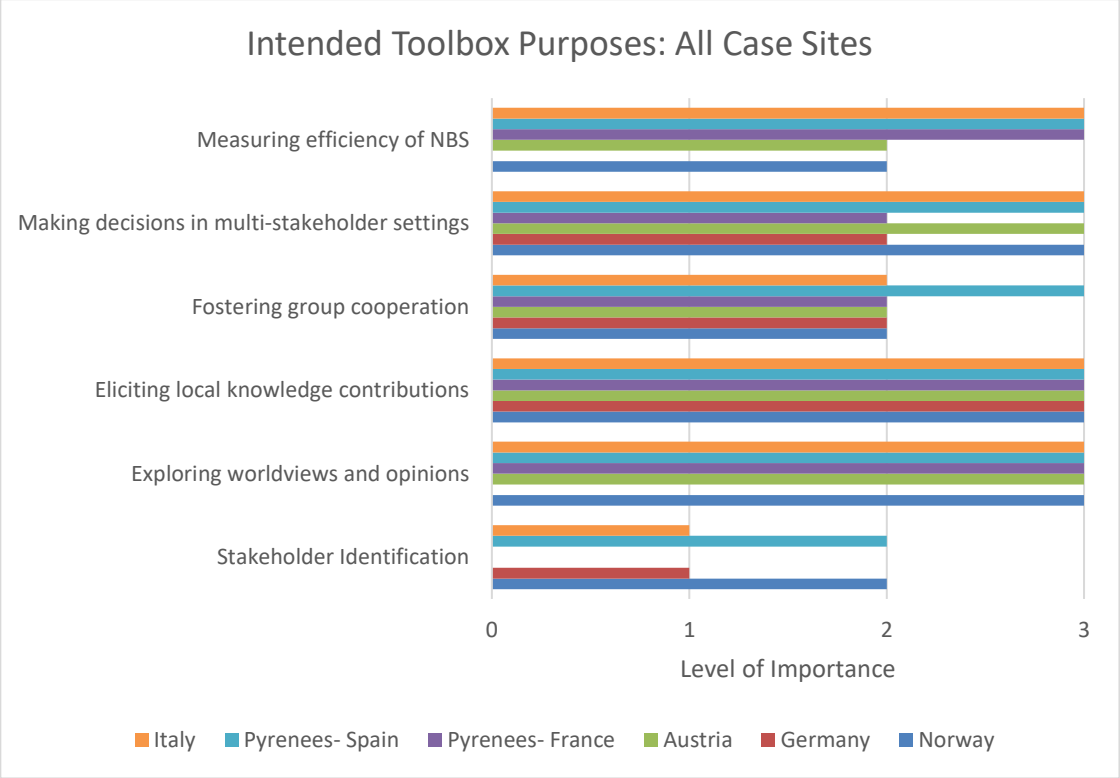

Chart 8. Most wanted toolbox purposes among all case study sites. Questions were answered on a Likert scale of 0= not intended, 1= not important, 2= somewhat important, 3= very important. Design: C. Jones 2019

The tool categories that were indicated as most necessary comprise group discussion methods; visualization, modelling and mapping tools (see Chart 9). Other specific requests that were made by facilitation teams include providing tools that could be used in conjunction with group discussion methods in order to synthesize the results of a group discussion and reach a conclusion. Additionally, almost all facilitation teams stated the importance of receiving tools that were equally applicable for both non-technical and technical stakeholders.

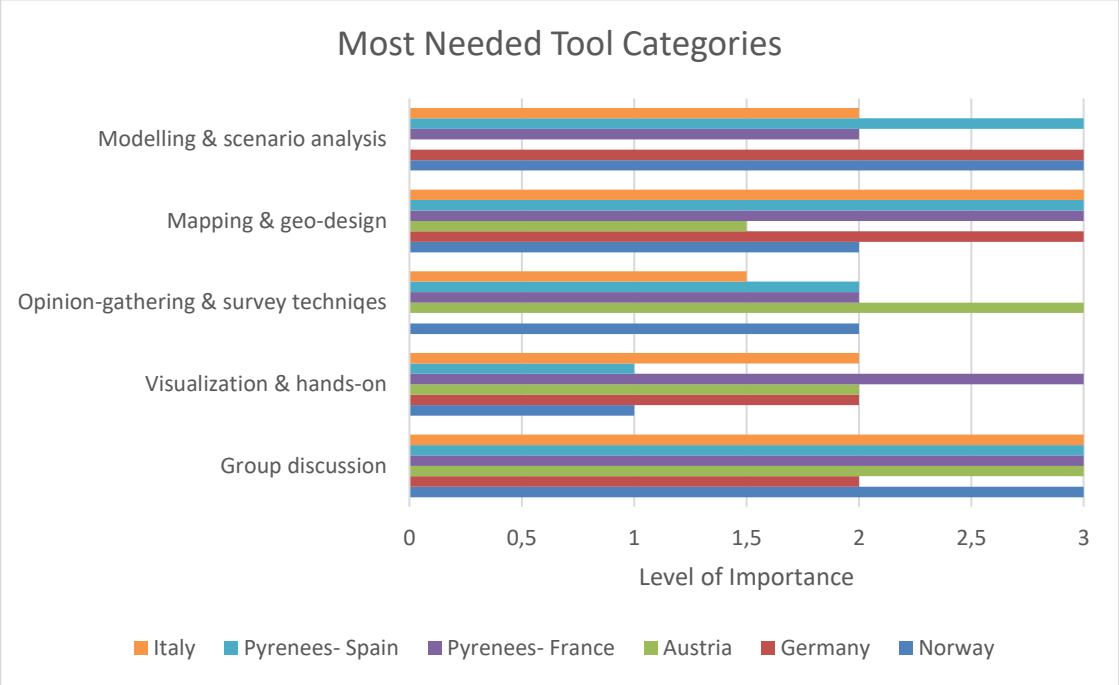

Chart 9. Most needed tool categories across all case study sites. Questions were answered on a Likert scale of 0= not intended, 1= not important, 2= somewhat important, 3= very important. (For this question, half grades were permitted). Design: C. Jones 2019

From the Tool Corner (see Chap. 2 and Annex B), one of the main take-aways was that facilitators demanded the tool descriptions to be orientated by practical application aspects mainly. Therefore, guidance regarding how, when and with whom a tool can be applied would be a useful addition to the final toolbox in order to better addressing and motivating facilitators for using the tools at their case sites. The most favoured tools were those that allowed for a visualization of aspects being discussed in a participatory setting (e.g., Geo Timeline, participatory mapping, participatory scenario planning, matrices) to thereby better synthesize the conclusions of stakeholders and condense their findings.

The findings gleaned from facilitator responses are largely in line with recommendations made by experts. In their consultation, experts also emphasized the importance of exploring worldviews/opinions and eliciting local knowledge contributions as specific purposes that the toolbox should fulfil. This goes hand-in-hand with the facilitators' own emphasis on these toolbox purposes as most important. Furthermore, both experts and facilitators were of a shared opinion that the focus should be on tools which are simple to medium level of complexity. Many of the specific tools mentioned as particularly useful by experts coincided with tools which facilitators indicated they were already familiar with (e.g. World Café, participatory scenario planning, Delphi). Therefore, special consideration should be placed on those tools when assembling the final set of tools.

5.3 The offer: the Toolbox concept at a glance

Based on the background considerations on targets, boundaries, structure and content of the presented Toolbox (see Chap. 5.1) and the tool demands of the PHUSICOS case sites articulated by facilitators and experts (see Chap. 5.2), the final concept of the Toolbox was developed. It comprises a total of five components:

Component 1: Division into Part A & B

At first hand and in the pursuit to address the needs of the deliverable's potential target groups (see Chap. 1.3) to the best extent, a division of this report into two main parts – Part A & Part B – seemed a reasonable step to do. With **Part A**, the *interested reader* receives abundant opportunity to get to know the theoretical background of this Toolbox. More specifically, substantial insight is offered into the justification of a stakeholder-centred approach in NBS co-design (Chap. 3) and the conceptual underpinnings of Stakeholder Knowledge Mapping (SKM) (Chap. 4). Furthermore, the background to the design of the Toolbox is made transparent by shedding light on both underlying deliberations concerning targets, boundaries, structure and content, as well as on the elicited tool demands from facilitators and experts (Chap. 5). **Part B**, hence, gives a shortcut entry point to the *quick reader*, to whom the tools might be of most interest. Here, a comprehensive overview to the assembled collection of 25 tools can be directly accessed, and individual portraits of all tools found (Chap. 6).

Component 2: Sub-division of Part B into Living Lab set-up & working process

In line with the goal to accompany the facilitation teams of the local demonstrator and concept case sites with guidance in both their **Living Lab set-up and working process** stages (see Chap. 1.2), the sub-division of the Toolbox' Part B according to these two Living Lab stages was a logical consequence. This sub-division is meant to ease the quick localization of tools, depending on whether the Living Lab set-up is still of relevance to a case site, or whether the Living Lab is already established and its work being underway. The diversity of the PHUSICOS case sites' current stages of NBS development and their very individual local conditions justify this consciously broader outline of the presented Toolbox.

Component 3: Structure of Tools into clusters

Resting on the outcomes of the expert consultation accomplished for this deliverable in and outside the PHUSICOS context (see Chap. 2), the third decision undertaken concerning the Toolbox' concept was to present the assembled tools in appropriate thematical clusters. These were built more specifically by identifying commonalities, and also differences between the tools under consideration, thus enabling to form coherent groups and titling them accordingly.

The identified clusters and sub-clusters applied for this Toolbox are (see Chap. 6):

Tools for the Living Lab set-up

- Common social-science methods to prepare a Living Lab process
- Tools for stakeholder identification and analysis

Tools for the Living Lab working process

- Basic group moderation techniques
- Tools for Stakeholder Knowledge Mapping and Co-Design of NBSs
    - *Mapping Tools*
    - *Tools for retrospective reflection and future planning*
    - *Tools to encourage creative thinking and mutual understanding*
    - *Decision-support tools.*

Component 4: Display of Tools in Tool portraits

The screening of other toolboxes and toolkits from PHUSICOS-alike contexts, such as landscape planning, participatory planning, innovation management, disaster risk management, climate change adaptation, and natural resource management (see Chap. 2 and 6.4), was supportive to the insight that it would not be enough to merely describe the Toolbox' tools. Instead, appealing and informative portraits would be needed and preferential, also to foster interest in working with the tool selection on behalf of its future users.
This was likewise echoed by the facilitator group in the framework of the Consortium meeting in Naples 2018, where the Tool Corner exercise and feedback provided clearly indicated this demand. Consequently, the Toolbox' concept adopted the idea of describing the recommended tools on behalf of practical tool portraits, addressing especially aspects such as a clear and concise tool definition; fields of application; information on suitable target groups; strengths and limitations as well as further reading hints on case studies and other background material (see Chap. 6).

Component 5: Characterization of Tools for aiding Tool selection

Closely connected to the previous component, it was decided to additionally characterize the assembled tools within their tool portraits by means of an informative chart (see Chart 10). This was based on the intention to aid the tool selection step to be done by the facilitators for their Living Lab processes. The tools' characterization was thus effectuated in close consideration of the demands articulated by the facilitator group (see Chap. 5.2). Furthermore common practice in toolboxes' design (e.g. Elliott et al. 2005; Slocum 2003; Arbter 2012) was observed and the suitability of the tools judged against the Living Lab phases being of relevance to the NBS realization process (see Chap. 6.1).

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration	☑	Stakeholder identification & analysis		◇ ◈ ◆	☺ ☺☺ ☺☺☺	🕒 🕒🕒 🕒🕒🕒	① ② ③
Selection		Explore opinions & worldviews	☑				
Co-Design	☑	Elicit local knowledge					
Evaluation		Foster group cooperation					
		Decision-making					
		Measure NBS efficiency					

Suitability for NBS Stage

The tool has suitability to be applied in the ….stage of the NBS innovation cycle:
(suitability indicated with ☑-symbol)

- NBS exploration
- NBS selection
- NBS co-design
- NBS evaluation

Main function(s) / purpose(s) of application

The tool is apt to fulfil the following function(s) / purpose(s) of application:
(each function indicated with ☑-symbol)

- Stakeholder identification & analysis
- Explore opinions & worldviews
- Elicit local knowledge
- Foster group cooperation
- Decision-making
- Measure NBS efficiency

Intensity of Participation

The tool allows for enabling stakeholder participation on the level of:

◇ Information
◈ Consultation
◆ Cooperation

Duration

The tool's application calls for a time effort of:

🕒 = some hours up to 1 day
🕒🕒 = 1-3 days or a weekend
🕒🕒🕒 = more than 3 days

Number of Participants

The tool works well with participant groups of:

☺ = individuals up to 15 persons
☺☺ = 15-30 persons
☺☺☺ = more than 30 persons

Cost

The tool has a / an … cost demand:

① = inexpensive
② = moderate
③ = expensive

Chart 10. Characterization chart for Tools and related explanatory key.
Design: S. Fohlmeister & I. Augenstein 2018

Chart 10 illustrates the most relevant elements of how the Toolbox' tools were characterized in the framework of their descriptive portraits (see Chap. 6 for portraits). A total of six characteristics were considered for each tool's judgement:

Suitability for NBS Stage

In the first column of the chart, the suitability of a tool with regard to its application in the different NBS innovation cycle stages (see Chap. 6.1, Figure 13) is informed. By doing so, the Toolbox's user receives an orientation on whether a tool might e.g. be apt to support exploration purposes, NBS selection, co-design, or be rather useful when wrapping up the Living Lab process and evaluating its outcomes. A given suitability is highlighted with a ☑-symbol, while suitability for more than one stage is permitted and informed accordingly.

Main function(s) / purpose(s) of application

In the second column of the chart, a tool's main functions respective purposes of application are made transparent to the Toolbox' user. To ease the tools' handling by the facilitator group, these functions / purposes have been formulated in-line with the interview design applied for the prior tool demand assessment (see Chap. 2 and Annex A). Consequently, the functions highlighted with the ☑-symbol enable to recognize at a glance, whether a tool helps to i) identify and analyse stakeholders; ii) explore opinions & worldviews; iii) elicit local knowledge contributions; iv) foster group cooperation; v) make decisions, or vi) measure NBS efficiency.

Intensity of Participation

The third column of the chart informs on the level of participation that a tool may allow for. The common differentiation between the levels of information, consultation and cooperation (e.g., IAP2; Arbter 2012), shall enable the Toolbox' user to take a conscious decision on the preferred stakeholder involvement level. This characteristic is represented by a ⌖-symbol in different degrees.

Number of Participants, Duration and Cost

The remaining three columns of the chart are intended to address the facilitators' articulated demand of receiving practical information on the provided tools (see Chap. 5.2). On the one hand, and marked with a ☺-symbol, the number of participants is informed, with which a tool may work well in practice. On the other hand, the estimated time demand for a tool's application is reported on behalf of the 🕒-symbol. As budgetary demands are highly context-bound, definite information on monetary expenditure ranges for each tool were impossible to provide in the frame of this work. However, for orientation purposes a rating of the tools was executed alongside the following considerations (see, e.g. Elliott et al. 2005): a tool was rated with (1) *inexpensive* if it calls for no or only low investment, being a hands-on tool and requiring standard moderation material only; with (2) *moderate* if moderate investment is necessary, e.g. for software; logistics/venue/catering; prepared input material (such as maps, big-sized paper sheets) or external facilitation; and (3) *expensive* if it has a high demand in resources, such as technology support; logistics/venue/catering; staff support and/or specialized external facilitation expertise.

PART B:

PHUSICOS TOOLBOX FOR STAKEHOLDER KNOWLEDGE MAPPING TO CO-DESIGN NATURE-BASED SOLUTIONS

6 Tools for Stakeholder Knowledge Mapping to Co-Design NBSs

6.1 Overview to Tool Collection

The tool selection effectuated for D3.2 *Starter Toolbox for Stakeholder Knowledge Mapping to Co-Design NBSs* evolved on the background of the three main phases of a Living Lab process (Figure 13), which are common when co-creating innovative solutions (Nedopil et al. 2013):

- **Phase 1**: **Understand, Investigate, Plan, Explore**: The first phase of a Living Lab process concerns the contextual understanding, discussion of different perspectives and objectives among stakeholders, and the achievement of common goals for the process;

- **Phase 2**: **Creative Co-design and Refinement**: The second phase of the Living Lab process involves all relevant stakeholders in active collaboration and seeks to elicit local knowledge and experience for the further NBS development process, i.e. selection, co-design and assessment;

- **Phase 3**: **Evaluation and Testing**: The third phase of the Living Lab process is dedicated to the joint reflection on the Living Lab process and its outcomes.

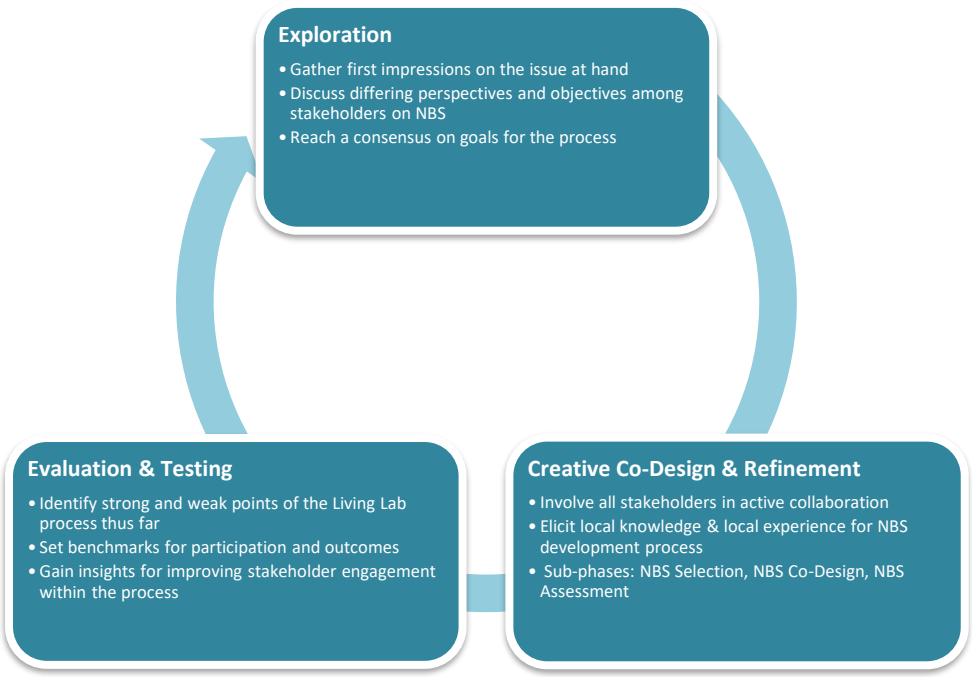

Figure 13. Phases of the PHUSICOS Living Lab process for NBS realization (according to Fohlmeister et al. 2018, based on Nedopil et al. 2013, Evans et al. 2017 and Steen et al. 2017). Design: C. Jones 2019

While stakeholder involvement is obvious for the co-design and evaluation phases of a Living Lab, the importance to consider stakeholders already before, during the set-up and exploration stages is often underestimated. Much of the stakeholder analysis literature assumes that stakeholders, their composition, availability and their knowledge are self-evident (Reed et al. 2009). As described in previous chapters and in D3.1 Guiding Framework (Fohlmeister et al. 2018), before starting a Living Lab, it is necessary to identify those who hold a stake and can contribute their knowledge to make it efficient. A sound set-up provides a frame and is decisive for a successful future work in Living Labs. Therefore, efforts have to be undertaken to set up a Living Lab with a clear scope, problem and solution definition and to have *the right stakeholders on board* (see Fohlmeister et al. 2018, Chap. 4.3).

Addressing this importance of a Living Lab set-up stage and in distinct pursuit to support the PHUSICOS Living Labs to build their working processes on a solid foundation, the tool selection offered in this report is organized as follows:

First, common social science methods are introduced, which can be of help in preparing the Living Lab process (see Chap. 6.2.1).

Second, tools are provided for stakeholder identification and analysis for the above mentioned reasons: the facilitator of a PHUSICOS Living Lab should find out "Who is in and why?" (Reed et al. 2009: 1933) and dedicate sufficient time to the recipient type perspective (see Chap. 4.3) to prepare the later co-design process (see Chap. 6.2.2).

Third, and most prominently, tools have been compiled for the Living Lab working process. To address the demand of facilitators for group moderation techniques (see Chap. 6.3.1), a small selection has been made and inserted prior to the core part of this Toolbox, which is dedicated to SKM and NBS co-design tools. To reflect this focus to a satisfying extent, a collection of 15 tools is provided and described in detail (see Chap. 6.3.2).

Wrapping-up the Toolbox, and in-line with the intention to offer more in-depth reading opportunities on individual tools, moderation techniques and other toolboxes, a Toolbox Library has been added (see Chap. 6.4).

For the choice of the presented tool compilation, several factors were evaluated. Most decisively, tools were selected by considering the degree to which they met both the demands identified through the literature review and those from facilitators (see Chap. 5.1 and 5.2).

Alongside these factors, experts' opinions on the individual tool's usefulness for the PHUSICOS context were taken into account. Next, the utility of a tool across the different Living Lab phases was considered, as tools which are well suited for more than one phase were regarded to be overall more useful for the facilitators. Tools which were evaluated as apt for the NBS Co-Design phase were especially considered as this is the main focus of the PHUSICOS project's goals. Furthermore, priority was given to those tools which most closely matched the needs of facilitators and experts as expressed in their interviews.

Beyond that, the purposes which each tool can meet were taken into consideration. As previously concluded from interviewing experts and facilitators, *Eliciting local knowledge contributions* and *Exploring worldviews and opinions* were the most desired purposes out of the six evaluated (see Chap. 5.2, Chart 8). Tools which can meet these purposes were emphasized, but not to the exclusion of tools with other secondary, yet no less important purposes.
The category to which each tool belongs was also considered, as facilitators and experts indicated preferences for group discussion techniques and mapping & geo-design methods above others (see Chap. 5.2, Chart 9).

Finally, aspects such as time and budgetary demands as well as the level of complexity for each tool were regarded, as both experts and facilitators unanimously agreed that low to medium level tools should be the focus of the final tool set (see Chap. 5.2).

Another consideration when assembling the final tool set was that, while the feedback gained from facilitators and experts is certainly valuable for the resulting Toolbox, it only reflects a snapshot of the current requirements at each case study site and does not account for how the needs of the facilitators may change over time as the stakeholder involvement processes mature and possibly advance during the lifetime of the PHUSICOS project. This fact was kept in mind in order to not risk excluding tools on the basis of the present state of affairs and thereby reject tools which may prove useful later on in the stakeholder involvement and co-design process.

Therefore, additional tools which can cover other purposes and phases were included, such as tools to provide for the preparation of a Living Lab process, tools for stakeholder identification and analysis, and tools for decision-making in multi-stakeholder settings when a final conclusion is due for how to proceed with NBSs.

With these aspects taken into account, Table 3 illustrates the tool compilation made for the PHUSICOS Toolbox as of this point in the project trajectory.

Table 3. Overview to Toolbox' Content, systematized by clusters and key information for application

Main Tool Cluster	Cluster Title	Sub-Cluster Title	Tool	Suitability for NBS stage…				Main functions / purposes of application						Intensity of Participation	Number of Participants	Duration	Cost
				Exploration	Selection	Co-Design	Evaluation	Stakeholder identification & analysis	Explore opinions & worldviews	Elicit local knowledge	Foster group cooperation	Decision-making	Measure NBS efficiency	Information ◇ Consultation ◈ Cooperation ◆	☺ ☺☺ ☺☺☺	🕒 🕒🕒 🕒🕒🕒	① ② ③
Tools for the Living Lab set-up	**Common social-science methods to prepare a Living Lab process**		Discourse Analysis	☑			☑	☑	☑					◈	☺☺	🕒🕒🕒	②
			Q methodology / Q-sort	☑	☑	☑	☑	☑	☑	☑		☑	☑	◈	☺-☺☺	🕒	①②
			Semi-structured Interview	☑	☑	☑	☑	☑	☑	☑			☑	◈	☺	🕒	①
			Snowball Sampling	☑				☑	☑	☑				◈	☺-☺☺	🕒	①
			Social Network Analysis	☑			☑	☑	☑					◈	☺-☺☺	🕒-🕒🕒🕒	①②
	Tools for stakeholder identification and analysis		Influence-Interest-Matrix	☑			☑	☑	☑					◈◆	☺-☺☺☺	🕒-🕒🕒	①②
			Stakeholder Mapping	☑			☑	☑	☑					◈◆	☺-☺☺☺	🕒-🕒🕒	①②
Tools for the Living Lab working process	**Basic group moderation techniques**		Card Inquiry	☑	☑	☑	☑		☑	☑	☑		☑	◈◆	☺-☺☺☺	🕒	①
			Focus Group Discussion	☑	☑	☑	☑		☑	☑			☑	◈	☺-☺☺	🕒	①
			World Café	☑	☑	☑			☑	☑	☑			◈◆	☺-☺☺☺	🕒-🕒🕒	①②
	Tools for Stakeholder Knowledge Mapping and Co-Design of NBSs	***Mapping Tools***	Node-link Diagrams	☑	☑	☑	☑		☑	☑	☑			◈◆	☺-☺☺☺	🕒-🕒🕒🕒	①②③
			Scale Mapping	☑		☑			☑	☑				◈◆	☺-☺☺	🕒	①②
			Sketch Mapping	☑		☑			☑	☑				◈◆	☺-☺☺	🕒	①
			Technology-supported Participatory Mapping	☑	☑	☑	☑		☑	☑	☑			◈◆	☺-☺☺☺	🕒-🕒🕒🕒	①②③
			Transect	☑					☑	☑				◈◆	☺-☺☺☺	🕒🕒	②
		Tools for retrospective reflection and future planning	Future Search Conference	☑	☑				☑	☑	☑	☑		◆	☺☺☺	🕒🕒🕒	③
			Geo Timeline	☑					☑	☑				◈	☺☺☺	🕒-🕒🕒🕒	②③
			Participatory Scenario Planning		☑	☑	☑		☑	☑	☑	☑	☑	◆	☺☺-☺☺☺	🕒🕒-🕒🕒🕒	②③
			Storywall / Storyboard	☑		☑	☑		☑	☑	☑		☑	◆	☺-☺☺☺	🕒-🕒🕒	①
			What's Your Agenda?	☑					☑	☑	☑			◈◆	☺-☺☺	🕒	①
		Tools to encourage creative thinking and mutual understanding	Multiple Perspectives Wheel	☑					☑		☑			◈◆	☺-☺☺	🕒	①
			Open Space Technology	☑	☑				☑	☑	☑			◆	☺☺☺	🕒🕒	②③
		Decision-support tools	Delphi Technique	☑	☑		☑		☑			☑	☑	◈	☺-☺☺☺	🕒🕒🕒	②③
			Multi-Criteria Decision Analysis	☑	☑		☑		☑			☑	☑	◈◆	☺-☺☺☺	🕒🕒-🕒🕒🕒	②③
			Simple Scoring and Ranking Methods	☑	☑	☑	☑					☑		◈◆	☺-☺☺	🕒	①

☑ Suitability of the tool for NBS stage or main function(s)	◇◈◆ Intensity of stakeholder participation which the tool allows	The Tool works well with participant groups of: ☺<15; ☺☺ 15-30; ☺☺☺ >30	The Tool's application calls for a time demand of: 🕒 < 1 day; 🕒🕒 1-3 days; 🕒🕒🕒 > 3 days	The Tool has a/an ….cost demand: ① inexpensive; ② moderate; ③ expensive

6.2 Tools for the Living Lab set-up

6.2.1 Common social-science methods to prepare a Living Lab process

There are several methods stemming from general social science which can be of high value in preparation of a Living Lab process.

For PHUSICOS purposes, the below-standing tools from this field were selected and regarded worthwhile of being included in the Toolbox:

- **Discourse analysis**
- **Q methodology**
- **Semi-structured interview**
- **Snowball sampling**
- **Social-Network Analysis (SNA).**

As the main target of the Toolbox consists in assembling and describing tools with focus on Stakeholder Knowledge Mapping to Co-Design NBSs, however, these tools have been considered in the framework of short portraits only.

Furthermore, it is noteworthy that the tools presented in this cluster may fulfil additional functions going beyond the preparation of a Living Lab process.

Discourse Analysis

What is it?

A discourse is the sum of linguistic statements on a particular topic that controls the perceptions, thinking, and actions of individuals in society. Discourse analysis is a social-science method that assesses written, spoken or sign-language use. Since discourses always are embedded in contexts, societal, institutional and structural relations have to be considered when analysing them (Keller 2008).

When to use / What for?

Discourse analysis can help to distil contested views and frames among interest groups or advocacy coalitions, sometimes due to their different worldviews, in conflict situations. It can also describe the regime of truth that exists in interest groups which can privilege certain types of knowledge and devaluate others (Leibenath & Otto 2014). Findings from a discourse analysis can also be used in conjunction with other tools such as the Social Network Analysis (SNA) to visualize e.g. advocacy coalitions.

For whom?

Discourse analysis can be applied with a broad range of stakeholders, crossing over from public sector officials, private sector partners, to civil society groups and individual citizens. The tool applicant should possess sound social-science skills.

Strengths and Limitations

Although different theoretical approaches exist and there is a deficit of methodology when discourse theories are transferred into research approaches (Keller 2008), pragmatic assessments orient on qualitative social science. Similar tools are used for data collection such as interviews or text analyses e.g. from websites of the organizations involved, leaflets, local newspaper reports, and letters to the editors of local newspapers for data collection (Keller 2008; Leibenath & Otto 2014). While discourse analysis can help to understand conflicts, the tool is not able to solve conflicts.

Best Practice and Further Reading

Sampling strategies orient to cover all aspects of a discourse. Starting with a key document or a transcript from an interview of an identified key person of an issue, the focus is laid to find a strongly different statement to cover the whole range of a discourse. The selection of the next document or interview partner is then based on this contrasting statement. The iterative process is carried out until no more additional information can be collected or additional interest groups can be identified. Further analyses would then only provide confirmations of already identified patterns (Keller 2008). To understand a single perspective or worldview and coalitions better and in-depth, a minimal contrast strategy can be applied. Then the aim is to find similar statements at contrasting stakeholders supporting this worldview (Keller 2008).

Further reading:

Keller, R. (2013): Doing Discourse Research: An Introduction for Social Scientists. SAGE, London, Thousand Oaks, New Delhi, Singapore 176 p.

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration	☑	Stakeholder identification & analysis	☑	◈	☺☺	🕒🕒🕒	②
Selection		Explore opinions & worldviews	☑				
Co-Design		Elicit local knowledge					
Evaluation	☑	Foster group cooperation					
		Decision-making					
		Measure NBS efficiency					

Q Methodology / Q Sort

What is it?

Q-methodology is an approach developed by Stephenson (1953) to study the perception of issues. The most known approach of the Q methodology is the so-called Q-sort technique (Stephenson 1953). It is a ranking procedure that usually maps statements, stakeholders or even images (e.g. Lupp 2008). Cards are arranged along a scale, for example a 5-point scale from very unimportant to very important in relation to each other.

When to use / What for?

The Q methodology can be employed to group and weight stakeholders or topics (Reed et al. 2009; Reed & Curzon 2015). The categorization of stakeholders or topics is based on an empirical analysis of stakeholder perceptions. Also discussions and discourses can be analysed and both diverse and shared perceptions be identified (Müller & Kals 2005).

For whom?

Q-Sort requires some skills for preparation and evaluation to generate outcomes, e.g. running statistical programs such as R or SPSS. Sorting procedures can be conducted with various group settings and for different purposes in several stages of the participatory process.

Strengths and Limitations

With its given set of statements, Q Sort needs preparation and already some previous information collected e.g. in interviews or focus groups. Although Q methodology is a more complex approach, it does only identify those issues which have been formulated and selected for sorting and is depending on the quality of prior work.

Best Practice and Further Reading

Barry, J. & J. Proops (1999): Seeking sustainability discourses with Q methodology. Ecological Economics, 28(3), 337-345.

Watts, S. & P. Stenner (2005): Doing Q methodology: theory, method and interpretation. Qualitative Research in Psychology 2, 67-91.

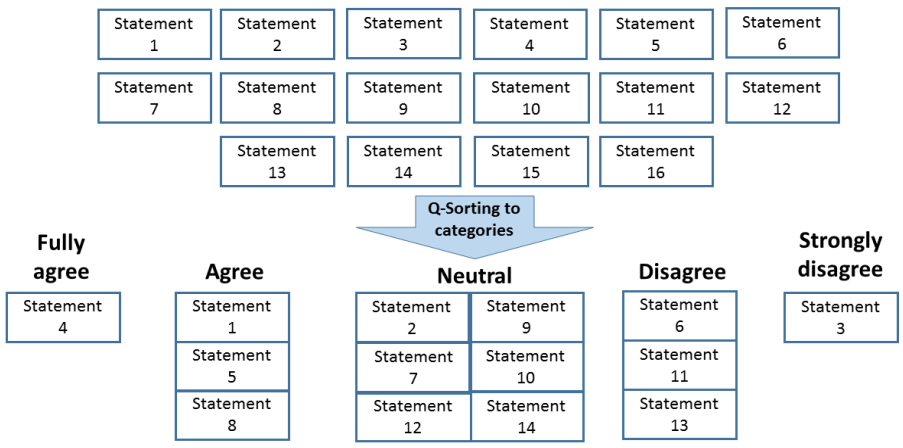

Figure 14. Example of a Q-Sort with a set of 16 statements. Stakeholders are asked to sort them to a scheme with five different degrees of agreement (based on Lupp 2008, modified).

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration	☑	Stakeholder identification & analysis	☑	◈	☺ ☺☺	🕒	① ②
Selection	☑	Explore opinions & worldviews	☑				
Co-Design	☑	Elicit local knowledge	☑				
Evaluation	☑	Foster group cooperation					
		Decision-making	☑				
		Measure NBS efficiency	☑				

Semi-Structured Interview (SSI)

What is it?

In comparison to a completely structured interview with a fixed set of questions to be answered, semi-structured interviews are more open and allow bringing in new ideas and aspects by the interviewee (Atteslander 2003). The interviewer uses a set of guiding questions or a list of topics and issues. Questions are open. Usually no choice of answers is given to ensure openness and to avoid any bias. Expert interviews are a special form of semi-structured interviews.

When to use / What for?

Semi-structured interviews are often used to explore problems. By selecting interviewees, different aspects and worldviews of a topic or issue can be captured (see also tool *Snowball sampling*).

The aim of expert interviews is to access professional expertise and knowledge of the person asked. The expert interview is one of the widest used methods in social science research (Marshall & Rossman 2015).

The tool can be a useful means to provide data and information inputs to other tools, such as discourse analysis and heuristic social-network analysis.

For whom?

Semi-structured interviews can be applied with various target groups and purposes. However, for larger groups, conducting and assessing semi-structured interviews rapidly get time-and resource consuming.

Strengths and Limitations

Challenges for interviewers are the selection of interviewees to cover all different aspects, stakeholders or worldviews and potential bias in 1:1 interview situations. Also the interview situation can lead to interactions between the interviewee and the interviewer and bias such as responses according to a perceived social desirability.

Best Practice and Further Reading

Flick, U., von Kardorff, E. & I. Steinke (Eds). (2004): A Companion to Qualitative Research. SAGE, London, Thousand Oaks, New Delhi, 432 p.

Clifford, N., Cope, M., Gillespie, T. & S. French (2016): Key Methods in Geography. SAGE, London, Thousand Oaks, New Delhi, 752 p.

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration	☑	Stakeholder identification & analysis	☑	◈	☺	🕒	①
Selection	☑	Explore opinions & worldviews	☑				
Co-Design	☑	Elicit local knowledge	☑				
Evaluation	☑	Foster group cooperation					
		Decision-making					
		Measure NBS efficiency	☑				

Snowball Sampling

What is it?

Snowball Sampling is a tool for recruiting and nominating participants or interviewees, who could contribute to increase and add knowledge. The snowball sampling starts with a small initial group of known persons who can provide relevant information. Using their social networks and contacts, new participants are recruited and nominated, who could contribute to increase and add knowledge (Corbin & Strauss 2008).

When to use / What for?

Using a diverse group of initial persons, a broad range of different worldviews and opinions can be leveraged.
To identify persons with different views, for example, at the end of a semi-structured interview of a person contacted in a snowball sampling procedure, a question is asked for a person or organization that might have an opposing opinion or be more knowledgeable on certain aspects regarding the respective topic at stake (Hunziker 2000).

For whom?

Snowball sampling helps to acquire participants or interviewees. Depending on the sampling strategy, it supports elaborating different aspects of one view or a broad range of different worldviews of a topic or issue to be captured.

Strengths and Limitations

The method strongly depends on the first persons recruited and their contacts and can lead to a community bias (also known as *Filter bubble effect*, Pariser 2011).

Using a diverse group of initial persons, this effect can be moderated. Also the principle of maximum contrast in the sampling procedure can contribute to collect a diverse set of persons with different world views to define the problem by collecting as many different opinions as possible.

Best Practice and Further Reading

Flick, U., von Kardorff, E., & I. Steinke (Eds). (2004): A Companion to Qualitative Research. SAGE, London, Thousand Oaks, New Delhi, 432 p.

Clifford, N., Cope, M., Gillespie, T. & S. French (2016): Key Methods in Geography. SAGE, London, Thousand Oaks, New Delhi, 752 p.

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration	☑	Stakeholder identification & analysis	☑	◈	☺ ☺☺	🕒	①
Selection		Explore opinions & worldviews	☑				
Co-Design		Elicit local knowledge	☑				
Evaluation		Foster group cooperation					
		Decision-making					
		Measure NBS efficiency					

Social Network Analysis (SNA)

What is it?

The Social Network Analysis (SNA) makes use of matrices to organize data on the relational ties how stakeholders are linked together. Rather than using key words in the matrix cells, numbers as codes are used for describing relations. Several matrices are developed representing a single aspect of relations between stakeholders, e.g. communication; leadership; friendship; advice; support; conflict or trust (Reed et al. 2009).

When to use / What for?

The tool captures different kinds of relations and the directions and strength of those ties. Much information collected with other tools can be used for SNA by combining and restructuring data. A systematic analysis of such matrices can help to better understand networks, e.g. which stakeholders are more in the central position and how stakeholders cluster. Relations can be visualized using network graphs and respective software tools (Otte & Rousseau 2002).

For whom?

In natural resources management, SNA can help to analyse stakeholders, ensure key groups are not marginalised, identify conflict, and select representatives for workshops based on the way that the network is structured. In addition, this information can be used to select stakeholders for cooperation who are likely to trust one another, and may help avoid exacerbating conflicts (Reed et al. 2009).

Strengths and Limitations

The SNA is dependent on the quality of the collected data. When data is robust, it can be a powerful tool assessing stakeholder systems, roles, power distributions and also demonstrate changes over time (Reed et al. 2009).

Best Practice and Further Reading

The tool makes use of several methods to analyse and quantify social networks systematically. The aim is to describe the relative position, role and influence of stakeholders, and facilitate understanding the complex pattern of social relations and how such relations influence collective and individual decision-making.

Data are typically collected with structured interviews, questionnaires, or observation. Software tools can support the analysis to draw relations and ties between the different stakeholders and visualize a variety of aspects. For freeware and commercial software see:

Gephi: https://gephi.org/
Netminer: http://www.netminer.com/main/main-read.do
NodeXL: https://archive.codeplex.com/?p=nodexl
R: https://www.r-project.org/
Tulip: http://tulip.labri.fr/TulipDrupal/

Further reading:

Jones, E.C. & A.J. Faas (Eds)(2016): Social network analysis of disaster response, recovery and adaptation. Butterworth-Heinemann.

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration	☑	Stakeholder identification & analysis	☑	◈	☺ ☺☺	🕒 🕒🕒 🕒🕒🕒	① ②
Selection		Explore opinions & worldviews	☑				
Co-Design		Elicit local knowledge					
Evaluation	☑	Foster group cooperation					
		Decision-making					
		Measure NBS efficiency					

6.2.2 Tools for Stakeholder identification and analysis

For setting up a Living Lab, relevant stakeholders should be on board and addressed right from the beginning of a Living Lab process. To be able to facilitate the latter one, besides having relevant actors identified, it is important to get to know decisive stakeholder attributes, such as influence, interests and power dynamics of the process` participants.

Reed et al. (2009) and Lynam et al. (2007) suggest a stepwise procedure for identifying stakeholders and assessing their attributes in natural resource management issues. Three steps for this procedure are described:

1. In step one, stakeholders are identified;
2. in step two, stakeholders are differentiated and characterized;
3. in step three, investigations about stakeholder relationships and their knowledge are conducted.

To support these relevant steps of stakeholder identification and analysis, the following tools have been portrayed for the present Toolbox:

- **Influence-Interest Matrix**
- **Stakeholder Mapping / Stakeholder Landscape.**

This restriction to the presented tool selection goes in-line with the demands expressed by the facilitator group of PHUSICOS demonstrator and concept case sites (see Chap. 5.2), indicating a lower priority of tools for stakeholder identification and analysis purposes.

In case of further interest in stakeholder identification and analysis proceedings and tools, it is recommended to adhere to D3.1 Guiding Framework for Tailored Living Lab Establishment at Concept and Demonstrator Case Study Sites (Fohlmeister et al. 2018, see especially Chap. 4.3 & 4.4) and the related further reading hints provided in the Toolbox Library (see Chap. 6.4).

Influence-Interest-Matrix / Power-Interest-Matrix

What is it?

The Influence-Interest-Matrix is a diagram-based visualization tool for categorizing a stakeholder landscape according to the attributes *influence* (*also: power*) and *interest* related to an issue at stake (e.g. NBS implementation). By application of the tool, a sound overview to a stakeholder set-up can be generated, thus enabling to deduce useful hints for the design of an appropriate participation strategy (Reed et al. 2009; Young et al. 2014). *Influence* is hereby defined as the influence (*also: power*) an actor may have to facilitate or impede a project's intervention (e.g. NBS), whereas *interest* stands for the interest an actor may have in the success (or also: failure) of it (Dearden et al. 2003).

In general, there are two ways to elaborate the Influence-Interest-Matrix: on the hand, it can be applied as analytical stakeholder catego-rization tool (*top-down-approach*) by a project team itself (Reed et al. 2009). On the other hand, it can be used as reconstructive stakeholder categorization tool (*bottom-up-approach*), hereby actively engaging stakehol-ders in the framework of a workshop setting or focus group discussion in i) brainstorming to identify relevant stakeholders; ii) categorizing the stakeholders according to their influence and interest and iii) organizing the diagram, thus directly cooperating in the further outline of the participation strategy for the issue at stake (Young et al. 2014; Dearden et al. 2003, Brouwer & Brouwers 2017).
Although both variants are possible and in use, the latter, interactive one can be considered the more beneficial way, as it may foster group cooperation among the related stakeholders, and engage them in a fruitful discussion regarding how to value each contributing force, thereby identifying the unique perspectives and value systems present within the group. The tool thus integrates visual and group discussion elements, while also providing a base of better understanding the current stakeholder set-up for all participants.

When to use / What for?

The Interest-Influence-Matrix is commonly applied when preparing and starting into a participatory process, serving the purposes of stakeholder identification and analysis. More precisely, the tool helps to map out the relevant stakeholders according to their relation to the issue at stake, making transparent the individual degree of influence on a project's target and level of interest each one may have concerning its realization (Brouwer & Brouwers 2017). This prepares the ground to build hypotheses on optional participation strategies, and to deduce further action in terms of how to design the participation strategy appropriately (Zimmermann & Maennling 2007).
Hereby, principally four main clusters and related optional participation strategies can be differentiated (Dearden et al. 2003; Reed et al. 2009; for an example see Figure 15):

Cluster / Quadrant A: Stakeholders with high interest and low influence *("Subjects*"): should be empowered, e.g. by capacity-building;

Cluster / Quadrant B: Stakeholders with high interest and high influence (*"Key Players")* should closely collaborate with the project team, i.e. should be actively engaged;

Cluster / Quadrant C: Stakeholders with high influence, but a low interest *("Context setters")* should be directly addressed, managed and monitored. Furthermore, the causes of their low interest should be elicited; awareness-raising might be useful for increasing their interest;

Cluster / Quadrant D: Stakeholders with low influence and low interest *("Crowd")* do not necessarily have to be actively engaged. Regular information and consultation to make sure they are heard might be sufficient (Reed et al. 2009; Zimmermann & Maennling 2007).

Once all stakeholders are positioned in the matrix' four quadrants, the stakeholder group may start into discussing and further fine-tuning the individual participation strategies.
Transferred to the PHUSICOS context, the Influence-Interest-Matrix is an adequate tool to be applied most prominently in the stage of

preparing and starting into the Living Lab process, when stakeholders need to be further identified and analysed. It can, however, also be of value as monitoring & evaluation tool alongside the full Living Lab process, as it possesses the capacity to track changes in a stakeholder set-up efficiently over time, when being used more than once, e.g. as a steady component in the framework of a Living Lab's yearly operational planning (Zimmermann & Maennling 2007).

For whom?

The Influence-Interest-Matrix is an appropriate tool for working with a broad range of stakeholders, crossing over from public sector officials, private sector partners, researchers and experts to civil society groups and individual citizens. Facilitation calls for basic to advanced skills.

Strengths and Limitations

A clear strength of the Influence-Interest-Matrix is its easy application as hand-held tool and option to do it interactively, contributing potentially to group cohesion and social learning in a stakeholder set-up. Depending on the individual process, it does not necessarily call for special software, but works well with standard moderation material, such as flipchart paper, sticky notes and markers. It can thus be regarded a flexible tool with low necessity on resource inputs. As for time demands, they might be higher in situations where separate stakeholder sessions are indicated (Dearden et al. 2003; Zimmermann & Maennling 2007); in general, however, a couple of hours may be sufficient to elaborate the matrix together with a stakeholder group.

A limitation of the tool can be recognized in the results being often biased by researchers (or study organizers). This is especially the case if the Influence-Interest-Matrix is elaborated without stakeholder interaction. Furthermore, there is the danger of identifying and analysing the "usual suspects" (Reed et al. 2009: 1939), resulting in marginalizing certain groups.
A possible way to overcome these bottlenecks is to utilize the tool in direct interaction with stakeholders. If already elaborated with the project team only, there should be openness to validate and adapt the results in close cooperation with the full stakeholder group.

Best Practice and Further Reading

The Influence-Interest-Matrix and its application in the field of natural resource manage-ment have been discussed in the review of stakeholder analysis methods put forward by Reed et al. (2009). Next to a sound provision of theoretical background considerations it also includes a description on how the tool was used in a computer-aided manner in several case studies of the UK Rural Economy and Land Use Program (RELU), illustrating procedural steps, possible bottlenecks and ways to overcome. The contribution also extends to the description of other stakeholder analysis tools' application in RELU, such as semi-structured interviews, rainbow diagramming and Social-Network Analysis (SNA).

Reed, M. S., Graves, A., Dandy, N., Post-humus, H., Hubacek, K., Morris, J., Prell, C., Quinn, C.H. & L.C. Stringer (2009): Who's in and why? A typology of stakeholder analysis methods for natural resource management. Journal of environmental management, 90(5), 1933–1949.

Reed, M.S. & R. Curzon (2015): Stakeholder mapping for the governance of biosecurity: a literature review, Journal of Integrative Environmental Sciences, 12:1, 15-38

A variant to the two-dimensional Influence-Interest-Matrix are three-dimensional versions, such as the visualization of power, interest and attitude recommended by Murray-Webster & Simon (2006) and Demir et al. (2015).

Murray-Webster, R. & P. Simon (2006): Making sense of stakeholder mapping. PM World Today, Vol. 8, No. 11, pp. 1–5.

Demir, S.T., Bryde, D.J., Fearon, D.J. & E.G. Ochieng (2015): Three dimensional stakeholder analysis – 3dSA: adding the risk dimension for stakeholder analysis, Int. J. Project Organisation and Management, Vol. 7, No. 1, pp. 15–30.
For practioner-orientated background information on stakeholder analysis tools, including the influence-interest-matrix, see:

Dearden, P., Jones, S. & R. Sartorius (2003): Tools for Development. A handbook for those engaged in development activity. Performance and Effectiveness Department. DFID – Department for International Development. UK.

Zimmermann, A. & C. Maennling (2007): Multi-stakeholder management: Tools for Stakeholder Analysis: 10 building blocks for designing participatory systems of cooperation. Deutsche Gesellschaft für Technische Zusammenarbeit GmbH. Eschborn.

For short tool descriptions of the matrix, see:

Brouwer, H. & J. Brouwers (2017): Tool 12. In: The MSP Tool Guide: Sixty tools to facilitate multi-stakeholder partnerships. Companion to The MSP Guide. Wageningen: Wageningen University and Research, CDI. http://www.mspguide.org/tool/stakeholder-analysis-importanceinfluence-matrix (accessed 7th March, 2019)

Young, J., Shaxson, L., Jones, H., Hearn, S., Datta, A. & C. Cassidy (2014): ROMA – A guide to policy engagement and influence. Research & Policy in Development. ODI – Overseas Development Institute, London, UK. 78p.

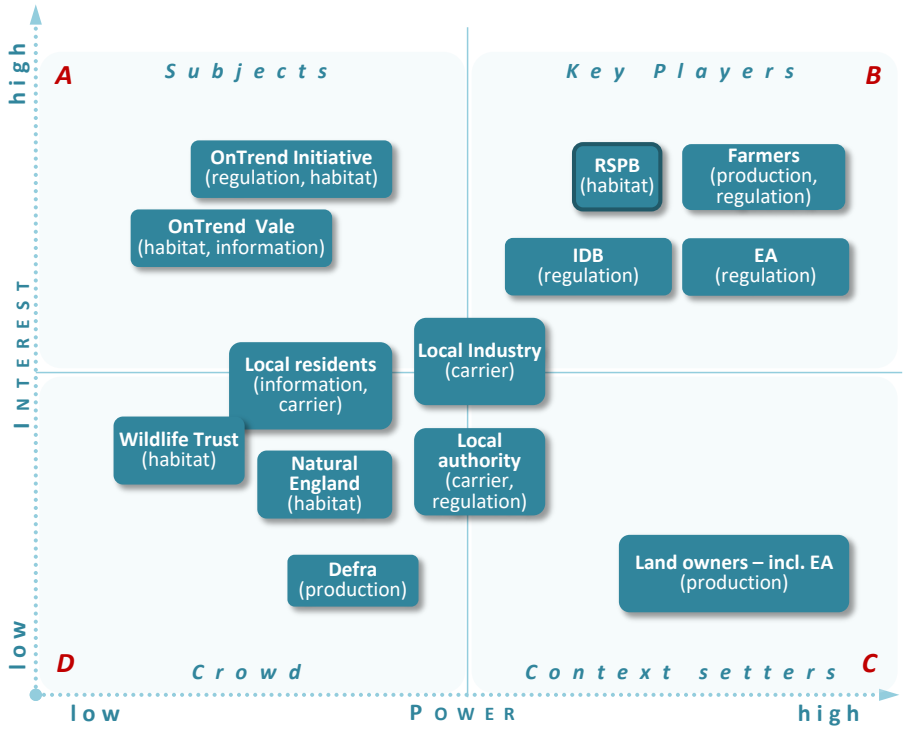

Figure 15. Example illustrating the stakeholder analysis tool "Influence-Interest-Matrix". (Graph: Fohlmeister et al. 2018, Design: C. Smida 2018, based on Reed et al. 2009)

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration	☑	Stakeholder identification & analysis	☑	◇◇	☺ ☺☺ ☺☺☺	🕒 🕒🕒	① ②
Selection		Explore opinions & worldviews	☑				
Co-Design		Elicit local knowledge					
Evaluation	☑	Foster group cooperation					
		Decision-making					
		Measure NBS efficiency					

Stakeholder Mapping / Stakeholder Landscape

What is it?

Stakeholder mapping can be defined both as an approach and as a tool. As an approach, it is often synonymously used with the term *Stakeholder analysis* (Reed & Curzon 2015; SDC 2011). In its tool function, Stakeholder mapping is a diagram-based visualization of all stakeholders being of relevance to an issue at stake in a systematic manner. It is thus a tool bringing together stakeholder identification, categorization according to the stakeholders' relevance to an issue and the investigation of stakeholder interrelations (Reed et al. 2009).

In general, Stakeholder mapping may be done in two ways: on the one hand, it can be applied as an analytical tool (*top-down-approach*) by a project team itself (Reed et al. 2009). On the other hand, it can be used as reconstructive tool (*bottom-up-approach*), hereby actively engaging stakeholders in the framework of a workshop setting or focus group discussion. Although both variants are possible and in use, the latter, interactive one appears the more beneficial way, as it fosters group cooperation and ownership for the process among the related stakeholders.

As for procedural steps and important principles, Stakeholder mapping comprises the following six main steps (SDC 2011):
Step 1, the *"Scope setting",* defines the frame of the mapping procedure by i) clearly formulating the focus / issue at stake of the mapping to guarantee visual clarity and narrowing the number of stakeholders to those of relevance; ii) deciding at what time the map shall be produced and updated; and iii) delineating the circle of stakeholders being involved in the map's production to ensure the representation of the perspectives is the intended and meaningful one (Zimmermann & Maennling 2007).

Step 2, the *"Identification of relevant actors and their basic profiling"* serves to list up all potential stakeholders, e.g. by brainstorming (Fohlmeister et al. 2018), and to achieve a first overview on the different actors. Simple tables can be used in this step to display some details on the stakeholders, such as the 4A's method, informing on the Actors (names, functions), their Agendas (mandates, missions), Arenas (fields of action) and Alliances (relations) (SDC 2011; Zimmermann & Maennling 2007) or the 4R framework, focusing on rights, responsibilities, returns and relations (Lynam et al. 2007).

Step 3, the *"Identification of key stakeholders",* is the next important step towards organizing the stakeholder landscape and further narrowing down the stakeholder list to those being of priority to the intended issue. This is done by assigning the assembled stakeholders to the categories of *key, primary and secondary* stakeholders and by especially having a close look at the core attributes of *legitimacy, resources and networks* (for definitions of the categories and attributes, see Figure 16).

After these essential preparatory steps, it is time for Step 4, the *"Elaboration of the map"*, which can be done on the basis of the metaplan method, differentiating the main actors of each category by different coloured and –sized paper cards. To yield a useful final result, the map should not be overloaded, and keep up a certain visual clarity (SDC 2011 and Figure 16).

Building on the elaborated stakeholder map, Step 5 is dedicated to the "*Visualization of the relationships between stakeholders"*. More specifically, alliances, cooperation, weak relations, tensions and conflicts can be highlighted in this step by using different graphic line elements, thus making transparent the quality of relationships in the existing stakeholder network.

In the final step of the mapping procedure, the resulting stakeholder map should be discussed and validated with the stakeholder group (SDC 2011). This step is especially of relevance in settings where the map was produced without direct stakeholder interaction.

When to use / What for?

Stakeholder mapping is commonly applied when preparing and starting into a participatory process. It is intended to visualize the full stakeholder landscape being relevant to an issue at stake, thus enabling to formulate first hypotheses and to draw conclusions with regard to the degree of influence individual stakeholders may have on the issue under consideration, learn more about mutual alliances and dependencies, and also to detect *blanks*, i.e. the further need of information or investigation on stakeholder interrelations (SDC 2011; Zimmermann & Maennling 2007).
Stakeholder mapping thus serves as important "backbone of a cooperation strategy" (SDC 2011: 1), as it helps to depict the key stake-holders and those who are connected to them, while also contributing to the identification of veto players (see Figure 16), without whose support the planned intervention may not work (Zimmermann & Maennling, 2007).

For whom?

Stakeholder mapping is an appropriate tool for working with a broad range of stakeholders, crossing over from public sector officials, private sector partners, researchers and experts to civil society groups and individual citizens. Facilitation calls for basic to advanced skills.

Strengths and Limitations

A strength of Stakeholder mapping is its application as hand-held tool and option to do it interactively, contributing potentially to group cohesion and social learning in a stakeholder set-up. It can be regarded a flexible tool, being apt to be adapted to individual purposes and situations, with low necessity on resource inputs (apart from standard moderation material). As for time demands, they might be higher in situations where separate stakeholder sessions are indicated (Dearden et al. 2003; Zimmermann & Maennling 2007), or where the complexity of the stakeholder set-up calls for additional investigations, e.g. in conjunction with a Social Network Analysis (see tool description of *Social Network Analysis*).

In general, however, a couple of hours up to one day might be sufficient to elaborate the map together with a stakeholder group.
A possible disadvantage of the tool is that the final result might lack the necessary visual clarity, especially when the focus is not clearly set. This, however, can be mastered by sound facilitation and a well-done scope setting prior to the map's elaboration.
As also the case for other stakeholder analysis tools, a further limitation of the tool can be recognized in the results being possibly biased by researchers (Reed et al. 2009; Reed & Curzon 2015) or the stakeholders who worked out the map. A way to overcome this bottleneck is to previously deliberate well on the stake-holder selection for the exercise to balance-out the potential negative effects. If already elaborated with the project team only, there should be openness to validate and adapt the results in close cooperation with the full stakeholder group (SDC 2011).

Best Practice and Further Reading

For practioner-orientated background information on stakeholder analysis tools, including Stakeholder mapping, see:

Dearden, P., Jones, S. & R. Sartorius (2003): Tools for Development. A handbook for those engaged in development activity. Performance and Effectiveness Department. DFID – Department for International Development. UK.

SDC – Swiss Development Cooperation (2011): Stakeholder Analysis and Mapping. SDC Knowledge Management Toolkit. SDC Political Economy and Development PED Network, PED basic Tools.

Zimmermann, A. & C. Maennling (2007): Multi-stakeholder management: Tools for Stakeholder Analysis: 10 building blocks for designing participatory systems of cooperation. Deutsche Gesellschaft für Technische Zusammenarbeit GmbH. Eschborn.

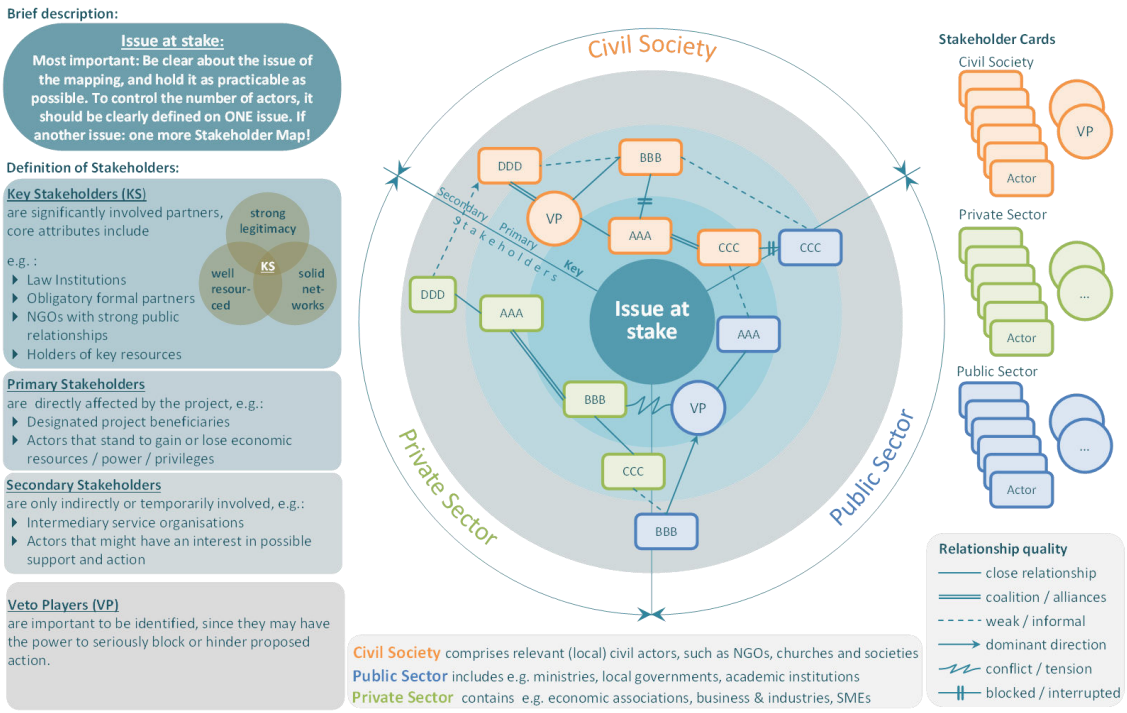

Figure 16. Conceptual tool description of a Stakeholder Map visualizing different qualities (and affiliations) of stakeholders and their relationships. (Graph: Fohlmeister et al. 2018, Design: C. Smida 2018, based on SDC 2011)

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration	☑	Stakeholder identification & analysis	☑	◇◆	☺ ☺☺ ☺☺☺	🕒 🕒🕒	① ②
Selection		Explore opinions & worldviews	☑				
Co-Design		Elicit local knowledge					
Evaluation	☑	Foster group cooperation					
		Decision-making					
		Measure NBS efficiency					

6.3 Tools for the Living Lab working process

6.3.1 Basic group moderation techniques

In response to the big interest articulated by the facilitator group in the framework of the tool demand assessment in Naples 2018 (see Chap. 2 and 5.2), some basic group moderation techniques have been incorporated in the Toolbox.

Detailed portraits can be found for the following techniques:

- **Card Inquiry**
- **Focus Group Discussion**
- **World Café.**

As previously stated, a more intense consideration of group moderation techniques might have been desirable, but likewise would have been beyond this Toolbox' focus targets and boundaries.

For a more in-depth study on facilitation techniques, consensus-building, effective group management and methods of group reflection the interested reader may consult the Toolbox Library (see Chap. 6.4).
For fostering decision-making in group settings, see Chap. 6.3.2, Cluster *Decision-Support Tools*.

Card Inquiry / Card Writing & Sorting

What is it?

The Card Writing & Sorting technique (*also: Card Inquiry or Metaplan method*) is a multitalented tool to support brainstorm sessions, small group/buzz group work or even larger group discussions. It helps crossing-over from conventional one-way dialogue schemes towards enabling participation of a stakeholder group on equal grounds concerning an issue at stake in an easy and accessible manner by simply providing the opportunity to put down and share ideas on paper cards, which are then collected, visualized and further worked on.
This visualization of thoughts and of the discussion process as a whole is not only of advantage to people preferring to contribute their viewpoints in a written manner over talking up in large group settings (IDS 2019); as practice demonstrates, the posting of ideas in a visible manner also makes people detect connections between items, prevents misunderstandings during the discussion and, above all, can be a leverage for a stakeholder circle to advance in its discussion process, as ideas are visibly spoken and heard, making further reiteration unnecessary (Vogt 2009).

The point of departure for the Card Inquiry is usually a well-formulated question presented by the facilitator, being accompanied by an explanation on the goal of the exercise. Upon the distribution of markers and cards to the participants of the group discussion, a suitable time-slot needs to be provided for individually brainwriting and documenting the ideas on cards. In the next step all cards are visualized on a pin board. Depending on the available timeframe and setting, this step can either be done by the facilitator, or the participants themselves. As soon as the card collection on the pin board is complete, the stakeholder group may shift towards the decisive next step of sorting, grouping and assessing the results (Metaplan GmbH). For this task, there are several variants existing. Ideas might be sorted by simply clustering similar ones and removing duplicates, for example. Discussing the pros and cons of each idea might help to narrow down a bigger number of results towards an intended reduced list. Furthermore, dot voting by participants can contribute to distil key aspects and preferences of the stakeholder group (Everyday Democracy 2008).

When to use / What for?

As stated above, the Card Inquiry is an *all-rounder* tool for dialogue circles and group work settings, apt to be a stand-alone tool or part of any participatory sequence (IDS 2019). It can be applied to capture or produce new ideas, collect, sort and analyse them and/or prepare related decisions.
Furthermore, it may support the exploration and exchange of worldviews and opinions, or contribute to the elaboration of solutions, such as the planning of work processes, distribution of responsibilities, action plans, etc.
Next to that, the Card Inquiry might also be a senseful step to enable a more in-depth examination of an issue from the participant group's perspectives, e.g. by assembling questions or problems related to the issue at stake (Metaplan GmbH, IDS 2019).

For whom?

The Card Inquiry is an appropriate tool for involving a highly diverse group of stake-holders, crossing over from public sector officials, private sector partners, researchers and experts to civil society groups and individual citizens.

Strengths and Limitations

Compared to the use of flipcharts or screen notes, the Card Inquiry is a very versatile tool, as cards can be easily distributed, clustered and re-clustered according to needs and discussion inputs, and added upon – and all this directly building on the involvement of the present stakeholder group.

A possible limitation might consist in stakeholder fatigue; this is especially possible in environments that frequently use Card Inquiry as a standard workshop tool.

Best Practice and Further Reading

Institute of Development Studies (IDS) (2019): Card writing and sorting. https://www.participatorymethods.org/glossary/card-writing-and-sorting. (accessed 6th March, 2019)

Everyday Democracy (2008): A Guide for Training Public Dialogue Facilitators. Paul J. Aicher Foundation. Connecticut, USA. https://www.everyday-democracy.org/resources/guide-training-public-dialogue-facilitators (accessed 8th March, 2019)

The Metaplan company published a primer on Metaplan basic techniques (English/French): http://resources.metaplan.de/wp-content/uploads/2017/04/Metaplan_Basiswissen_engl.pdf (accessed 1st March, 2019)

Impressions from Metaplan workshops can be gained by this YouTube video: https://www.youtube.com/watch?v=p7UJX7XF0Xo (accessed 6th March, 2019)

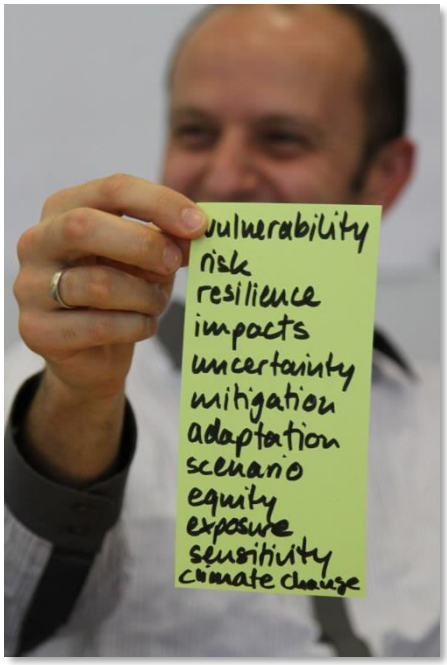

Figure 17. Card Inquiry in practice. (Pictures: Barth/Fohlmeister/Hossini 2011, CCCA Workshop Bonn)

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration	☑	Stakeholder identification & analysis		◈◈	☺	🕒	①
Selection	☑	Explore opinions & worldviews	☑		☺☺		
Co-Design	☑	Elicit local knowledge	☑		☺☺☺		
Evaluation	☑	Foster group cooperation	☑				
		Decision-making					
		Measure NBS efficiency	☑				

Focus Group Discussion (FGD)

What is it?

The Focus Group Discussion (FGD; *short: Focus Group*) is a discussion format for small groups (4-12 persons) of stakeholders, which is guided by a skilled facilitator with the target to obtain information about people's preferences, values and their underlying thinking related to a distinct topic in a natural, social environment (Elliott et al. 2005). The Focus Group can thus be understood as a combination of a focused interview with a discussion group, allowing for participants to discuss the nuances of an issue and to reflect on it from multiple perspectives in a peer group setting they feel comfortable with, while direct observation of the participants' non-verbal communication and interaction offers additional insights to the conducting study organizers (Duerrenberger et al. 1997; Action Catalogue Engage 2020).

The composition of the group can be chosen in different ways, either representing an even spread of all relevant stakeholders, or putting an emphasis on certain target groups (Wascher 2013). The individual participant selection calls in any case for a careful planning, and will very much depend on the purpose of the Focus Group, the information needed and the number of sessions foreseen; if more than one Focus Group is planned, a differentiation by aspects such as gender or interest groups might be useful (Elliott et al. 2005).

When to use / What for?

Focus Group turns out to be highly suitable for exploratory purposes, to reveal stakeholders' concerns and to bring forward new, creative ideas. This makes it an especially useful tool to be applied in the initial stages of a project, for purposes of planning or concept development (Wascher 2013). However, the tool has much more to offer, and thus is also frequently applied in pre-test work, input generation on policy proposals, for evaluation purposes and need assessments (Elliott et al. 2005).

With glance at the PHUSICOS context, the Focus Group is among the most versatile options of the group discussion techniques, as it can be modified to suit discussion within multiple Living Lab phases (for exploratory purposes to reach a consensus, to select possible NBS, to contribute to design aspects of a selected NBS, or to discuss assessment of an NBS's performance). Furthermore, Focus Groups are easily used alongside or in support of other methods, such as PGIS or PSP.

In a study by Bracken et al. (2016) of flood management planning within rural communities in the UK, focus groups undertaken in the form of semi-structured interviews were paired in a planning process with community drawn maps of the affected areas that were later digitized using GIS to display how local stakeholders viewed the area and the main contributing factors to the flooding. Focus groups were done both before and after map creation to judge how opinions of local contribution to flood management changed from the collective analysis of the maps.

For whom?

The Focus Group Discussion is an appropriate tool for working with a broad range of stakeholders, crossing over from public sector officials, private sector partners, researchers and experts to civil society groups and individual citizens.

Strengths and Limitations

The Focus Group offers a simple and very time-efficient way to structure in-depth conversations while providing a natural, social atmosphere for participants and generating a sound understanding of stakeholder percep-tions (Wascher 2013).

A challenge to Focus Group outcomes might be a bias caused by interference of group expression with individual expression (Elliott et al. 2005). Other shortcomings can evolve by persons dominating the discussion, which emphasizes the importance of professional facilitation skills (Lynam et al. 2007).

Best Practice and Further Reading

As the tool belongs to the *classics* of qualitative research, there's a rich pool of information and lessons learned available on it.

Further reading:

Duerrenberger, G., Behringer J., Dahinden, U., Gerger, Å., Kasemir, B., Querol, C., Tabara, D., Schühle, R., Toth, F., van Asselt, M., Vassilarou, D. Willi, N. & C. Jäger (1997): Focus Groups in Integrated Assessment: A Manual for Participatory Research. ULYSSES Working Paper WP−97−2. Darmstadt: Darmstadt University of Technology

For more detailed tool descriptions, step-by-step guidance, resource considerations, see e.g.:

Elliott, J., Heesterbeek, S., Lukensmeyer, C.J. & N. Slocum (2005): Participatory Methods Toolkit. A Practitioner's Manual. King Baudouin Foundation and the Flemish Institute for Science and Technology (viWTA).

Action Catalogue Engage2020, administered by the Danish Board of Technology: Focus Group http://actioncatalogue.eu/method/7409 (accessed 6th March, 2019)

Wascher, D. (2013): Focus group. LIAISE Toolbox. Download: http://www.liaise-kit.eu/ia-method/focus-group (accessed 6th March, 2019)

A case study example from the field of flood risk management on how focus groups might be combined with other tools such as PGIS is provided in:

Bracken, L. J., Oughton, E. A., Donaldson, A., Cook, B., Forrester, J., Spray, C., Cinderby, S., Passmore, D. & N. Bissett (2016): Flood risk management, an approach to managing cross-border hazards. Natural Hazards, 82(S2), 217-240.

Figure 18. Focus Groups in practice: doing needs assessments, Mongolia. (Pictures: Fohlmeister 2005)

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration	☑	Stakeholder identification & analysis		◈	☺ ☺☺	🕒	ⓘ
Selection	☑	Explore opinions & worldviews	☑				
Co-Design	☑	Elicit local knowledge	☑				
Evaluation	☑	Foster group cooperation					
		Decision-making					
		Measure NBS efficiency	☑				

World Café

What is it?

The World Café is a creative group discussion format for medium to large-sized stakeholder groups (>12) which engages participants in an authentic dialogue circle for exchanging knowledge, experiences and ideas and fostering collaborative learning on an issue at stake (Čolić 2013; Brown 2002 cited in Elliott et al. 2005).
The special feature is – as the tool's name says – the Café ambience, which is consciously set-up for giving the group discussion a framework for exploring a topic that matters to them at ease, sharing and co-producing ideas at café-style tables in small groups. By moving between the different topic tables at regular intervals (20-30 min.), the participants cross-fertilize each table's elaborated ideas, and jointly contribute to stimulate innovative thinking and exploring action possibilities related to real-life issues.
As for the documentation process, each table is guided by a *table host*, whose task is to shortly update the newly arriving participants by synthesizing the previously effectuated discussion, and inviting the new contributions. On such basis, each table's small group of exchange can evolve step-by-step, putting down and adding to ideas and notes directly on the provided paper tablecloth (see Figure 19).
Upon conclusion of the event, main ideas are summarized in the plenary by the facilitator(s), giving an outlook to further follow-up action.

When to use / What for?

The World Café is useful in situations which call for input generation, knowledge sharing and innovative thinking by group discussion, while preparatory demands are comparatively low.
As the tool is also good at developing a sense of trust between stakeholders in a convenient atmosphere, it is further of use for sparkling ownership-building in a stakeholder set-up with already established or new relationships (Čolić 2013).

In the PHUSICOS context, the World Café is a capable tool to initiate stakeholder processes, such as building consensus and to establish a shared knowledge pool on NBSs to start from for a longer-term Living Lab process. As it is an *all-rounder* tool, however, the creative group discussion format might also be of use for many other purposes, such as more-in-depth examining of key challenges of NBSs or to promote mutual ownership for future outcomes in an existing group (Elliott et al. 2005).

It appears not the right *time for a coffee* if solutions or answers are already set, and acceptance for them is to be achieved, or if implementation should be planned more in detail. Furthermore, it is recommended to go for another dialogue circle format, if the group size is too small (<12 people) (Brown 2002).

For whom?

The World Café is an adequate tool for involving a highly diverse group of stake-holders, crossing over from public sector officials, private sector partners, researchers and experts to civil society groups and individual citizens. Depending on the stakeholder group's size, it should be facilitated by one or two facilitators, the so-called *Café hosts*. Although being an easy-to-handle tool, it is indeed the facilitator who can make the difference between achieving an interesting conversation, or real co-production of knowledge (Brown 2002). Facilitators being interested in the tool's application should thus be well-prepared and possibly possess some experience with the tool.

Strengths and Limitations

A distinct strength of the World Café is its flexible and easy-to-handle design, making it possible to set-up a café ambience in a very simple manner almost in every setting, just

depending on tables and chairs, flipchart paper and similar standard moderation equipment. Furthermore, the time needed for the tool's application, being limited to a couple of hours only, is a clear advantage over more time-demanding group discussion formats.

The success of a World Café event very much depends on the careful formulation of the topic of matter and related questions, which build the backbone of the format. It is thus key to invest sufficient time on the selection and formulation of both. Another possible pitfall is the choice of the wrong number of participants per table: the "magic number" is four; in case of less, inputs might not reach the necessary substance, while more than that may mean a barrier to a fair and equal engagement of all participants at a table (Brown 2002).

Best Practice and Further Reading

Brown, J. & D. Isaacs (2005): The World Café. Shaping our Futures through Conver-sations that Matter. Berrett-Koehler Publishers.

Website of the World Café Community Foundation: http://www.theworldcafe.com/ (accessed 6th March, 2019)

More detailed tool descriptions, step-by-step guidance and case studies:

Action Catalogue Engage2020: Tool World Café. http://actioncatalogue.eu/method/7402 (accessed 7th March, 2019)

Brown, J. (2002): The World Café. A Resource Guide for Hosting Conversations that Matter at the World Café. Whole Systems Associates. http:/www.theworldcafe.com Download: http://www.meadowlark.co/world_cafe_resource_guide.pdf (accessed 7th March, 2019)

Elliott, J., Heesterbeek, S., Lukensmeyer, C.J. & N. Slocum (2005): Participatory Methods Toolkit. A Practitioner's Manual. King Baudouin Foundation and the Flemish Institute for Science and Technology (viWTA).

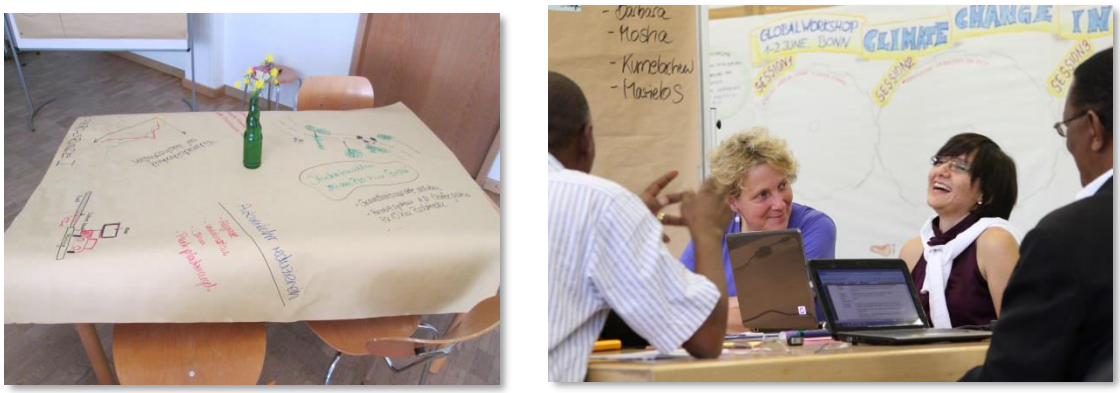

Figure 19. Collaborative dialogue in café ambiance: the World Café. (Pictures: Fohlmeister 2017 (left) and Barth/Fohlmeister/Hossini 2011, CCCA Workshop Bonn (right))

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration	☑	Stakeholder identification & analysis		◈◈	☺ ☺☺ ☺☺☺	🕒 🕒🕒	① ②
Selection	☑	Explore opinions & worldviews	☑				
Co-Design	☑	Elicit local knowledge	☑				
Evaluation		Foster group cooperation	☑				
		Decision-making					
		Measure NBS efficiency					

6.3.2 Tools for Stakeholder Knowledge Mapping and Co-Design of NBSs

To efficiently support the Living Lab working process, and orientated by expert consultation, the following clusters were built for presenting the recommended tools for Stakeholder Knowledge Mapping to Co-Design NBSs:

Mapping Tools

- **Node-link diagrams**
- **Scale Mapping**
- **Sketch Mapping**
- **Technology-supported Participatory Mapping**
- **Transect**

Tools for Retrospective Reflection and Future Planning

- **Future Search Conference**
- **Geo Timeline**
- **Participatory Scenario Planning (PSP)**
- **Storywall / Storyboard**
- **What's Your Agenda?**

Tools to encourage Creative Thinking and Mutual Understanding

- **Multiple Perspectives Wheel**
- **Open Space Technology (OST)**

Decision-Support Tools

- **Delphi Technique**
- **Multi-Criteria Decision Analysis (MCDA)**
- **Simple Scoring and Ranking Methods**

MAPPING TOOLS

Node-link diagrams

What is it?

Node-link diagrams provide a visual picture of relations among objects (or informational items such as concepts). Entities are captured as nodes (represented by words or by labelled boxes or circles) and relationships as links (represented by lines for undirected relations or by arrows for directed relations). Positional proximity of nodes denotes closer relationships among entities. Node-link diagrams are particularly useful to help individuals or groups externalise, structure and share their knowledge on complex facts, concepts, principles and procedures. The final diagram provides a structured visual overview of the studied issue which can also serve to document the findings. In a group setting, the interactive diagramming process itself is arguably more beneficial than the output itself since the participants are able to find, see and understand connections between bits of information that describe complex systems.

From the multitude of node-link diagram varieties to systematically analyse a wide range of issues, a selection of established techniques considering stakeholder knowledge is described in the following. The intensity of stakeholder involvement and the complexity of application varies between the tools, both characteristics are indicated for each tool in the descriptions.

Simple and effective for visual problem structuring are **problem trees**. The problem tree analysis is undertaken in a multi-stakeholder workshop setting to define and examine actual local problems. The tool helps to identify the underlying causes and effects of the unsatisfactory situation and to reveal the cause-effect relationships (Narayanasamy 2009). After discussing and singling out the core problem, it is written on a card and centrally displayed on a pin board (e.g. parts of settlement are flooded each year). Departing from this 'tree trunk', the problem tree is interactively developed with the participants in such a fashion that the immediate and direct causes of the focal problem are placed in parallel beneath it, and the immediate and direct effects of the focal problem are placed in parallel above it (Dearden et al. 2003). According to the causal relationships in the system, the outer roots and branches are gradually established. When the participants agree that all essential information has been included in the diagram that explain the major cause and effect relationships characterising the problem, the problem analysis can be concluded (ibid.). The cause-effect tree illustrates the dependent and independent factors influencing the focal problem helping to identify entry-points to take action. Based on the problem tree, an objective tree for future remedy can be set up by transforming all problem tree elements into statements of the desired state and conditions which can be used to discern priorities of intervention measures (Franz & Schall 2002). Tree diagrams in general are networks in which there is only one possible path to go from one node to another (Bertin 2011: 276). Their clear structure makes tree diagrams effective multi-purpose visual tools for narrowing down and dissecting problems, identify and prioritise objectives and decisions.

Primary use of **mind maps** is to discover and explore associations between ideas, encourage brainstorming and spontaneous, creative thinking (Dixon & Lammi 2014). Through the organised visualisation of information, mind maps can serves as aides-memories (Davies 2011). In its traditional form, a mind map is a hand-drawn rich picture around a central topic. Radiating from the central issue, workshop participants think free and unrestricted about the core topic and add their thoughts in form of images, pictures, symbols or keywords, so that the main themes grow outward like the branches of a tree. The connecting lines between them are usually unlabelled (Davies 2011). With growing map the themes fan out in smaller subsets.

Under the heading of **causal map** several variants of node-link diagrams illustrating causal relations can be encountered utilising network theory or system dynamics. In a rather common variant, the causal links are associated

with a specified strength of causality and assumed positive or negative polarity. The strength of positive loading (the connected nodes change in the same direction) or negative loading (the nodes change in opposite directions) is depicted with a number, usually in the range of from 1 (weak) to 3 (strong) (Kivijärvi et al. 2008). Linkages in node-link diagrams that are used to represent the causal relationships of concepts held in the human mind show indicative labels in the case of Novakian **concepts maps** (Novak & Canãs 2006). In the case of Axelrodian **cognitive maps,** the links hold plus signs for positive relationships and minus signs for negative connections (Axelrod 1976).

To show the causal relationships between multiple and interacting variables where the system is affected by non-linear behaviour, feedback loops and time delays, **causal loop diagrams** are employed (Lopes & Videira 2015). Important features of the diagram are so called closed circles that are differentiated in reinforcing feedback loops and balancing feedback loops. Positive feedback loops indicate reinforcing dynamics that underlie continued growth or decline patterns unless any relationship has been severed (Kim et al. 2017). A balancing loop is defined as negative feedback relationship in which the loop returns an attenuating effect on the initial variable through which the system can find its balance in a steady state.

When fuzzy logic is applied to causal mapping, the variant is termed **Fuzzy Cognitive Mapping** (FCM). A fuzzy cognitive map is a node-link map in which the relative strength of the causal relationship between system variables (or concepts) is ranked by assigning a number between −1 and 1, instead of using an ordinal scale as for 'ordinary' causal diagrams.

When to use / What for?

Applied in the early stages of a project, a **problem tree** provides a systematic way to analyse the core problems existing in a project area. The tool helps workshop participants to separate the underlying actual problems from the symptoms (Franz & Schall 2002). Thus root causes can be revealed and consecutive steps identified to tackle the core constraints.

Sketching a **mind map** in a workshop setting can be applied for example to stimulate visioning sessions where participants explore and discuss desired future states for a project site, and foster dialogue and collaboration among participants in general. Especially in the co-design phase, mind mapping can be helpful to inspire out of the ordinary thinking and develop unconventional ideas.

Causal mapping engages workshop participants in exploring cause-effect relationships between physical system elements or concepts and hence get a better idea of complex systems and mental models. **Causal loop diagramming approaches** allow to apply system dynamics theory to analyse complex phenomena such as ecosystems and landscapes as dynamic social-ecological systems.

For whom?

In principle, all groups of stakeholders can be involved in knowledge mapping processes using node-link diagrams. To explain and apply the more sophisticated tools such as causal loop diagramming and fuzzy cognitive mapping in a workshop setting, requires experienced facilitators and expert knowledge for the analysis of the generated diagrams.

Strengths and Limitations

Problem tree analysis is simple to apply and facilitate, independent of technology and provides effective visual aid to get an overview of actual problems. Making those transparent, provides a firm basis for dialogue with and among stakeholders, further and deeper analysis, and consider means of remediation. According to Franz & Schall (2002), a limitation of the tools is that it does not discriminate the severity of problems but treats them as equally important.

Mind mapping is easy to learn and to apply, encourages creativity, provides a visual overview of ideas and themes which can be easily further developed and extended (Davies 2011). However, generated mind maps can be inconsistent showing no clear links between depicted concepts and can be difficult to decipher and understand by others than the

authors (Eppler 2006). They cannot deal with complex relationships between concepts, are often inconsistent in terms of level of depicted detail and can become convoluted and messy if many aspects are considered (Davies 2011).

Structured visualisation by **causal maps** helps to detect misconceptions or faulty ideas thus providing ways to meaningful learning and to better understand complex phenomenon. Causal maps organise complex ideas by depicting only the critical concepts related to a topic in an organised way but may turn difficult to read if the maps contain a high number of nodes and connections.

However, the particular strength of all types of causal mapping unfolds when used as tool for in-depth quantitative analysis of complex physical systems, social-ecological systems or human mental models where qualitative data holds decisive information. When graph theory is applied, structural indices such as density, complexity and centrality can be calculated. For example, centrality indicates how influential a (concept) variable is in the model (Gray, Zanre & Gray 2014), whereas density is the number of connections compared to the overall number of possible connections (ibid.). It is assumed that a higher density value indicates more entry-points for change and intervention measures as there are more connections in the network (Özesmi & Özesmi 2004). Structural indices derived from causal maps can provide relevant information from a natural resource management and environmental planning point of view.
However, researchers and facilitators motivated to harness this strength need to be aware that applying these tools as analytical measurement techniques is complex, time-consuming and demands considerable conceptual and procedural know-how (Mohammed et al. 2000; Gray, Zanre & Gray 2014).

Best Practice and Further Reading

Several tool collections related to Participatory Rural Appraisal (PRA) and for multi-stakeholder partnerships provide step-by-step guidance on **problem tree analysis** and case study examples illustrating its use (e.g. Dearden et al. 2003; Narayanasamy 2009; Brouwer & Brouwers 2017).

Mind maps are common and widely applied tools for which a lot of information and software tools are provided in literature and on the internet. For a group work setting, hand drawn mind maps are recommended to involve the participants and foster group cooperation. An arts-based methods toolkit for stakeholder engagement is provided by Pearson et al. (2018) (see also Chap. 6.4 Tool Library).

Many illustrative examples on the use of **causal diagrams** can be found in literature: Proposing a methodological framework for participatory scenario development, Reed et al. (2013) use causal diagrams as integral part of the conceptual modelling approach to capture stakeholders' understanding of socioeconomic and biophysical processes related to the management of uplands in the UK.

Kim et al. (2017) employed **causal loop diagramming** to analyse the social-ecological system dynamics of the Shinduri coastal region in South Korea. Based on the analysis results, a sustainable land-use planning strategy was developed to enhance coastal resilience. For the study, data describing the social system were derived from written secondary sources such as government policies, local government reports and news articles. Lopes & Videira (2015) applied a participatory system dynamics modelling approach to conceptualise stakeholders' perceptions of ecosystem services in the Arrábida Natural Park, Portugal. The study included a participatory systems mapping workshop and **causal loop diagramming** to capture perceptions and mental models of the local participants.

Özesmi & Özesmi (2004) explain a multi-step **Fuzzy Cognitive Mappin**g (FCM) approach, in which they combine expert and local people's knowledge to model social-ecological systems more appropriately. For a case study example, see Gray et al. (2014), who used FCM to assess individual and collective perceptions of stakeholders in regard to climate vulnerability and adaptation in the coastal areas of Tralee Bay, Republic of Ireland, and the Outer Hebrides in Scotland.
To conduct FCM analysis, several software packages are available allowing the incorporation of individual and group-level knowledge derived from participants' fuzzy cognitive maps and calculate structural metrics

such as the already mentioned density and centrality indices. Among the software programs employed in studies modeling social-environmental systems are Matlab (Tiller et al. 2016), FCMapper software (Gray et al. 2014; Mehryar et al. 2017; Olazabal & Pascual 2016), and Mental Modeler software (Henly-Shepard et al. 2015; Verkerk et al. 2017).

Figure 20. On the way to a common understanding: A mind map visualising the associations of Sustainable Resource Management students when thinking about landscape as social-ecological system. (Picture: Augenstein 2018)

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration	☑	Stakeholder identification & analysis		◈ ◈	☺	🕒	①
Selection	☑	Explore opinions & worldviews	☑		☺☺	🕒🕒	②
Co-Design	☑	Elicit local knowledge	☑		☺☺☺	🕒🕒🕒	③
Evaluation	☑	Foster group cooperation	☑				
		Decision-making					
		Measure NBS efficiency					

Scale Mapping

What is it?

Scale mapping is a participatory mapping technique that allows to elicit, represent and process local spatial-environmental knowledge using official topographic maps, ortho-rectified aerial photographs or specifically created base maps as georeferenced background providing orientation to the participants. Scale maps are commonly used where place-based experiential knowledge of local stakeholders enhances and complements the so called scientific or expert knowledge on the study area and where the real-world geographic localization of the stakeholder input and quantifiable units matter for further data processing and analysis.

The usual setting for scale mapping is a workshop during which locals gather in small groups around the background map discussing e.g. the delineation of sensitive or hazard-prone sites and drawing their input either directly on the georeferenced representation of the area or on a transparent foil. The latter has the advantage that the individual drawings of participant groups as well as those of key informants can be overlaid and compared to check for consistency or discrepancies between participants to get an idea of the rigor of the findings.

Base maps specifically designed for such an event should be easy to read and include elementary spatial information such as roads and settlements or natural landmarks such as rivers or mountain tops providing the participants with clues for orientation and helping them to recognize their whereabouts.

For digital forms of participatory mapping see tool description *Technology-supported Participatory Mapping.*

When to use / What for?

Harnessing local knowledge is the major purpose of scale mapping. The inclusive activity can boost discussion and brainstorming among participants and may encourage users to think more deeply about a local situation and understand its complexity. Scale maps provide descriptive information to outside facilitators and experts and provide indications to interpret the significance locals assign to the descriptive facts. The combination of conventional survey techniques, spatial modelling and participatory mapping may result in complementary types of insights on the study area. The tool can also assist in the selection and co-design of NBSs and the generation of alternatives.

Scale mapping can be combined with various other techniques. Conducted as part of key informant interviews for example, the visual stimuli can ease and enhance communication between interviewer and interviewee. The drawings may enrich verbal answers thus integrating qualitative and quantitative information. Participatory mapping is particularly useful for topics closely related to place-based knowledge of local people which is not or not sufficiently covered by conventional maps, surveys or published literature (Debolini et al. 2013). The mapping process could reveal what is valued by locals and improve communication and understanding among participants and outside officials or researchers. Content and reliability of the information gained by scale mapping is dependent upon participant's familiarity with the study area, topic understanding and ability to draw maps (Golobic & Marusic 2007). When inviting locals to share and transfer their knowledge these considerations have to be taken into account. To support effective dialogue, the scale of the provided background maps has to be selected with care. A common approach is to provide the informants with large-scale maps of the study area allowing detailed drawings and a map showing the broader surroundings of the area to give overview and orientation.

For whom?

Scale mapping is a suitable tool for a broad range of users from local stakeholders and citizens, public officials, consulting experts and researchers.

Strengths and Limitations

Scale maps are easily facilitated cartographic media that do not rely on technological understanding of participants. After initial introduction and once familiar environmental features and the spatial relations are recognised on the georeferenced, two-dimensional representation seen from above, participant usually feel comfortable with drawing delineations, marks and using their own symbols to convey their experiential knowledge and perceptions on the issue at hand (Golobic & Marusic 2007). By using georeferenced background maps, local knowledge is gathered in a way which eases transferability to GIS and real space enabling verification of the information by ground-truthing as well as subsequent spatially explicit analysis of the data. The method is relatively inexpensive since only paper background maps or aerial photographs, colour markers and maybe overlay transparencies have to be provided.
Limitations of the tool lie in the size of the printing paper which restricts the extent of the studied area, map scale or resolution respectively. Legibility and interpretation of the drawings could be difficult. The information given might be incorrect or inaccurate. Skilful facilitation takes care that the composition of the participant group is not biased in relation to e.g., status factors, gender or age (IFAD 2009).

Best Practice and Further Reading

Scale maps are established tools with a long tradition in research and practice. For further reading on using scale maps in the framework of natural disaster risk management research, the following case studies are recommended:

Haworth, B., Whittaker, J. & E. Bruce (2016). Assessing the application and value of participatory mapping for community bushfire preparation. Applied Geography, 76: 115–127.

Reichel, C. & U. Frömming (2014): Participatory Mapping of Local Disaster Risk Reduction Knowledge: An Example from Switzerland. International Journal of Disaster Risk Science, 5 (1): 41–54.

Figure 21. Workshop participants elaborating a scale map. (Picture: Augenstein 2018)

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration	☑	Stakeholder identification & analysis		◈◈	☺ ☺☺	🕒	① ②
Selection		Explore opinions & worldviews	☑				
Co-Design	☑	Elicit local knowledge	☑				
Evaluation		Foster group cooperation					
		Decision-making					
		Measure NBS efficiency					

Sketch Mapping

What is it?

Sketch maps are freehand drawings providing visual representations of significant features of the physical environment. Members of the local community or other stakeholders individually or in groups draw spatial entities of interest such as e.g. erosion-prone areas by memory on large pieces of paper (IFAD 2009). Unlike scale maps, sketch maps are not geographically accurate representations of a particular environment but show from a bird's-eye view those spatial elements and issues to which the participants assign specific relevance. Sketch maps can only indicate the relational size and position of the depicted features since they neither rely on georeferenced data nor use a consistent mapping scale. They convey local knowledge and personal perceptions of space in a format easy to understand for a diverse set of stakeholders.

When to use / What for?

Sketch maps are engaging and effective tools to capture, visualize and record local knowledge and stakeholder perceptions. Better than oral descriptions alone, maps convey complex spatial information which can enhance understanding and awareness of specific site conditions (Reichel & Frömming 2014). They are also effective means to articulate and communicate local experience to outsiders. With the help of the drawings, ideas and visions can be shared, spatial relations made apparent and thus may foster holistic thinking as well as stimulating and supporting constructive dialogue among stakeholder groups. Sketch mapping can be easily combined with other stakeholder-engagement tools (e.g., Hohenthal et al. 2017). They are especially helpful in situations where quick visualizations ease and enhance the sharing of information and view-points among participants during discussions.

A variant of the method is the *hazard sketch map* that provides effective means to capture the knowledge and experience of local people on areas prone to natural hazards such as flooding or landslides. Cronin et al. (2004) used sketch mapping to integrate local knowledge and the traditional world-view into a volcanic hazard awareness and evacuation preparation program for one of the islands of Vanuatu, which resulted in a higher acceptance of the hazard management guidelines by the local communities.

For whom?

Sketch mapping is suitable for a broad range of users from local stakeholder and citizens, public officials, consulting experts and researchers.

Strengths and Limitations

Sketch mapping is a simple hands-on mapping technique, which is easy to explain and conduct with non-technical participants. The drawing process is intuitive and familiar to most people. The tool allows to tap local knowledge and to capture the specific characteristic of study sites from a stakeholder perspective. For example, landscape elements, specific places and other features cherished and valued by locals can be identified as well as issues of environmental concern. The application of the tool is simply prepared by providing large sheets of paper (e.g. flip chart paper) and pencils of different colours.

The major shortcoming of sketch mapping is that the resulting map is not georeferenced which prohibits quantifications such as size and distance measurements. Landscape features depicted in sketch maps might not be easily located in real space. The restricted spatial explicitness might pose communication problems with technical experts and challenges to transpose the findings to GIS. When results are not transposed into GIS, there is a risk that the maps are not used after creation, or get lost. The restricted number of participants asks for skilful facilitation to avoid a biased composition

of the group in relation to e.g., status factors, gender or age (IFAD 2009).

Best Practice and Further Reading

For a study conducted in the Swiss Alps providing an insightful example on the use of participatory mapping techniques to capture local environmental knowledge, perceptions, and strategies to handle natural hazard risks accelerated by climate change in a PHUSICOS-related context see:
Reichel, C. & U. Frömming (2014): Participatory Mapping of Local Disaster Risk Reduction Knowledge: An Example from Switzerland. International Journal of Disaster Risk Science, 5 (1): 41–54.

Guidance on the application of several mapping techniques in the context of development cooperation provides:

IFAD - International Fund for Agricultural Development (2009): Good practices in participatory mapping. Rome. Online available: http://www.ifad.org/pub/map/PM_web.pdf. (accessed 14th February, 2019).

Figure 22. Villagers preparing a sketch map within the framework of a study on the use of natural resources, Mongolia. (Pictures: Fohlmeister 2005)

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration	☑	Stakeholder identification & analysis		◈◈	☺ ☺☺	🕒	①
Selection		Explore opinions & worldviews	☑				
Co-Design	☑	Elicit local knowledge	☑				
Evaluation		Foster group cooperation					
		Decision-making					
		Measure NBS efficiency					

Technology-supported Participatory Mapping

What is it?

Three major varieties of technology-supported mapping techniques can be differentiated where stakeholders and citizens are involved to create, collect and display place-related information. Though intimate experts in the field distinguish the types according to criteria such as purpose, spatial context, data collection approach, financing body, and ownership of the outcome (Brown & Kyttä 2014), the differentiation is not easily apparent for 'outsiders' resulting in the terms to be used interchangeably. All three types have in common that stakeholders and citizens are actively involved and, in varying degrees, have ownership of (parts of) the data-gathering and analysis process.

Participatory GIS (PGIS) developed from non-profit and scientific work in rural areas of developing countries with the primary focus on promoting the perspectives and concerns of local people and their empowerment through the mapmaking process and by communicating on par with other stakeholders (Rall 2018). According to Brown & Kyttä (2014), PGIS is the result of merging geographic information technologies with established methods of Participatory Learning and Action (PLA), an approach that assists communities to appraise local conditions and discover substantive action to improve quality of life in a self-determined manner based on the premise that local communities have unique expert knowledge of their local environments. It is a strength of PGIS that it allows the integration of knowledge of local participants with scientific knowledge from conventional sources (e.g. surveys, remote sensing data). The role of the participants and the extent of active involvement in PGIS processes vary considerably, ranging from participants being mere information providers, over helping to build and update spatial data repositories, to taking part in PGIS-facilitated collaborative discourse and decision-making.

Predominantly used by urban and regional government agencies in the developed world to enhance public involvement in spatial planning is **Public Participation GIS (PPGIS**) which "integrates geospatial technologies with public knowledge in a geo-survey format to support collaborative planning processes and spatial decision-making" (Rall 2018: 20). With growing interest in PPGIS as geo-survey tool for obtaining social and perceptual information in administration and academia, the number of available mapping techniques, in particular web-based applications, increased rapidly (Brown & Kyttä 2018).

More recently emerged **Volunteered Geographic Information (VGI)** which refers to place-related information voluntarily created and gathered by private citizens using smartphones and technologies like social media and web-based mapping (Haworth et al. 2016). The main emphasis of VGI is to build collective intelligence and engage "citizens as sensors", e.g. for data inventory or reporting problems encountered in the city, thus contributing to an improved and more publically accessible spatial information base (Rall 2018: 20).

When to use / What for?

While technology-supported participatory mapping techniques are among the most complex and requiring significant set-up procedures and knowledge base on the part of the facilitator, they also offer an unparalleled ability to illustrate NBS design features for non-technical audiences, making them indispensable for use in NBS co-design. "High-tech" and "low-tech" options can be chosen, depending on the level of technical familiarity present among the participating stakeholders and the software and skills available to facilitators. Technology-supported participatory mapping techniques can be used in different sequences to engage stakeholders in contributing their local knowledge on landscape structure and processes to co-design, in both pre-process or post-process formats. Bracken et al. (2016) used existing paper maps of the study area as the base for participating stakeholders to draw in their own

knowledge and visions of landscape features and interactions among them. These were then digitized with GIS and used as the basis for further discussion in subsequent focus groups. PGIS in this case can be viewed as the "post-process", a tool used after initial discussions and map drawing activities to synthesize the results. Alternatively, in a study of flood management with farmers in Scotland, Lavers and Charlesworth (2018) created digital land cover maps that were then used to conduct site visits with local farmers and to discuss in real-time which areas of their farms may be most important for flood management and why, and how separate parcels could work together to overcome challenges. In this sense, PGIS was used as the "pre-process", the foundation on which further participatory discussion was initiated. Regardless of the order in which it is combined with other tools, PGIS gives unprecedented ability to discuss structural design components of NBS with stakeholders. Furthermore, the analytical functionality of PGIS can be used to explore and answer community-driven questions (IFAD 2009).

As participatory mapping can capture spatially explicit narratives and cultural values hold by individuals and groups (Rohrbach et al. 2018; Brown & Brabyn 2012), technology-supported participatory mapping tools provide ways to capture experiential knowledge on the daily lives of citizens, their perspectives, opinions, preferences and priorities, and may have the potential to reach groups of the population that are difficult to reach by traditional methods such as surveys and town meetings (Rall et al. 2017; Brown & Kyttä 2014). Thus, the tools can provide essential information for planning sustainable and livable environments, in particular they can be applied to identify suitable sites for implementing NBS measures and incorporate stakeholder knowledge in the selection and co-design of NBS.

For whom?

In principle, anyone can be involved in technology-supported participatory mapping processes, provided participants are open-minded and willing to use the technical applications. When used to derive quality spatial information for research, a degree of "geographic and spatial literacy" is required of the participants (Brown & Kyttä 2018).

Strengths and Limitations

Technology-supported participatory mapping promote the inclusion and empowerment of citizens and stakeholders in the creation, collection, analysis and use of spatial information (Rambaldi et al. 2006). Especially the web-based mapping applications can help to tap the knowledge of the technology-affine younger population that feel not addressed by conventional forms of participation. The involvement of multiple stakeholder groups may create awareness for nature and landscape-related topics and foster social learning.

For "high-tech" applications, an experienced facilitator is required who introduces the tool to the participants, gives instructions how to use the tool and encourages active participation of the stakeholders. In specific cases, it might be necessary to train the participants and pay attention to the quality of the generated data.

Limited resources are reported as a barrier for technology-supported participatory mapping. Brown & Kyttä (2018) note that high quality participation mapping cannot be realized without investment, since time, expertise, and motivation are needed even if the technology applied were free or inexpensive. Furthermore, Brown & Kyttä (2018) find the development of accessible technology-supported participatory mapping tools for data collection and data analyses lagging and asks for critical research to study the quantity and quality of knowledge produced with the new techniques.

Best Practice and Further Reading

Technology-supported participatory mapping techniques have been applied at various spatial scales and in a range of research areas, including natural resource management (Brown 2005; Debolini et al. 2013), natural hazard management (Haworth et al. 2016; Bracken et al. 2016), conservation planning (Greg & Weber 2011; Wolf et al. 2015) and the assessment of ecological services (Fagerholm et al. 2016; Rall et al. 2017).

PGIS – case studies "low tech" version:

Lavers, T. & S. Charlesworth (2018): Opportunity mapping of natural flood management measures: a case study from the headwaters of the Warwickshire-Avon', Environmental Science and Pollution Research, 25: 19313-22.

Debolini, M., Marraccini, E., Rizzo, D., Galli, M. & E. Bonari (2013): Mapping local spatial knowledge in the assessment of agricultural systems: A case study on the provision of agricultural services. Applied Geography, 42: 23–33.

PGIS – case study "high tech" version:

Liu et al. (2018) engaged young *social mobilizers* and volunteers to co-produce locally relevant geographic information on flood hazard, exposure and vulnerability at the household and community levels across the lower Karnali river basin in Western Nepal. The study combines internet-based collaborative digital mapping technologies with a number of low-tech, community-based field mapping tools such as transect walk, resource and hazard mapping, for which the paper includes brief descriptions and provides helpful hints on effective application.

Liu, W., Dugar, S., McCallum, I., Thapa, G., See, L., Khadka, P., Budhathoki, N., Brown, S., Mechler, R., Fritz, S. & P. Shakya (2018): Integrated Participatory and Collaborative Risk Mapping for Enhancing Disaster Resilience. ISPRS International Journal of Geo-Information, 7, 68; doi:10.3390/ijgi7020068.

PPGIS – case study:

Rall, E., Bieling, C., Zytynska, S. & D. Haase (2017): Exploring city-wide patterns of cultural ecosystem service perceptions and use. Ecological Indicators, 77: 80–95.

Among the software programs available for PPGIS data collection and analysis that were applied in the reviewed literature are Maptionnaire (https://maptionnaire.com) in Rall et al. (2017), map-me (https://map-me.org) in Huck (2014) and Brown & Kyttä (2018) mentions CyberTracker (https://www.cybertracker.org/).

The webpages hosted by the Open Forum on Participatory Geographic Information Systems and Technology (http://www.ppgis.net/) and the Landscape Values & PPGIS Institute (http://landscapevalues.org) contain a wealth of information on PGIS, PPGIS and open source GIS, including practical tips for facilitators.

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration	☑	Stakeholder identification & analysis		◇ ◈	☺ ☺☺ ☺☺☺	🕒 🕒🕒 🕒🕒🕒	① ② ③
Selection	☑	Explore opinions & worldviews	☑				
Co-Design	☑	Elicit local knowledge	☑				
Evaluation	☑	Foster group cooperation	☑				
		Decision-making					
		Measure NBS efficiency					

Transect Walk

What is it?

The transect walk is an information-gathering field trip along a predefined route (transect) across the area of interest which is undertaken by the research team together with a group of local stakeholders and villagers to get an overview of the local situation based on the knowledge and perspectives of community members (Narayanasamy 2009). The outcome of the exercise is a transect diagram providing a cross-sectional visual representations of the findings at a certain period in time. Having a long tradition as spatial pattern analysis tool used in agroecosystem research, natural resource management and rural development initiatives (Chambers 1994), transect walks have been used to systematically collect spatial-environmental information and discuss key characteristics of the community area such as e.g., soil type and climate variability, natural resources and their utilisation, local practices and customs with the participants but also with persons met by chance on the route.

Depending on the size of the area and the ability of the participants, the group walks or drives along a path covering the main variations in topography or the features of interest, usually starting from the village centre to the periphery. It is recommended to either stop in regular intervals or to do so at key features or borders of discernible ecological or land use zones to facilitate dialogue and note down collected information, take GPS measurements or record the distance from the last zone (World Bank 2005). To ease the pressure of note taking, the conversation might be recorded and photographs of the environmental zones taken.

At the end of the transect walk, the group settles down and prepares an illustrative diagram on a large sheet of paper to document the field observations and the information shared by local community members. In the top row, the pathway is sketched depicting the different zones that have been visited on the walk. Down the left column, headings are written that describe the various topics of interest (e.g., land use, soil type, ecosystem services). The group observations and opinions for each zone are concisely summarised in the corresponding topic rows. For documenting the results, a large group of participants could be divided into thematic sub-groups. A variant of the technique is the historical transect diagram showing landscape changes over time which are compiled by a transect walk with experienced older villagers and recording their recollections of past conditions.

When to use / What for?

Transect walks are easily adopted at community level and according to Chambers (1997) belong to the most participatory methods. When properly prepared and all relevant knowledgeable local actors motivated to participate, transect walks provide efficient means of capturing group perspectives on place-based issues whilst providing trustworthy data on topics that are of particular relevance for the community. Depending on the size and structural complexity of the study area, several hours are needed to conduct the outdoor activity. Especially at the beginning of a project, a transect walk could provide a quick overview on the spatial-environmental conditions and may help to build rapport with local stakeholders. The tool is often combined with conventional survey techniques, focus group discussions, semi-structured interviews and, when the aim is to construct a chronology of events, with a time line.

For whom?

Everyone can participate in a transect walk. The group should include local key informants, an experienced facilitator and a note-taker, or make use of advanced recording technology (see e.g., Liu et al. 2018).

Strengths and Limitations

A transect walk is an engaging activity through which locals and visiting researches get in immediate contact in an easy, informal manner. The visual impressions on the walk through the landscape stimulate dialogue which is not restricted to the elicitation of local factual knowledge on environmental conditions but may also reveal intangible values held by the local population and meanings they associate with specific places. A transect walk can therefore serve many purposes. The task to prepare the transect diagram and express the group findings pictorially, inspires participants to think deeply about the landscape as complex system thus making underlying concerns that move the community explicit. The application of the tool is inexpensive and independent of technology, only large sheets of paper, markers and note-taking equipment are needed.
However, transect walks require time, the willingness to cooperate on part of the local stakeholders and participatory facilitation skills on part of the research teams.

A limitation of the tool is that transect diagrams are not georeferenced making quantitative measurements difficult, especially the deduction of surface areas. When GPS data is recorded during the walk (see e.g. Kaul & Thornton 2014), the transect path can be transposed in GIS.

Best Practice and Further Reading

Step-by-step guidance on the technique is provided by:

FAO (2011) Land Degradation Assessment in Drylands: Manual for Local Level Assessment of Land Degradation and Sustainable Land Management. Part 2: Field Methodology and Tools. Food and Agriculture Organization of the United Nations, Rome, Italy.

Narayanasamy, N. (2009): Participatory rural appraisal: Principles, methods and application. SAGE Publications, New Delhi: p. 83-96.

Figure 23. Example of a Transect diagram. (Picture: Fohlmeister 2014)

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration	☑	Stakeholder identification & analysis		◈◈	☺ ☺☺ ☺☺☺	🕒🕒	②
Selection		Explore opinions & worldviews	☑				
Co-Design		Elicit local knowledge	☑				
Evaluation		Foster group cooperation					
		Decision-making					
		Measure NBS efficiency					

TOOLS FOR RETROSPECTIVE REFLECTION AND FUTURE PLANNING

Future Search Conference

What is it?

The Future Search Conference is a dialogue, planning and strategy meeting format for group discussion of big stakeholder circles (60-100) scheduled over a three day period with different pre-scribed phases conducted in each day. It combines various other tools, such as timeline and mind mapping, to get a large cross-section of stakeholders in one room and discuss *the future of...* the topic at hand. With this focus on the future, it is a strong tool for clarifying what the shared vision should be among stakeholders, especially in complex, uncertain or fast-changing situations (Vesper & Scholz 2011; McDonald et al.2009; Nauheimer 2005). The inherent aim of the Future Search Confe-rence is to focus on finding common ground as a sound basis for further action and to make participants thinking of a problem in a new way. Possible disagreements of participants are not sought to be solved, but just kept apart, so that the time can be used for a constructive dialogue (Action Catalogue Engage2020).

The Future Search Conference follows a well-structured work programme of two days, being consciously spread over three days to give its participants room and time for reflection and relax in between the sessions (Action Catalogue Engage2020). In total, there are five program elements / tasks, being followed both in smaller and larger working groups.
The first stage is *"Focus on the past"*. In this step, the stakeholder group is requested to reflect on local and global milestones related to the issue at hand in order to build up a common history.
Based on this entry point, the stakeholder group turns towards the *"Focus on the present"*. In a large group setting, a mind map is elaborated on the current trends which impact the conference's topic. By an exercise of priority-zation, the group carves out a collective consensus regarding the problem (Nauheimer 2005; McDonald et al. 2009). Changing to peer groups, stakeholders are then encouraged to make up their minds on the so-called *"Prouds & Sorries"*. In this step, they still reflect on the present, now assessing what they are proud of, or sorry about, concerning the identified trends on the issue at stake. This step helps to assume a certain responsibility for the status-quo, and to get insight into each peer group's underlying thinking (Nauheimer 2005).
In the next stage, the *"Focus on the Future"* allows for working out ideal scenarios of the preferred future, which is done in mixed groups. Participants are requested to identify possible barriers on the way towards this preferred state which they envision, and to present the scenarios in a creative way (Vesper & Scholz 2011). Following this stage, it is time to detect and formulate the "*Common ground for the Future*". In this decisive part of the conference the stakeholder group distils the common key features being apparent across all scenarios, and clusters them into a Common Ground Agenda (Nauheimer 2005; Vesper & Scholz 2011).
In the final segment *"Planning for the Future"*, the floor is open for stakeholders to volunteer for future action planning, i.e. participants jointly discuss necessary and possible short-term and long-term initiatives, and commit to them for further elaboration and implemen-tation in the aftermath of the conference (McDonald et al.2009; Vesper & Scholz 2011).

When to use / What for?

The Future Search Conference is an appropriate tool when there is a definite need in place for a whole system to create a common view on the future related to a certain issue, or when an action plan is targeted and people are needed to get committed to implement it. A fundamental pre-condition for the successful use of the tool is thus an authentic need to change and act (Vesper & Scholz 2011). It is also adequate if prior efforts to do so have not achieved the desired impact, or in situations where opposing parties need a good forum to get together in a constructive manner. The tool is not intended or meant to work on different values of a stakeholder group, nor to find a compromise in

conflict situations. It thus needs transparency and acceptance by the participants that the focus is clearly set on carving out common ground apart from possibly diverging interests (Vesper & Scholz 2011).

For whom?

A Future Search Conference usually works with large stakeholder groups of 60-80 (also hundreds) participants. The "magic number" is 64, as it is possible to form teams of 8 then (Nauheimer 2005: 191).
Three major types of stakeholders should be on board for a successful execution of the tool: i) professionals with know-how and information; ii) stakeholders with authority and resources for action and iii) beneficiaries, i.e. persons being influenced by the conference's results (Action Catalogue Engage2020).

Strengths and Limitations

The special capacity of the Future Search Conference has to be seen in its suitability for paving common ground and detecting possible paths of action for a particular problem and controversial topics. The approach to cross over from the past and presence towards the future in the manner it does helps bridging potential barriers of hierarchy, culture and societal differences. A further strength of the tool is the duration and style of meeting, which fosters to build a strong stakeholder network being useful beyond the conference (Action Catalogue Engage2020). By mixing different tools and group sizes, the tool has an energising and motivational effect on participants (Vesper & Scholz 2011).

What is considered to be among the key principles of the tool, *to get the whole system in one room*, might likewise be a limitation of it at the same time. Often enough, getting key stakeholders committed to an event of three days is a significant challenge. The absence of such key players, however, also might lower the relevance of the conference and its results (Action Catalogue Engage2020).
That said, strong facilitation skills should be in place to both organize and steer the event for being able to harvest the desired outcomes.

Best Practice and Further Reading

As the tool has been applied since the 1960s, there's a rich pool of information and lessons learned available on it from worldwide application.

Further reading:

Weisbord, M.R. & S. Janoff (2010): Future Search. Getting the Whole System in the Room for Vision, Commitment and Action. San Francisco: Berrett-Koehler Publishers.

Website of the Future Search Network, with detailed information on the tool, case studies and resources for further reading:
http://futuresearch.net/
(accessed 1st March, 2019)

A detailed tool description, step-by-step guidance and case study examples are available in the Action Catalogue Engage2020, administered by the Danish Board of Technology:
http://actioncatalogue.eu/method/7416
(accessed 1st March, 2019)

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration	☑	Stakeholder identification & analysis		◈	☺☺☺	🕒🕒🕒	③
Selection	☑	Explore opinions & worldviews	☑				
Co-Design		Elicit local knowledge	☑				
Evaluation		Foster group cooperation	☑				
		Decision-making	☑				
		Measure NBS efficiency					

Geo Timeline

What is it?

The Geo Timeline (*also: Community Geo Timeline*) is a web-based tool giving the opportunity to stakeholders to collectively pool local knowledge regarding historical changes in topography, infrastructure, and values of place, both tangible and intangible.
Based on a map of the place of interest, stakeholders can add events and change markers they deem relevant along a timeline using an open online resource. Furthermore, space for comments is provided for entering additional information on why the change is worthwhile mentioning from the viewpoint of the contributing agent.

Following the principle of crowd-sourcing information, the tool thus helps to build up and make transparent a local community's place-bound narrative, being both a stepping stone for joint learning as well as for collective action, e.g. in the field of climate change adaptation (Borsi 2016).

When to use / What for?

The Geo Timeline can be applied in the pursue to access and elicit a local community's knowledge, especially with regard to common history, identity and place attachment – items, which are usually *off the track* in stakeholder discussions on local development and planning processes. It thus bears the capacity to create a collective data pool being both beneficial for the interested research community and local authorities, as well as for the civil community itself.
While the latter one profits from connecting to important community information, local authorities may gain relevant insights into path-dependencies and relationships of ongoing developments (e.g. infrastructural changes and social adaptation) (Borsi 2016).

The Geo Timeline rests on the assumption that every community's history offers a fundus of challenges and related responding action undertaken, e.g. to address hydro-meteorological events, which are connected to available resources to address and recover. Deficient knowledge sharing and stakeholder involvement, however, can be hindrances in tracking such past changes and corresponding adaptation action (Oppla 2018).

On this background, the Geo Timeline appears a useful tool of record-taking. Making transparent a community's capital in this way, ideas can be generated and innovative solutions found to place-related problems. That said the Geo Timeline can be considered not only a tool of retrospective reflection, but also an "entry gate" in respect that it may prepare and thus ease up-following stakeholder consultation and negotiation in planning processes (Borsi 2016).

For whom?

The Geo Timeline works best counting on a broad variety of users, ranging from the relevant public bodies being responsible for local and regional community development, to interested citizens and community groups, consulting experts and researchers. Online tool affinity is a precondition for use.

Strengths and Limitations

One of the strengths of the Geo Timeline is that it is useful for making transparent local information which is often inherent, and thus fosters learning for planners and other interested agents who might easily merge such wise gained information with hard data, e.g. statistics or spatial information (Borsi 2016).

Due to its web-based character, it is not dependent on the availability of stakeholders for workshops or other events which call for a personal contact. Instead, community members can post and share their memories, facts and ideas at ease, contributing pro-actively to develop a rich information pool for their community and integrating stakeholders.

The tool can further be supportive to identify patterns being related to the evolution of a community's capacity and resilience over time. This feature makes it especially interesting for monitoring and evaluation purposes towards strengthening local social resilience.

A possible shortcoming of the tool lies in its limitation to those stakeholder groups who are inclined to use online tools, excluding other groups with limited or no access or affinity to do so. Moreover, compared to natural and built capital which can be grasped in terms of ecological and monetary assets, a community's social capital can hardly be quantified, although playing an important role (Oppla 2018).

Best Practice and Further Reading

The Geo Timeline has been developed and applied by the University of Nottingham on the case study of Meadows in the framework of the TURAS project ("Transitioning towards Urban Resilience and Sustainability") funded by the European Commission under FP7 2011-2016. In this context, it has been used for urban and sub-urban planning purposes mainly.

Short tool description available via the European commission's data platform OPPLA:
https://oppla.eu/product/17498
(accessed 27th February, 2019)

Video with background information on the tool provided by the University of Nottingham:
https://www.youtube.com/watch?v=br01g1QxuAg (accessed 27th February, 2019)

Geo Timeline case study Nottingham:
https://nottinghamtimeline.co.uk/
(accessed 27th February, 2019)

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration	☑	Stakeholder identification & analysis		◈	☺☺☺	🕒	②
Selection		Explore opinions & worldviews	☑			🕒🕒	③
Co-Design		Elicit local knowledge	☑			🕒🕒🕒	
Evaluation		Foster group cooperation					
		Decision-making					
		Measure NBS efficiency					

Participatory Scenario Planning (PSP)

What is it?

Scenarios can be defined as "narrative descriptions of potential futures that focus attention on relationships between events and decision points" (Elliott et al. 2005: 163). Participatory Scenario Planning (PSP) combines quantitative models on issues such as land use and natural processes with narrative methods that can help stakeholders in the visualization on how landscapes or infra-structure may look and change under various future conditions. It can be a powerful tool to discuss and plan future action since it provides a setting for the exchange of knowledge, common learning and collaboration (Tress & Tress 2003; Lupp et al. 2016).
PSP obviously has high potential for the PHUSICOS context, as it is especially well suited for innovative solutions to complex, multi-disciplinary problems that have no or few external examples of their success, and for situations in which the past or present state of events is unlikely to be a reliable guide for future events (Elliott et al. 2005). In the era of climate change and the rapid increase in extreme natural disasters, PSP can offer insight and projection on how present day actions can mitigate future risks by displaying drivers of change, uncertainties, and causal relationships (Carlsson et al. 2015).

When to use / What for?

PSP is most useful for creating a shared vision among stakeholders of how future changes could look like and how they should be implemented. It can also serve as a dashboard for prototyping and ideation through its ability to analyse a change in multiple variables at once. In the PHUSICOS context, it is therefore most applicable for the NBS co-design process, when a common definition of the problem and goal has already been decided upon among stakeholders and a collaborative dialogue has been established; hereby, PSP could be best used for the tasks of NBS selection and NBS co-creation, depending on the types of scenarios utilised or planned.

Three types of scenarios are designated within literature: explorative, normative, and predictive scenarios (Carlsson et al. 2015). Explorative scenarios are recommendable to identify *what could happen* if certain options are chosen, making it especially useful for the task of NBS selection. Normative scenarios address the "ideal" situation and issues of what would be the best option when assuming certain values or preferences for different traits. Using these types of scenarios during NBS selection could assist in boosting acceptance as it encourages communication about values among stakeholders. Finally, predictive scenarios answer the question of *what is likely to happen*, making them more suited to NBS co-design, when a particular solution has been chosen already, and the pros and cons of its use need to be analysed.

For whom?

The application of PSP works well with a broad variety of stakeholders, such as public and private sector partners, interested citizens and community groups, consulting experts and researchers.

Strengths and Limitations

PSP has been shown to be most effective when "narrative methods" involving stakeholder knowledge are used in coordination with quantitative scenario models (Houet et al. 2017). Such incorporation of local knowledge can also boost legitimacy and acceptance of solutions decided upon during the co-design process (Carlsson et al. 2015).
A distinct strength is its flexibility of use, as both "low-tech" and "high-tech" options can be combined with PSP. For example, participatory zoning, where stakeholders use physical, paper maps to draw, outline, or delineate changes they have already seen or would like to see, can be used as an initial step (Houet et al. 2017). These hand-drawn maps can then be digitized and fed into a scenario model to see the changes they

would entail. Nevertheless, a certain limitation of PSP is its requirement of significant set-up procedures and knowledge base of the facilitators steering the stakeholder process. A possible way to overcome this bottleneck is thus to choose either "low tech" or "high tech" options of PSP, depending on the level of technical familiarity present among the participating stakeholders and the software and skills available to facilitators.

Best Practice and Further Reading

Several toolboxes illustrate low-tech PSP practices which are undertaken through a combination of group discussion and visualization (McDonald et al. 2009; Elliott 2005; td-net Toolbox; CTA Toolbox). Case study examples using low-tech PSP formulation can be found in literature, such as Karrasch et al. (2017) and Reed et al. (2013), where concept map based scenarios were developed in coordination with stakeholders by collaboratively identifying the main drivers of change, change variables and end goals envisioned for each possibility. Alternatively, more technical PSP can take place by using data and computer software to develop digital scenarios that can then be manipulated and discussed in groups to show possible changes. This high-tech version of PSP is particularly promising for NBS co-design as it can incorporate environmental data, land use change models and geographic information systems to visualize landscape level changes and their effects on ecosystems and communities. Examples of such high-tech PSP can be seen in Endo et al. (2017), where spatially explicit GIS maps were combined with hydrological models to create several different scenarios of possible future flood conditions. These were then used as the basis
for further group discussion. Additional software tools are available for use by facilitators in order to more easily integrate data-driven scenarios in participatory planning processes, neutralizing the need to manually calibrate and visualize data models. An example is the software Quickscan (http://www.quickscan.pro/) developed by Wageningen University. It is a spatial modelling environment that allows researchers to combine expert opinions and multi-criteria analysis with spatial and statistical data to then produce maps and visualizations of potential trade-offs for different outcomes.

PSP – case study "high tech" version:
Endo, I., Magcale-Macandog, D. B., Kojima, S., Johnson, B. A., Bragais, M. A., Macandog, P. B. M., & H. Scheyvens (2017): Partici-patory land-use approach for integrating climate change adaptation and mitigation into basin-scale local planning. Sustainable Cities and Society, 35, 47-56.

PSP – case studies "low tech" version:
Karrasch, L., Maier, M., Kleyer, M., & T. Klenke (2017): Collaborative Landscape Planning: Co-Design of Ecosystem-Based Land Management Scenarios. Sustainability, 9(9),15.

Reed, M. S., Kenter, J., Bonn, A., Broad, K., Burt, T. P., Fazey, I. R., Fraser, E.D.G., Hubacek, K., Nainggolan, D., Quinn, C.H., Stringer, L.C., & F. Ravera (2013): Partici-patory scenario development for environmental management: a methodological framework illustrated with experience from the UK uplands. J Environ Manage, 128, 345-362.

Step-by-step guidance:
Elliott, J., Heesterbeek, S., Lukensmeyer, C..J. & N. Slocum (2005): Participatory Methods Toolkit. A practitioner's manual. King Baudouin Foundation; Flemish Institute for Science and Technology Assessment (viWTA).

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration		Stakeholder identification & analysis		◈	☺☺ ☺☺☺	🕒🕒 🕒🕒🕒	② ③
Selection	☑	Explore opinions & worldviews	☑				
Co-Design	☑	Elicit local knowledge	☑				
Evaluation	☑	Foster group cooperation	☑				
		Decision-making	☑				
		Measure NBS efficiency	☑				

Storywall / Storyboard

What is it?

The Storywall (*also: Storyboard*) is a qualitative method based on storytelling for retrospectively collecting and reflecting on progress made and events seeming key to a stakeholder group in a collective process. Based on a horizontal timeline with the process' starting and ending dates being drawn on a blank big-sized sheet of paper (wall paper; combined flipchart paper sheets), the participants exchange upon and jointly mark important events, turning points, supporting and disturbing factors of their process in the order they occurred, thus creating a "joint story" of their process (Wülser 2018).
For achieving the tool's crucial side effects of fostering group cooperation and a sound mutual understanding, it is key to proceed hereby in a stepwise manner: after having drafted the timeline on paper, the group may collectively decide whether and how the timeline should be further structured, e.g. by process phases or organizational levels. Then, the participants individually identify events, influences and factors seeming of relevance to them to be marked along the timeline. Building on such individual reflection, the stakeholder group starts into the discussion on what was perceived as crucial elements of the process, sharing and ultimately mounting up the diverse perspectives to a collective understanding and joint picture.

As an outcome, the tool application results in a big-sized poster reflecting the key elements of the process from the group's perspective (Wülser 2018), which might be used both as final product or input to an up-following working process of the stakeholder group.

When to use / What for?

The Storywall gives an opportunity to a stakeholder group to collectively look back and reflect upon a jointly experienced process, enabling to make transparent even contrasting perspectives and perceptions. In this way, it contributes not only to a better mutual understanding of individual members of a stakeholder group, but also offers the chance to go a step beyond, and create a common understanding of the past.

Usually, the tool is applied ex-post, i.e. when wrapping-up a group process (Wülser 2018). It might, however, also be applicable as an interim step of reflection and learning, using the jointly created narrative as a point to start from for a future undertaking of the stakeholder group.
Transferred to the Living Lab context of PHUSICOS, the Storywall can serve thus several purposes: it might be apt to jointly reflect on past processes of stakeholder involvement in the context of disaster risk management or hydro-meteorological events and corresponding action undertaken, and to identify important lessons to learn for performance improvement in future planning processes. Likewise, it might be a suitable tool for reflection on the process of knowledge co-production itself once the Living Lab process is running, and also when it comes to its final evaluation, e.g. in the framework of lesson learned workshops.
This makes the Storywall being a suitable tool for the starting stage of a Living Lab (exploration of the problem, exchange of different stakeholders' perspectives on the past), its co-design stage (joint reflection on working process) as well as its final stage (reflection on joint LL process, deriving lessons learned for similar processes and projects).
The tool is not recommendable in situations where a stakeholder group cannot relate to a joint process experience.

For whom?

The Storywall is a simple tool which can be applied with a broad range of actors from all sectors and levels. It profits from having the participant group representing a diversity of perspectives. In complex settings or contested terrain, an experienced facilitator or supporting coach might be recommendable to steer the tool

process towards achieving its positive effects (Wülser 2018).

Strengths and Limitations

Compared to similar tools addressing retrospective reflection, the Storywall can be considered a low-budget and simple tool, getting along without online resources to create a stakeholder group's narrative. As a group-based workshop tool, it allows to harvest all benefits of a face-to-face stakeholder process, such as the opportunity of profiting from direct and personal exchange, gaining mutual understanding and learning from listening to others' perceptions. The use of storytelling helps bridging different thought-styles (Wülser 2018), while the tool itself does not call for sophisticated skills or equipment other than big-sized sheets of papers, tape, markers and tables or a wall.
Participant groups being equipped with advanced visualization skills and lust for assembling their narrative in a more creative manner, may also apply the Storywall/ Storyboard concept more literally, using drawings or pictures, and putting them into a narrative sequence (Tassi 2009).

If used with too many graphical elements or drawings, stakeholders not used to or inclined to apply such tools might feel resistant to participate in the process. This aspect needs attention especially in contested or conservative, very hierarchical environments. A possible way-out is, however, to apply the tool in an easy manner, focusing on written elements.

Best Practice and Further Reading

Tool description, illustration examples and step-by-step guidance on the tool Storywall:

Wülser, G. (2018): Tool Storywall. In: Methods and tools for co-producing knowledge. Swiss Academies of Arts and Sciences, Network for Transdisciplinary Research td-net. URL https://naturalsciences.ch/topics/co-producing_knowledge/methods/td-net_toolbox/storywall
(accessed 28th February, 2019)

Tool description and illustration examples from the field of Service design for the tool Storyboard:

Tassi, R. (2009): Tool Storyboard. Service design tools.
http://www.servicedesigntools.org/tools/13
(accessed 28th February, 2019)

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration	☑	Stakeholder identification & analysis		◈	☺	🕒	①
Selection		Explore opinions & worldviews	☑		☺☺	🕒🕒	
Co-Design	☑	Elicit local knowledge	☑		☺☺☺		
Evaluation	☑	Foster group cooperation	☑				
		Decision-making					
		Measure NBS efficiency	☑				

What's Your Agenda?

What is it?

The tool "What's Your Agenda?" is an illustrated template that encourages stakeholders in a creative, structured and simple manner to identify what they would consider to be both the best-case and worst-case scenarios for a particular project, and consequently to make up their minds on ways to achieve respectively to avoid these scenarios.

In a first step, the template is prepared by filling in the name of the future project or activity on top of the sheet, which is then folded horizontally in order to keep the bottom half of the template still *secret* to the meeting's participants. After delivery of the template (one-pager, being divided in four quadrants, see Figure 24), the participants are invited to complete it by describing the worst case scenario by drawings and/or key words, followed by the best case scenario which they individually relate to the issue at stake. In the next step, participants are allowed to uncover the bottom part of the sheet, then going into detail on how to avoid the worst case scenario, and concluding the exercise by outlining how to target the best case scenario (New IDEAS project / ImaginationLancaster 2019). Upon completion, the group discussion process is initiated by enabling participants to present their templates individually, and applying common moderation techniques to synthesize key aspects into a roadmap for future action.

When to use / What for?

What's Your Agenda? is most useful in settings which are about to start into a project or an activity, as it possesses the capacity to make transparent the different and possibly also divergent perspectives stakeholders are bringing along into a joint endeavor. At the same time, it does not stop at analyzing these perspectives, but efficiently stimulates the process of thinking towards action by asking participants to outline necessary steps, elements and resources they imagine to go for the best case, and keep away from the worst case.

The solution-orientated tool thus provides a simple and likewise creative point of departure to start into more in-depth dialogue and discussion. Good outcomes can especially be achieved in meetings or workshops with smaller group settings, which allow for fostering the stakeholders' exchange on how to address the revealed concerns and detect possible ways out collectively (New IDEAS project / ImaginationLancaster 2019).

For whom?

What's Your Agenda? especially calls for smaller group settings and a trustworthy atmosphere between participants for reaching its intended outcomes of revealing personal and institutional agendas (New IDEAS project / ImaginationLancaster 2019).
The tool seems to be a good entry point when starting into a Living Lab process with a core circle of stakeholders from public, private, research and civil society sectors, who intend to work with each other towards a joint goal. Open-mindedness for thinking a bit "out of the box" can be a plus for the tool's application.

Strengths and Limitations

A definite advantage of the tool is its accessibility: the template is free-of-charge, and can be downloaded and edited according to individual purposes. Moreover, it is rather self-explanatory, thus not calling for complex explanations.

Another strength can be seen in the "invitation to extremes" (New IDEAS project / ImaginationLancaster 2019), which guides participants naturally towards thinking out of the (everyday-pattern) box and impart their personal and institutional agendas.

Beyond that, the process of outlining the best and worst outcomes more in detail is not only fun, but also a reasonable step for a stakeholder group when starting into action, while at the same time taking care of avoiding failure and ensuring success (New IDEAS project / ImaginationLancaster 2019).

A possible shortcoming of the tool could be seen in restricted space for the elaboration on ideas, when used in A4 format. This might be easily bridged by transferring the template to other, bigger-sized formats, although increasing the preparatory demand prior to a meeting or workshop.
Another limitation might consist in the restricted usefulness of outcomes if the tool is not applied or token by participants with the necessary degree of seriousness. Furthermore, fair facilitation skills are needed to manage sub-groups in parallel in case of a bigger stakeholder workshop setting; the same holds true for synthesizing results if stakeholders' agendas are highly divergent.

Best Practice and Further Reading

Tool description and free download of the illustrated template from the website of the New IDEAS project / Imagination Lancaster, Lancaster University UK:

New IDEAS project/ImaginationLancaster (2019): Tool What's your Agenda? Collaboration & Impact Toolbox. Lancaster University, UK. Download: http://impact.lancaster.ac.uk/tools/#/agenda (accessed 28th February, 2019)

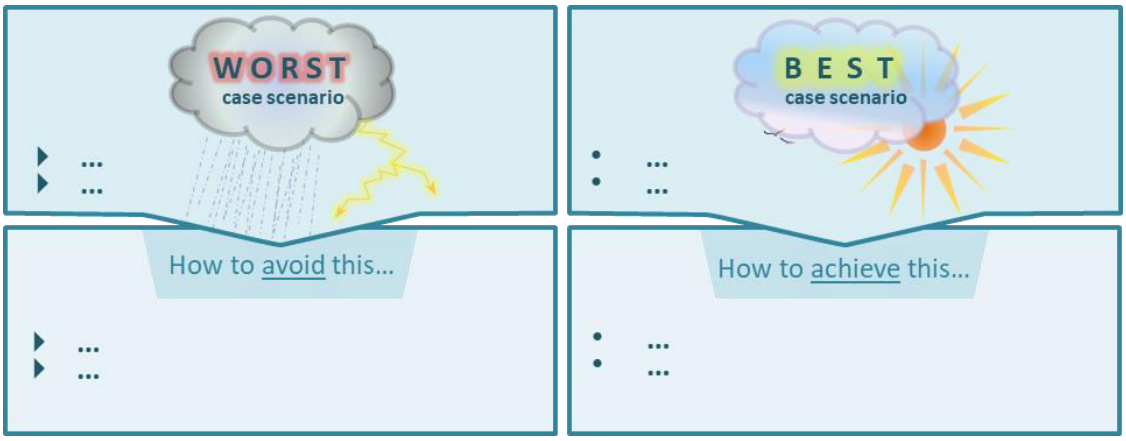

Figure 24. Tool template of "What's Your Agenda?" (Design: C. Smida 2019, based on the New IDEAS project / ImaginationLancaster, Lancaster University, UK 2019)

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration	☑	Stakeholder identification & analysis		◈ ◈	☺ ☺☺	🕒	①
Selection		Explore opinions & worldviews	☑				
Co-Design		Elicit local knowledge	☑				
Evaluation		Foster group cooperation	☑				
		Decision-making					
		Measure NBS efficiency					

TOOLS TO ENCOURAGE CREATIVE THINKING AND MUTUAL UNDERSTANDING

Multiple Perspectives Wheel

What is it?

The Multiple Perspectives Wheel is a technique of perspectives' change being apt to foster mutual understanding and group cooperation. Based on the conviction that considering as many perspectives as possible opens up new possibilities for effective action (Roberts and Boswell cited in Senge 1994), it is a tool which supports a stakeholder group in reflecting on an issue from different viewpoints (Brouwer & Brouwers 2017; Nauheimer 2005).

The Multiple Perspectives Wheel is applied in three sequential steps: Step 1 consists in the *preparation of the setting*. In this step, either moderation cards or a paper wheel are provided, with the name of the issue at stake put on a card in the centre of a table or pin board (paper wheel version). On further cards, the titles of key stakeholders are written, and placed around the central card. Transferred to the PHUSICOS context, these might embrace farmers' association, land-owner, Ski resort owner, tourism entity, municipality officer, Water Authority, mountain pass security officer, National Park authority, herder, environmental NGO, and likewise. Importantly, there should be as many different stakeholder types prepared as participants present in the group work exercise.

In step 2, the *"Generation of perspectives",* roles are distributed to the participants, who are then requested to slip into the mentioned stakeholders' shoes and comment on the issue at stake by mentioning the critical issues, constraints and possible solutions in a time slot of 3 to 5 minutes each. Issues are consequently collected on a flipchart, building up descriptions of each perspective in a step-wise manner. Once the first round is complete, stakeholder roles are distributed again for 2-3 times, thus enabling the participant group to experience different stakeholder perspectives. To conclude, step 3 *"Working with perspectives"* is dedicated to a group discussion on each of the perspectives, supporting the group to distil similarities, differences and conclusions for the further work process. Insights are derived on how to improve the effectiveness and cooperation of the stakeholder group, and on how to best make use of the different perspectives (Brouwer & Brouwers 2017; Nauheimer 2005).

When to use / What for?

The Multiple Perspectives Wheel is a good choice in situations which call for exploring and taking into consideration a stakeholder group's diverse and possibly divergent perspectives on an issue at stake. Unlike the common approach to make use only of one or two different perspectives, the tool intends to benefit from looking at the full spectrum of existing nuances (Brouwer & Brouwers 2017). In this way, the collective wisdom of the group can be appreciated (Nauheimer 2005) for preparing problem-solving and decision-making in multi-stakeholder settings.

For whom?

The Multiple Perspectives Wheel profits from having a diverse mix of different stakeholder viewpoints represented. Depending on the individual set-up, these can stem from public and private sector partners, individual citizens and civil society groups, researchers and experts of diverse technical background. The ideal number of stakeholder roles being gathered around a Wheel or table is 6 to 8.

Strengths and Limitations

A distinct strength of the Multiple Perspectives Wheel is certainly its simplicity. If applied with moderation cards only, it does not call for any bigger preparation efforts or sophisticated facilitation skills; moderation cards, markers, tables for group work, a flipchart and eventually pin boards will suffice.
In its function as a tool for perspectives' change, it especially enables to execute a fundamental

step for preparing and starting into a Living Lab, being enriching for the team spirit and thus building a solid ground for any longer-term group work process. While often enough the framing of the problem is already "set", the Multiple Perspectives Wheel steps back and allows for making transparent the diversity of problem frames which might exist in a stakeholder group. This can contribute to an increased efficiency and quality of the participatory process.

A possible bottleneck of the tool might consist in its demand on stakeholders to *step into each other's shoes*. Similar to other tools of perspectives' change, this calls for the willingness and capacity to do so and fair facilitation.

Best Practice and Further Reading

Tool description and step-by-step guidance:

Brouwer, H. & J. Brouwers (2017): Tool 29. In: The MSP Tool Guide: Sixty tools to facilitate multi-stakeholder partnerships. Companion to The MSP Guide. Wageningen: Wageningen University and Research, CDI.

Download in English/French/Spanish versions from: http://www.mspguide.org/msp-guide (accessed 1st March, 2019)

Nauheimer, H. (2005): The Change Management Toolbook: A collection of tools, methods, and strategies. Download: http://www.mspguide.org/sites/default/files/resource/the_original_change_management_toolbook.pdf (accessed 1st March, 2019)

A modification of the Multiple Perspectives Wheel appears as the *Resilient Wheel*. This is a tool which has been applied in the context of resilience and climate adaptation research for purposes of jointly assessing institutional capacities, enablers and barriers to develop adaptive capacities and knowledge co-production at the science-practitioner interface.

Further reading on the Resilient Wheel:

Aldunce, P., Bórquez, R., Adler, C., Blanco, G. & R. Garreaud (2016): Unpacking Resilience for Adaptation: Incorporating Practitioners' Experiences through a Transdisciplinary Approach to the Case of Drought in Chile. Sustainability 2016, 8, 1-21.

Gupta, J., Termeer, K., Klostermann, J., Meijerink, S., van den Brink, M., Jong, P., Notteboom, S. & E. Bergsma (2010): The Adaptive Capacity Wheel: A Method to Assess the Inherent Characterstics of Institutions to Enable the Adaptive Capacity of Society. Environmental Science & Policy, 13, 6, 459-471.

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration	☑	Stakeholder identification & analysis		◈◈	☺ ☺☺	🕒	①
Selection		Explore opinions & worldviews	☑				
Co-Design		Elicit local knowledge					
Evaluation		Foster group cooperation	☑				
		Decision-making					
		Measure NBS efficiency					

Open Space Technology (OST)

What is it?

The Open Space Technology (OST) is a group discussion technique which supports stakeholder groups from 5 - 2000+ participants to self-identify and discuss topics of relevance, utilizing separate rooms or circular chair formations to reflect on them and freely move among the different themes. Notes are kept in each discussion, and compiled at the end of the 1 to 3 day event into a plenary discussion and comprehensive report.

For preparation of an OST event, an over-arching question or statement needs to be formulated, which will serve as umbrella motto and focus of the group discussion. Depending on the number of participants, several variants of the kick-off setting are possible, ranging from a circle of chairs to a conference-alike plenary setting.

One of the first steps after the introductory part is to compile the so-called *marketplace,* i.e. participants first identify which themes they are most passionate about discussing, which are consequently compiled into a list by the facilitator, and distributed among the different group settings. In this way, the participants themselves actually set the agenda for the discussion, rather than the facilitator or study organizers.

Participants then freely move between discussion groups they are interested in, cross-fertilizing the individual discussion groups by new perspectives and ideas, establishing also links between the themes at stake (Brouwer & Brouwers 2017). One person during each discussion acts as note-taker, and these notes are then synthesized into a comprehensive report for the end of the event. However, there is no discussion leader; participants rather monitor themselves and set the direction of the discussion. The only rule for the discussions is termed the "Law of Two Feet", which indicates that a participant should leave a discussion and move to another if he feels he is neither contributing nor learning anything from it (McDonald et al. 2009: 70).

When to use / What for?

The Open Space Technology is most useful for situations in which the path towards a solution to a problem is still unclear or very complex, and for which important knowledge of steps to proceed is missing or only few recommendations for such exist. It is thus appropriate to be used in early stages of a multi-stakeholder process, when exploration, problem-solving and planning are central aspects (Brouwer & Brouwers 2017).

In the context of NBSs design for hydro-meteorological disaster risk management, such tool capacity fits well given the relative novelty of NBSs use in solutions to disaster risk, the lack of publicly available knowledge and public acceptance surrounding NBSs, and the complicated, often transdisciplinary nature of its implementation and operation. The OST can assist in forming a dialogue in such situations, as well as identifying issues related to the problem that should be explored, opportunities for change, and setting priorities for future action among stakeholders (McDonald et al. 2009). Therefore, it is best suited for Living Lab set-up processes, where the issue needs to be initially explored, and consensus and trust among stakeholders have to be built.

The special feature of inviting the members of a heterogeneous stakeholder group to self-responsibly create the meeting's agenda and explore issues which are of relevance to them, makes the tool very capable of capturing knowledge, experience and innovative ideas, which could not be released by conventional closed system processes before (SDC 2009).

As the tool's name already indicates, however, it is a fundamental precondition of application that the space indeed is *open*. In other words, it is not recommendable to apply OST in settings of predetermined agendas and desired out-

comes set. Furthermore, a strong commitment of stakeholder leaders to the process as a whole, including the outcomes and willingness of implementation thereof, needs to be in place, next to sufficient energy among the participant group (SDC 2009).

For whom?

The Open Space Technology is a good tool for involving very diverse groups of stakeholders, crossing over from public sector officials, private sector partners, researchers and experts to civil society groups and individual citizens. A principle of the OST is: "Whoever comes are the right people" (Brouwer & Brouwers 2017), meaning that there are no limitations concerning the audience. Although being a highly self-responsibly process, facilitation should be professional in terms of guaranteeing that participants indeed will have an open and inviting space for discussion, while at the same time receiving orientation and information on the procedural steps whenever needed.

Strengths and Limitations

When it comes to mention the particular strengths of the OST, the tool's flexibility is certainly among them. Although being usually applied for larger stakeholder groups, the tool can be tailored to a variety of settings, covering different participant numbers (5-2000+) and time slots between a couple of hours and several days (Nauheimer 2005; McDonald et al. 2009; SDC 2009).

Next to that, the concept of self-organization is the core driver for releasing creativity, leadership and networking in the participant group (SDC 2009), catalysing also commitment and ownership for the process on the long-term.

Due to the *free-style* and little structured approach, a robust framework, suitable infrastructure, fair facilitation as well as proper information on both the methodology and objectives of the tool need to be provided to the participants; otherwise there is the risk that stakeholder expectations might remain un-met (Action Catalogue Engage2020). In case of conceptualizing the event over several days, time-intensity might interfere with key stakeholders' usually loaded agendas.

Best Practice and Further Reading

As the tool has been applied since 20+ years, there's a rich pool of information and lessons learned available on it from worldwide application.

Further reading:

Owen, H. (2008): Open Space Technology. A User's Guide. San Francisco: Berrett-Koehler

Website of the worldwide Open Space practitioner community, with detailed information on the tool, case studies and practitioner resources for further reading: https://openspaceworld.org/wp2/ (accessed 1st March, 2019)

A detailed tool description, step-by-step guidance and case study examples are available in the Engage2020 Action Catalogue, administered by the Danish Board of Technology: http://actioncatalogue.eu/method/7401 (accessed 1st March, 2019)

Informational video on OST methodology: https://www.youtube.com/watch?v=a3jVOKQYm6E (accessed 1st March, 2019

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration	☑	Stakeholder identification & analysis		◈	☺☺☺	🕒🕒	② ③
Selection	☑	Explore opinions & worldviews	☑				
Co-Design		Elicit local knowledge	☑				
Evaluation		Foster group cooperation	☑				
		Decision-making					
		Measure NBS efficiency					

DECISION-SUPPORT TOOLS

Delphi Technique

What is it?

The Delphi technique is a tool to collect and condense judgements from a wide variety of stakeholders by using an iterative sequence of standardized questionnaires (Elliott et al. 2005; McDonald et al. 2009).

When to use / What for?

The Delphi technique is a suitable tool for efficiently gathering expert feedback in an iterative process that allows stakeholders to also view the answers and opinions of their peers. It can be useful for framing problems at hand as well as exploring a multitude of options at once. These qualities make it a good choice e.g. to discuss different NBS types with stakeholders and gradually consolidating a group's viewpoint on them. More specifically, in the PHUSICOS context the Delphi technique can be beneficial in the systematic collection of NBS-related opinions, preferences and demands from stakeholders, especially over large spatial or time horizons, given that it can be implemented via mailing or interactive web platforms.

Its iterative character allows both facilitators and stakeholders to get a better grasp of existing consensus and dissent in place within the group, and the underlying argumentation thereof (Pohl 2018), and thus to plan for adequate strategic steps related to the further stakeholder involvement process.

For whom?

To ensure good-quality results, the group of interviewees should represent the entire range of views on a topic. Hereby, the number of people interviewed does not necessarily have to be high (Häder 2002). As the name implies already, the Delphi Technique has been conceptualized and in use as iterative survey for experts mainly (Elliott et al. 2005; Pohl 2018; Action Catalogue Engage2020).

Strengths and Limitations

A particular strength of the Delphi technique is the equal involvement of all stakeholders in a process to define goals and the stepwise formation of a common ground for preparing decision-making. A further relevant advantage of the Delphi is that persons can express their opinion freely without interruption, and revise their opinion after each round, as anonymity is maintained without interaction during the interviews (Lupp et al. 2013). This helps to bridge common challenges associated with committee processes, such as skewed power dynamics or the unwillingness to share thoughts in front of certain groups (McDonald et al. 2009; Elliott et al. 2005).
Limitations of the tool consist on the one hand in its substantial demands in time and resources, which needs to be taken in consideration also with regard to an adequate recognition of the stakeholders' engagement (ActionCatalogue Engage2020). Furthermore, pitfalls are possible with regard to poor synthesis of group results and ignorance of disagreements (Elliott et al. 2005). Integrating the Delphi technique with technology, however, has shown to be a promising approach to increase the efficacy when dealing with a large number of stakeholders or time constraints (Coleman et al. 2017).

Best Practice and Further Reading

Examples of how the Delphi technique can be used as a basis for consensus on which further participatory processes and tools might be implemented are found within literature, such as the online *crowdsourced* Delphi created by Coleman et al. (2017) for the purpose of public participation in water pollution control and climate change adaptation. The case study demonstrates an innovative way to implement a Delphi aside from the traditional form of mail-in questionnaires or individual interviews, as stakeholders can give and receive feedback in real time. Here, the Delphi was implemented using an online forum, where stakeholders could read through provided background information

and then propose their own *interventions* to combat pollution issues, and other stakeholders could comment on the proposed interventions. At the end of the time-span for the forum, interventions were recorded, grouped together and further analyzed in a multi-stakeholder workshop with the entire group (Coleman et al. 2017).

Further reading on the mentioned case study:

Coleman, S., Hurley, S., Koliba, C., & A. Zia (2017): Crowdsourced Delphis: Designing solutions to complex environmental problems with broad stakeholder participation. Global Environmental Change, 45, 111-123. doi:10.1016/j.gloenvcha.2017.05.005

For practioner-orientated tool descriptions, see:

Action Catalogue Engage2020: Tool Delphi. http://actioncatalogue.eu/method/7399 (accessed 7th March, 2019)

Pohl, C. (2018): Tool Delphi. In: Methods and tools for co-producing knowledge. Swiss Academies of Arts and Sciences, Network for Transdisciplinary Research td-net. URL https://naturalsciences.ch/topics/co-producing_knowledge/methods/td-net_toolbox/delphi (accessed 7th March, 2019)

Further reading on the Delphi Method:

Linstone, H.A. & M. Turoff (Eds.)(1975): The Delphi Method – Techniques and Applications. Reading, MA: Addison-Wesley. 620p.

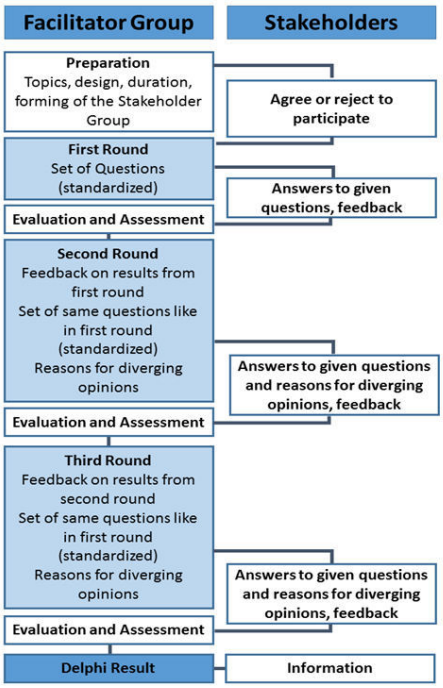

Figure 25. Flowchart outlining a Delphi process. (Design: G. Lupp 2018, based on Götze 1995 and Lupp 2008)

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration	☑	Stakeholder identification & analysis		◈	☺ ☺☺ ☺☺☺	🕒🕒🕒	② ③
Selection	☑	Explore opinions & worldviews	☑				
Co-Design		Elicit local knowledge					
Evaluation	☑	Foster group cooperation					
		Decision-making	☑				
		Measure NBS efficiency	☑				

Multi Criteria Decision Analysis (MCDA)

What is it?

The Multi Criteria Decision Analysis (MCDA) is both an approach and set of techniques, that targets at structuring a decision problem in several possible alternative options, and to assess each of them under multiple criteria at once (Geneletti 2013). It is thus a tool being apt to aid thinking about and work with complex decision problems, transferring it into manageable parts for allowing data judgements to be made (Action Catalogue Engage2020).

As for MCDA methods, there is a big variety to choose from for ranking, comparing and selecting the options at stake according to the previously defined criteria. The methods differ from another by the decision rules used (compensatory, partial-compensatory or non-compensatory) and by the data they process (quantitative, qualitative, or both) (Geneletti 2013). Preferences on the decision rules and data availability thus usually guide the choice of appropriate MCDA methods.

When to use / What for?

Characteristically, in multi-criteria approaches the evaluation is based on a set of explicitly formulated criteria, by which the performance of the alternatives at stake can be judged with respect to a number of objectives. Another typical feature is the considerable variation in nature of the criteria. This particularity makes the MCDA especially suitable for sustainability appraisals, impact assessments and similar type of decision problems possessing conflicting, multiple objectives, often also characterised by a mixture of monetary and non-monetary aspects (Geneletti 2013; Action Catalogue Engage2020).

In the PHUSICOS context, the MCDA seems useful especially for NBS selection and evaluation purposes in the Living Lab work. Hereby, it might fulfil diverse purposes, such as to single out a most preferred option, ranking a set of options, compiling a short list of options for further more in-depth consideration or to support cost-benefit analyses including different stakeholders' perspectives (Action Catalogue Engage2020; EC 2018). Moreover, MCDA can be applied for ecosystem service assessment, and if made spatially explicit, efficiently orientate landscape and land use planning (e.g., Saarikoski .et al. 2016).

Most relevant in regard to the application of the MCDA is a sound and well-structured definition of the problem and objectives prior to its use; thus, issues of exploration need to be clarified and settled beforehand. Moreover, it should not be neglected that the MCDA is a socio-technical process. That said the technical dimension is only one side of the medal, calling for a sound design of the social process for being a suitable framework of the technical modelling task at the same time.

For whom?

The MCDA can be applied with a broad variety of stakeholders, such as public and private sector partners, interested citizens and community groups, consulting experts and researchers. Sound facilitation is a must-have.

Strengths and Limitations

A clear advantage of the tool consists in its ability to be easily combined with other participatory tools and methods for benefiting from a full picture of stakeholders' demands. As the robustness of MCDA results is often influenced by commonly agreed weights and values, stakeholder knowledge elicitation practices such as the Delphi survey or stakeholder analysis are well suited for combination with MCDA (Geneletti 2013). Further strengths are the tool's characteristics to stimulate discussion and ease the understanding of complex decision-problems (Gamper & Turcanu 2007), having positive effects on a

stakeholder group's learning and cohesion. Moreover, the MCDA is flexible in terms of being adaptable to a large variety of contexts, with objectives and criteria being open to change, if deemed necessary (Action Catalogue Engage2020).

Limitations of the tool can be recognized in being possibly time-consuming and technically complex. Practice shows that e.g. especially stages of preference modelling and aggregation could be lengthy and difficult to follow by stakeholders (Gamper & Turcanu 2007). Facilitators guiding a MCDA should thus possess a sound understanding of the methodology. Furthermore, additional software might be needed for data processing (Geneletti 2013).

Best Practice and Further Reading

For a more detailed tool description, step-by-step guidance and case study examples, see e.g:

Action Catalogue Engage2020: Tool description Multi Criteria Decision Analysis. Administred by the Danish Board of Technology; funded by European Commission.
http://actioncatalogue.eu/method/7393
(accessed 4th March, 2019)

European Commission (2018): Better Regulation Toolbox. Tool 63: Multi-Criteria Analysis.
https://ec.europa.eu/info/sites/info/files/file_import/better-regulation-toolbox-63_en_0.pdf
(accessed 4th March, 2019)

Geneletti, D. (2013): Multi-criteria analysis. LIAISE Toolbox.
http://www.liaise-kit.eu/ia-methods/multi-criteria-analysis
(accessed 4th March, 2019)

Gamper, C.D. & C. Turcanu (2007): On the governmental use of multi-criteria analysis. Ecological Economics, Elsevier, vol. 62(2), pp. 298-307.

Case study example from the field of flood risk management:

Ceccato, L., Giannini, V. & C. Giupponi (2011): Participatory assessment of adaptation strategies to flood risk in the Upper Brahmaputra and Danube river basins. Environmental Science & Policy 14 (2011), 1163-1174.

Case study example for combination of MCDA with web-based maps for sourcing different preferences for CCA measures in the context of water scarcity in the Alps:

Bojovic, D., Giupponi, C., Klug, H., Morper-Busch, L., Cojocaru, G., & R. Schörghofer (2017): An online platform supporting the analysis of water adaptation measures in the Alps. Journal of Environmental Planning and Management, 61(2), 214-229.

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration	☑	Stakeholder identification & analysis		◈ ◈	☺ ☺☺ ☺☺☺	🕒🕒 🕒🕒🕒	② ③
Selection	☑	Explore opinions & worldviews	☑				
Co-Design		Elicit local knowledge					
Evaluation	☑	Foster group cooperation					
		Decision-making	☑				
		Measure NBS efficiency	☑				

Simple Scoring and Ranking Methods

What is it?

When possibilities are explored, the discussion of pros and cons of ideas, on further working steps or planning options comes to a close and before action can be taken, decisions have to be made. For deciding low-stakes issues in a workshop setting, simple scoring and ranking methods can be used for systematically comparing and deciding on a pool of alternative items. Nevertheless, it is recommended that an agreement on decision rules is achieved right at the beginning of a participatory project (Kaner et al. 2014). For high-stakes issues or more complex ones, other means have to be considered to successfully integrate divergent viewpoints and for preparing decisions (e.g. Multi-Criteria Decision Analysis).

Dot Voting
The list of rating items or options to decide upon is displayed on a board, well visible for all participants. Each participant receives the same number of dots or other stickers to mark his choices. Before the actual voting by sticking the dots next to the preferred options can take place, the rules on how marks can be given have to be clarified (e.g. only one dot per item, a defined maximum of dots per item, any number within the personal limit per item) (Brouwer & Brouwers 2017). Majority vote decides which item or option 'wins'. An advantage of the method is, that the result is clear for all to see and documented for the later stages of the process. To decide sensitive issues in smaller group settings, the dot voting can take place in private behind the board.

A variant of dot voting is suggested by Kaner et al. (2014) to narrow down a list of ideas or alternative proposals too long to proceed all. The number of items on the list is divided by three. The participants get only that number of dots but can distribute those dots according to their free choice. The three options receiving the most support will be further discussed and developed. The advantage of this variant is that unconventional ideas are preserved and "minority voice" protected (Brouwer & Brouwers 2017: 111).

Pair-wise ranking
Pair-wise ranking, also called *preference ranking*, helps a group to determine main preferences and priorities for a set of already discussed items (Pretty et al. 1995). As the name of the method implies, pair-wise ranking compares each item/option of the predefined list directly against the others until all items are ranked from highest to lowest preference (Narayanasamy 2009: 222 sub.). A matrix table is prepared showing each item across the top (x-axis) and down the left side (y-axis) of the matrix. By asking the participants to nominate their preference, the facilitator works through each combination of pairs and writes down the prioritised item in the respective box of the matrix. When the pair-wise comparison is completed, the number of times each item is mentioned in the matrix is counted and noted down in the "Score" column in the respective item row. According to the scores received, the final rank of each item is displayed in the "Rank" column.

Ranking can be done in various ways, from which pair-wise preference ranking is arguably the easiest to understand and apply (Pretty et al. 1995). To share and learn the reasons behind the preferences, respondents can be asked to explain their choices. When the ranking is done against a set of criteria agreed upon before-hand, it gives information about why people make certain choices without having to ask them and offers the possibility to assign different weightings to the criteria.

When to use / What for?

Simple scoring and ranking techniques are helpful when seeking an overview of a broad array of topics and to establish priorities. Categories and items should be relatively simple to select and define (Evans et al. 2006).

For whom?

Simple Scoring and Ranking works well with non-technical stakeholders and citizens. Technical experts might have reservations against the tools because of their limitations (see following paragraph).

Strengths and Limitations

The presented tools are simple diagnostic rating procedures, rapid and flexible in use. The results can be replicated and the resulting numerical data allows easy summary and comparison (Evans et al. 2006). The rating process itself can stimulate discussion and help participants to clarify their topic understanding and priorities.

The main weakness of the tools is that none of them are truly scientific (Brouwer & Brouwers 2017), but can reveal the preferences held in a group and make them transparent to the participants. As for open voting procedures in general, there is a risk of people being influenced by others.

Best Practice and Further Reading

Several tool guides on stakeholder engagement describe easy to use tools for concluding discussions and preparing decisions, e.g.:

Brouwer, H. & J. Brouwers (2017): The MSP Tool Guide: Sixty tools to facilitate multi-stakeholder partnerships. Companion to The MSP Guide. Wageningen University and Research, CDI, Wageningen: pp. 148. Download: http://www.mspguide.org/ (accessed 18th March 2018).

World Food Programme (2001): Participatory Techniques and Tools. A WFP Guide, Rome.

On participatory decision-making, a wealth of information is provided by:

Kaner, S., Doyle, M., Kerney, K., Berger, D. & L. Lind (2014): Facilitator's Guide to Participatory Decision-Making. Third edition. Jossey-Bass. San Francisco.

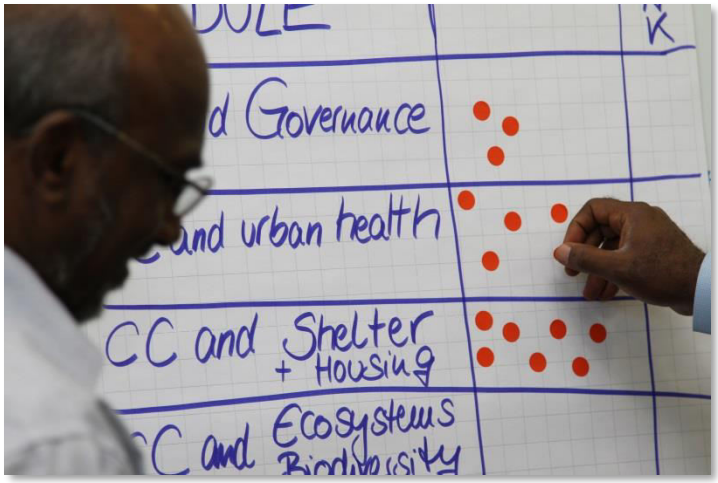

Figure 26. Dot voting in practice as tool to foster decision-making. (Picture: Fohlmeister/Barth/ Hossini 2011, CCCA Bonn)

Suitability for NBS Stage		Main function(s) / purpose(s) of application		Intensity of Participation	Number of Participants	Duration	Cost
Exploration	☑	Stakeholder identification & analysis		◈ ◈	☺ ☺☺	🕒	①
Selection	☑	Explore opinions & worldviews					
Co-Design	☑	Elicit local knowledge					
Evaluation	☑	Foster group cooperation					
		Decision-making	☑				
		Measure NBS efficiency					

6.4 Toolbox Library

The Toolbox Library is a compilation of selected further reading material and useful background information deemed interesting and relevant to the PHUSICOS demonstrator and concept case sites' local facilitation teams.

It shall serve the purpose of enabling more in-depth reading and studying on individual tools, general facilitation techniques as well as further toolkits and knowledge platforms from PHUSICOS-alike contexts.

The Toolbox Library should, however, not be interpreted as bibliography or state-of-the-art literature review aspiring to be a complete material collection. It is much more an optional offer to look a bit beyond of what has been portrayed in the Toolbox, hinting at some useful titles for further reading, especially with regard to articulated individual needs of demonstrator and concept case sites, which could not be addressed to bigger extent in the framework of the presented report.

The Toolbox Library has been clustered as follows:

- **Further Reading on Stakeholder Identification & Analysis**
- **Further Reading on General Facilitation Techniques**
- **Further Reading on Creative Participation and Group Reflection Techniques**
- **Further Reading on Individual Tools / Tool Selections**
- **Further Reading on Participatory Rural Appraisal (PRA) Tools**
- **Further Reading on Soft Systems Modelling**
- **Further Toolboxes and Toolkits.**

In-line with the presented Toolbox, the Toolbox Library has also been conceptualized as a *living document*. That said, it is open to be further expanded by useful material and add-ons at any time.

Further Reading on Stakeholder Identification & Analysis

An excellent overview on stakeholder identification and analysis methods in the realm of natural resources management is provided in:

Reed, M. S., Graves, A., Dandy, N., Posthumus, H., Hubacek, K., Morris, J., Prell, C., Quinn, C.H., & L.C. Stringer (2009): Who's in and why? A typology of stakeholder analysis methods for natural resource management. Journal of environmental management, 90(5), 1933–1949.

For practioner-orientated background information on stakeholder analysis tools:

Dearden, P., Jones, S. & R. Sartorius (2003): Tools for Development. A handbook for those engaged in development activity. Performance and Effectiveness Department. DFID – Department for International Development. UK. Download: https://webarchive.nationalarchives.gov.uk/+/http:/www.dfid.gov.uk/Documents/publications/toolsfordevelopment.pdf (accessed 8th March, 2019)

Zimmermann, A. & C. Maennling (2007): Multi-stakeholder management: Tools for Stakeholder Analysis: 10 building blocks for designing participatory systems of cooperation. Deutsche Gesellschaft für Technische Zusammenarbeit GmbH. Eschborn. Download: https://www.fsnnetwork.org/sites/default/files/en-svmp-instrumente-akteuersanalyse.pdf (accessed 8th March, 2019)

Further Reading on General Facilitation Techniques

Everyday Democracy (2008): A Guide for training Public Dialogue Facilitators. The Paul J. Aicher Foundation. East Hartford, Connecticut. Download: https://www.everyday-democracy.org/resources/guide-training-public-dialogue-facilitators (accessed 8th March, 2019)

A substantial material collection on different aspects of facilitation, group work, consensus-building and others offers the platform Seeds for Change (UK) on its website: https://www.seedsforchange.org.uk/. Exemplary guidelines:

Seeds for Change Lancaster Cooperative Ltd (2018): Effective groups. A guide to successful group organising, from starting up groups to keeping them going. In-depth guide. Footprint Workers Cooperative.

Seeds for Change Lancaster Cooperative Ltd (2013): A Consensus Handbook. Cooperative decision-making for co-ops and communities. Footprint Workers Cooperative.

Seeds for Change Lancaster Cooperative Ltd (2009): Facilitation Tools for meetings and workshops. In-depth guide. Footprint Workers Cooperative.

Further Reading on Creative Participation and Group Reflection Techniques

Pearson, K.R., Backman, M., Grenni, S., Moriggi, A., Pisters, S. & A. de Vrieze (2018): Arts-Based Methods for Transformative Engagement: A Toolkit. Wageningen: SUSPLACE. Download: https://www.sustainableplaceshaping.net/arts-based-toolkit/ (accessed 8th March, 2019)

Gordijn, F., Eernstman, N., Helder, J. & H. Brouwer (2018): Reflection Methods. Practical Guide for Trainers and Facilitators. Tools to make learning more meaningful. Wageningen Centre for Development Innovation, Wageningen University & Research. http://www.mspguide.org/tool/reflection (accessed 12th March, 2019)

Further Reading on Participatory Rural Appraisal (PRA) Tools

Chambers, R. (2002): Participatory Workshops: A Sourcebook of 21 Sets of Ideas and Activities. Earthscan, London: pp. 240.

Narayanasamy, N. (2009): Participatory Rural Appraisal: Principles, Methods and Application. SAGE Publications, New Delhi: pp. 364.

Further Reading on Individual Tools / Tool Selections

Brouwer, H. & J. Woodhill, with Hemmati, M., Verhoosel, K. & S. van Vugt (2016): The MSP Guide. How to design and facilitate multi-stakeholder partnerships. Wageningen: Wageningen University and Research. CDI and Rugby, UK: Practical Action Publishing. http://dx.doi.org/10.3362/9781780446691

Brouwer, H. & J. Brouwers (2017): The MSP Tool Guide: Sixty tools to facilitate multi-stakeholder partnerships. Companion to The MSP Guide. Wageningen: Wageningen University and Research, CDI. Download: http://www.mspguide.org/sites/default/files/case/msp_tool_guide.pdf

(available in English; French, Spanish) (accessed 12th March, 2019)

Elliott, J., Heesterbeek, S., Lukensmeyer, C.J. & N. Slocum (2005): Participatory Methods Toolkit. A Practitioner's Manual. King Baudouin Foundation and the Flemish Institute for Science and Technology (viWTA). Download: https://www.livingknowledge.org/fileadmin/Dateien-Living-Knowledge/Dokumente_Dateien/Toolbox/LK_A_Particpatory_Methods.pdf (accessed 8th March, 2019)

Swiss Agency for Development and Cooperation (SDC) (2009): Knowledge Management Toolkit. SDC Knowledge and Learning Processes Division. Berne. https://usaidlearninglab.org/sites/default/files/resource/files/SDC-KM-Toolkit.pdf (accessed 8th March, 2019)

Further Reading on Soft Systems Modelling

Checkland, P. & J. Scholes (1990): Soft systems methodology in action. Chichester: Wiley.

FURTHER TOOLBOXES AND TOOLKITS

Table 4. Overview to further Toolboxes and Toolkits (1/4)

Legend: Major Disciplines of Reviewed Toolboxes			
	Participatory Planning		Environmental Planning
	Trandisciplinary Research Integration		Consumer Products Design
	International Development Policy		

Toolkit Name	General Description	Institution (if applicable)	Criteria for Inclusion of Tools	Categories for Systemization	Examples of Past Use	Practical Considerations for Application Conditions	Provides Additional Sources of Information on Tools	Reference Source
Action Catalogue	•Provides 57 participatory methods aimed at enabling researchers and policy-makers to undertake inclusive research with stakeholders. •It also offers a specialized search function allowing users to filter the 57 methods according to any of the 32 criteria provided.	European Commission- Engage2020 Project	N/A; No clear criteria given for the inclusion or exclusion of tools	Methods can be sorted according to 32 different criteria, including: •Level of stakeholder participation •Skills required in order to apply the method •Direct participants in the process •Skills required of participants.	Yes	Yes	Yes	Action Catalogue. European Commission- Engage2020 Project. http://actioncatalogue.eu/.
Change Management Toolbox	Provides a varied collection of theories, tools, discussions, cognitive research, and participatory tools to facilitate any type of change, either within one's self, within an organization, or within larger systems/societies.	N/A	N/A; No clear criteria given for the inclusion or exclusion of tools	Divided into three main levels of of tools according to institutional or organizational level, including: Self, Team, System. No clear distinction is made between tools and concepts or theories.	No	No	Yes	Nauheimer, H. (2005): The Change Management Toolbook: A collection of tools, methods, and strategies.
Collaboration & Impact Toolbox	•Mini toolkit of six hands-on, participatory tools that emphasize simplicity, activity, and inclusivity in co-design and planning processes •Focuses on highly hands-on and interactive tools that facilitate overall dialogue and engagement among stakeholders as well as co-design.	Lancaster University	Proprietary tools, all created by Lancaster University to be used in general participatory processes	No categories provided, given that it is a small toolbox of only six tools and all are intended for general participatory processes.	No	Yes	No; because tools are proprietary	New IDEAS Project. Collaboration & Impact Toolbox, Lancaster University. http://impact.lancaster.ac.uk/tools/#/
Constructive Technology Assessment (CTA) Toolbox	Provides tools to address the societal and ethical aspects of technology development, with many examples of its use in the fields of medicine, pharmaceuticals, and biotechnology.	University of Twente	All tools were selected on the basis of their ability to be integrated into "lab-floor" practices and help interdisciplinary research teams.	Tools are divided in two different manners: •For early vs. advanced stages of a project •By their abilities, including: 1) broadening research scope, 2) engaging stakeholders, 3) anticipating future impacts.	Yes	Yes	No	Constructive Technology Assessment (CTA) Toolbox. University of Twente. https://cta-toolbox.nl/.
Integration and Implementation Sciences (I2S): Improving research impact on complex real-world problems	This online library provides both concepts, methods and case studies intended for interdisciplinary teams working on complex, multi-sector issues from both social and environmental perspectives.	Australian National University (ANU)	Tools were selected for inclusion on the basis of meeting at least one of three main objectives within research integration: synthesizing stakeholder knowledge, understanding and managing diverse unknowns and research support for policy and practice change.	While the library is sub-divided by resource types into tools, approaches, cases and journals, the tools themselves are still very generalized concepts of tools with little practical implementation information given and few clear objectives states. Furthermore, many of the tools are highly specific to particular disciplines, such as medical sciences, etc.	Yes	No	Yes	Integration and Implementation Sciences (I2S): Improving research impact on complex real-world problems. Australian National University (ANU). https://i2s.anu.edu.au/.
Linking Impact Assessment Instruments to Sustainability Expertise (LIAISE) Toolkit	•Aims to improve environmental policy impact assessment (IA) for sustainable development policies. •Includes models for assessing impacts across different sectors, as well as methods and practical examples of how to apply policy IA methods.	Helmholtz Centre of Environmental Research- UFZ; European Commission	N/A; No clear criteria given for the inclusion or exclusion of tools, however, the toolkit is continually updated as new methods are identified	Divides the listed methods by their potential use, including: Qualitiative methods, Quantitative methods, Data visualizations, Participatory methods, Monitoring & Evaluation.	Yes	Yes	Yes	Linking Impact Assessments to Sustainability Expertise (LIAISE) Toolkit. Helmholtz Centre of Environmental Research- UFZ & European Commission. http://www.liaise-kit.eu/.

Compilation and Design: C. Jones (2019)

Table 4. Overview to further Toolboxes and Toolkits (2/4)

Legend: Major Disciplines of Reviewed Toolboxes			
	Participatory Planning		Environmental Planning
	Trandisciplinary Research Integration		Consumer Products Design
	International Development Policy		

Toolkit Name	General Description	Institution (if applicable)	Criteria for Inclusion of Tools	Categories for Systemization	Examples of Past Use	Practical Considerations for Application Conditions	Provides Additional Sources of Information on Tools	Reference Source
Multi-Stakeholder Partnerships (MSP) Tool Guide	•A toolbox composed of 60 tools aimed at facilitating collaborative processes that bridge sectors such as business, government, civil society and science •Breaks each tool down with a description of it's usefulness, implementation process, and provides additional sources of information.	Wageningen University	Tools included are based on the organizing experts' personal choices. Tools were selected by experts and practitioners as those "especially useful for MSP processes".	Categorized by six different purposes that a particular tool can meet. These are: Connection, Issue exploration & shared language, Divergence, Co-creation, Convergence, Commitment.	No	Yes	Yes	Brouwer, H., & J. Brouwers (2017): The MSP Tool Guide: Sixty tools to faciliate multi-stakeholder partnerships, Wageningen University and Research, CDI. http://www.mspguide.org/tools-and-methods.
OPPLA	Provides a "knowledge marketplace", which includes both knowledge exchange opportunities via an online community, as well as a library of methodologies, participatory tools, and case studies. It is focused on the subjects of ecosystem services, natural capital and nature-based solutions.	European Commission	It is an open-source toolbox where resources can be uploaded by any participating research institution, university or consulting service. Therefore, there are no defined criteria for the inclusion or exclusion of tools.	Categories include resource type within toolbox, such as: document, dataset, guidance, software, etc. Also uses additional criteria to further sort within categories such as: regions, topics, ecosystems, etc.	Yes	Yes	Yes	Oppla Marketplace (2018): European Commission. https://oppla.eu/.
Participation & Sustainable Development in Europe (PSDE)	•A collection of participatory methods for the field of sustainable development •Tools are grouped into categories based on three criteria: number of participants for which they are best suited (e.g. small groups, medium groups, large groups), the time required, and the level of participation (e.g. information, consultation, joint decision).	Austrian Ministry of the Environment	N/A; No clear criteria given for the inclusion or exclusion of tools	A simplified categorization model is used in this toolbox, with tools organized on the basis of the number of participants: small group (up to 15 people), medium groups (15-30 people) and large groups (over 30 people). Within each group, practical considerations are given for each tool, such as the time needed to use it and the dept of participation it can facilitate (e.g. informational, consultation or joint decision).	Yes	Yes	No	Participation & Sustainable Development in Europe. Austrian Ministry of the Environment. https://www.partizipation.at/methods.html.
Participatory Methods Toolkit: A Practitioner's Manual	This is a practitioner's manual for planning and implementing participatory processes, composed of 10 tools, with a strong basis in group disucssion methods, along with implementation guidelines and comparisons between methods.	Flemish Institute for Science and Technology Assessment	N/A; No clear criteria given for the inclusion or exclusion of tools	Given the small size of the toolbox, tools are not further subdivided into categories. However, an emphasis is placed on the explanation of practical considerations and technical implementation components (e.g. objectives, topic, time, budget, and participants) for each tool, inluding using comparative charts to showcase the strengths and weaknesses between tools.	No	Yes	Yes	Slocum, N. (2003): Participatory Methods Toolkit: A Practitioner's Manual, King Baudouin Foundation; Flemish Institute for Science and Technology Assessment (viWTA).
Participedia	It is a crowdsourced public catalogue for participatory tools, methods, and examples from a wide range of settings including participatory workshops, classrooms, grassroots organizing, public protests, etc.	Social Sciences and Humanities Research Council of Canada (SSHRC)	It is an open-source toolbox where resources can be uploaded by any participating research institution, university or consulting service. Therefore, there are no defined criteria for the inclusion or exclusion of tools.	Methods are kept separated from use cases to ease the search process. Methods are categorized according to a wide range of criteria, such as: type of participant interaction, geographical scope, technical complexity, intended purpose, etc.	Yes	No	Yes	Participedia. Social Sciences and Humanities Research Council of Canada (SSHRC). https://participedia.net/en.
Rapid Outcome Mapping (ROMA): A guide to policy engagement and influence	Provides a suite of tools to help policy makers better diagnose problems and improve policy engagement with stakeholders, as well as the monitoring and evaluation of policy.	Overseas Development Institute (ODI)	N/A; No clear criteria given for the inclusion or exclusion of tools	This toolkit is organized based on the three main temporal phases in policy-making, including: Diagnosing a Problem, Developing and Engagement Strategy and Monitoring & Learning.	No	Yes	No	Young, J., L. Shaxson, H. Jones, S. Hearn, A. Datta, & C. Cassidy (2014): ROMA: A guide to policy engagement and influence. Overseas Development Institute (ODI).

Compilation and Design: C. Jones (2019)

Table 4. Overview to further Toolboxes and Toolkits (3/4)

Legend: Major Disciplines of Reviewed Toolboxes			
	Participatory Planning		Environmental Planning
	Trandisciplinary Research Integration		Consumer Products Design
	International Development Policy		

Toolkit Name	General Description	Institution (if applicable)	Criteria for Inclusion of Tools	Categories for Systemization	Examples of Past Use	Practical Considerations for Application Conditions	Provides Additional Sources of Information on Tools	Reference Source
Research Integration Using Dialogue Methods	Provides a set of group discussion methods that focus on two main themes: integrating knowledge or judgements and integrating worldviews or opinions.	Australian National University (ANU)	Tools were selected on the basis of their frequency of past use in participatory setting and the availability of information regarding their implementation. All tools were selected based on their ability to facilitate "dialogue", rather than general organized conversation such as debate.	The main categorization method within this toolkit is dividing the tools between those which integrate judgements or knowledge and those which integrate worldviews, interests, opinions and visions.	Yes	Yes	Yes	McDonald, D., Bammer, D. & P. Deane (2009): Research Integration Using Dialogue Methods, ANU E Press. The Australian National University (ANU).
Responsible Research Innovation (RRI) Toolkit	This toolkit is dedicated to encouraging ethical social innovation and stringent research standards that make scientific research more transparent and put the benefits in the hands of the general public. It includes a wide variety of resources including tools, library elements, projects, etc. It includes many links to other toolkits focused on bridging the communication gap in scientific research between academics and the general public.	La Caixa Foundation	It is an open-source toolbox where resources can be uploaded by any participating research institution, university or consulting service. Therefore, there are no defined criteria for the inclusion or exclusion of tools.	Resources within the toolbox are categorized according to either their nature (e.g. tool, library element, project, case study), the discipline which they address (e.g. science education, governance, ethics, etc.) or the stakeholders for which they are best suited (e.g. policy makers, business & industry, etc.).	Yes	No	Yes	Responsible Research Innovation (RRI) Tools. La Caixa Foundation. https://www.rri-tools.eu/.
Service Design Tools	Combines tools and methodologies from the social sciences, business, design and technology into one toolkit aimed at improving communication processes with stakeholders, users and design team members •The toolkit is categorized in four categories: Design Activities (the intended aim of the activity), Representations (the method or displaying or carrying out the activity, such as texts, graphs, models, etc.), Recipients (which types of people/stakeholders is the activity intended for), Contents (the type of interaction or system).	Department of Industrial Design (INDACO)- Polytechnic University of Milan	N/A; No clear criteria given for the inclusion or exclusion of tools	Uses four main categories to divide tools. These are: Design Activities (the aim of the activity), Representations (the tool type), Recipients (for whom is each activity intended), Contents (the type of interaction that takes place when using the tool). These categories aim to answer the main questions of "Who?, What?, When?, Why? and How?". Within each of these categories, there are further subcategories.	No	No	Yes	Tassi, R. (2009): Service Design Tools: Communication Methods Supporting Design Process, Department of Industrial Design (INDACO) - Polytechnic University of Milan. http://www.servicedesigntools.org/.

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Table 4. Overview to further Toolboxes and Toolkits (4/4)

Legend: Major Disciplines of Reviewed Toolboxes			
	Participatory Planning		Environmental Planning
	Trandisciplinary Research Integration		Consumer Products Design
	International Development Policy		

Toolkit Name	General Description	Institution (if applicable)	Criteria for Inclusion of Tools	Categories for Systemization	Examples of Past Use	Practical Considerations for Application Conditions	Provides Additional Sources of Information on Tools	Reference Source
td-Net Co-Production Toolkit	•Focuses on knowledge synthesis in transdisciplinary research, facilitating knowledge co-production within highly diverse groups of stakeholders •Tools are mostly based on group discussion methods with low technology use.	Swiss Network for Transdisci-plinary Research, Swiss Academies of Arts and Sciences	Criteria for inclusion of tools: brings together different thought styles, uses low tech equipment, communicates using everyday language, develops a shared understanding, identifies consensus or dissent, facilitates jointly-produced knowledge Criteria for exclusion: integration of knowledge is done by a single person, integrates knowledge within only one thought collective or styles	Uses two methods of organization, key issues or phases of development. Key issues: •Identify actors •Embrace differences & resolve conflicts •Navigate normative goals (value systems) •Integrate different disciplines •Review impacts Phases: •Envisioning a project •Frame goals & problems •Conduct research •Explore ways to impact society	Yes	Yes	Yes	td-Net: Methods and tools for co-producing knowledge. Swiss Academies of Arts and Sciences. https://naturalsciences.ch/topics/co-producing_knowledge/methods/td-net_toolbox.
U4IoT Toolbox	This toolbox was created to assist European large scale pilots to drive user engagement as part of a Living Lab dedicated to communication technologies for consumers and IoT innovation. It includes not only planning and prototyping tools, but also conceptual guidance and case studies from past consumer-based Living Labs.	European Large Scale Pilots Programme (IoT)	N/A; No clear criteria given for the inclusion or exclusion of tools	Tools and other resources are divided into categories based on the 3 main phases of Living Labs. Each phase is further divided into "tracks" related to different needs within a Living Lab: Use cases, Co-Creation, Prototyping & Testing, User research. Alternatively, tools can be selected according to their complexity of implementation: Beginner, Intermediate, Advanced.	Yes	No	Yes	U4IoT End User Engagement Toolkit. DunavNET European Commission. https://u4iot.eu/end-user-engagement-toolkit.html.
WFP Guide: Participatory Techniques and Tools	This is a practical manual for designing participatory processes to generate community-based solutions to environmental and food-related problems, especially in developing countries. It provides some tools, but mainly generalized "techniques" for participatory planning, which can be described as guidelines or concepts to keep in mind when organizing processes.	World Food Programme (WFP)	N/A; No clear criteria given for the inclusion or exclusion of tools	Resources in this toolkit are divided between techniques (generalized concepts and guidelines for organizational purposes) and meetings, which indicate only three main ways of organizing participatory meetings.	No	Yes	No	Participatory Techniques & Working With Communities (2001): Participatory Techniques and Tools: A WFP Guide. World Food Programme.

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7 Further outlook

This deliverable *D3.2 Starter Toolbox for Stakeholder Knowledge Mapping to Co-Design NBSs* was developed by WP3 as a stepping stone between the preparation and operationalization stages of the Living Labs at the demonstrator and concept case sites of PHUSICOS. Carrying the title *Starter Toolbox*, it can be interpreted by its users in three ways mainly:

First, the Toolbox is intended to support the local facilitators in *starting* their stakeholder involvement processes and to set-up their Living Labs for their further work on the NBSs of interest. Therefore, the toolbox contains methods and tools being suited for stakeholder identification and analysis, for exploring problems and worldviews on NBSs, and for assessing the stakeholders' awareness on NBSs – all being relevant steps prior to the further co-design work on NBSs.

Second, the Toolbox shall be a means of catalysing the Living Labs' operational work processes on selecting, co-designing and evaluating the NBSs at stake. Thus, it is intended to support facilitators in kick-starting the Living Lab participants' and stakeholders' dialogue and to turn it into a worthwhile experience to take part in throughout the Living Labs' further working processes. Tools to prioritize and select NBSs, to co-design and evaluate them shall especially contribute to this purpose.

Third, the toolbox can also be regarded as *Starter* Toolbox due to its conceptualization as *living document*. Although being presented in its second, fully revised and updated version, it is still desirable from the viewpoint of the author team that the toolbox will further evolve throughout the lifetime of PHUSICOS, being enriched by continuous feedback on behalf of its users, and enabling further tool add-ons which seem valuable for the Living Lab work in the field.
In this way, it is hoped that local demands might be addressed in a satisfying manner, bringing forward a toolbox being useful for the local partners of PHUSICOS, and beyond.

Upon delivery of this report in its revised version (March 2019), demonstrator and concept case sites will have taken their first steps related to their individual local stakeholder processes already. Looking ahead, next steps to follow will be to have stable stakeholder core circles defined for the further Living Labs' work, formulate the individual scope of co-design and outline the outcomes to be achieved by the Living Lab processes more in detail. Guidance upon these steps will be provided by WP3 on occasion of the upcoming Consortium Meeting in Vienna (May 2019).

Furthermore, the quality management of the Living Lab processes will be supported by D3.3 *Monitoring and Evaluation Scheme to assess stakeholder participation and user satisfaction with Living Lab experience*, which is intended to be delivered to the case site partners in its first draft version in May 2019.

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Appendix A

Semi-structured Interview Guideline for Tool Demand Assessments with Facilitators and Experts (Naples, November 2018)

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A1 Semi-structured Interview Guideline for Tool Demand Assessments with Facilitators

FACILITATOR ORIENTATION DAY – NAPLES, 13th Nov, 2018
CONSORTIUM MEETING PHUSICOS – NAPLES, 14th-15th Nov, 2018

FACILITATOR CONSULTATION ON DEMANDS CONCERNING

STARTER TOOLBOX FOR STAKEHOLDER KNOWLEDGE MAPPING TO CO-DESIGN NATURE-BASED SOLUTIONS AT CASE STUDY SITES

INTERVIEW GUIDELINE: VERSION FOR FACILITATORS

elaborated by: Chelsea Jones and Sandra Fohlmeister (TUM)

Background information on the project context
PHUSICOS, meaning 'According to nature', in Greek φυσικός, is a four-year Innovation Action project that started in May 2018 and is funded by the European Union's Horizon 2020 research and innovation programme (Grant agreement No. 776681). The project consortium comprises 15 organizations from 7 countries (Norway, Germany, Austria, Italy, France, Spain and Andorra) and includes end-user partners from local and regional administrative units. The main objective of PHUSICOS is to demonstrate that nature-based or nature-inspired solutions (NBSs) for reducing the natural hazard induced by extreme weather events in particularly vulnerable areas such as rural mountain landscapes are technically viable, cost-effective and implementable at regional scale.
Multi-stakeholder participation is an overarching issue of PHUSICOS and, as such, forms a foundation to foster innovation at all levels and at all case study sites. Specifically, Work Package (WP) 3 (Service innovation – Stakeholder participation through Living Labs) is dedicated to employ a Living Lab approach as key mechanism of local stakeholder involvement for the purpose of successfully accompanying the intended NBSs' selection, design, planning, implementation and evaluation.

Interview objective
In the pursue to support the local case study sites in the initiation of participatory processes and further work of their Living Labs, WP3 is currently compiling a Toolbox, which shall contain useful tools to be applied by the local facilitators of the Living Labs to capture local stakeholders' knowledge for selecting, co-designing, implementing and evaluating the planned nature-based solutions (NBSs).
To achieve this usefulness and applicability of the Toolbox to the desirable extent, WP3 relies on your feedback. A sound understanding of your individual needs, expectations, intended application, but also possible limitations will be highly relevant and helpful to be able to compile the "right mix" of Tools for you. All ideas and comments are thus warmly welcomed.

Hints on Interview proceedings
This Interview guideline is intended to be completed jointly and interactively with the in-person interview. However, if time does not allow for its completion within the interview, please fill in the remaining parts according to instructions given for each question and return it by 19th Nov, 2018 to team TUM.

For further questions or comments regarding the interview process, please feel free to contact us.

Thank you for your time and participation!

Part 1: Personal Data on Interviewee

Q1.1 Name of Case site:

_____

Q1.2 Case site is qualified as…. in PHUSICOS:

☐ Demonstrator Case Site ☐ Concept Case Site

Q1.3 Name of Interviewee 1:

_____
_____

Q1.4 Organization of Interviewee 1:

_____
_____
_____

Q1.5 Position of Interviewee 1:

_____
_____
_____

Q1.6 Role in PHUSICOS project of Interviewee 1:

_____
_____

If more than one interviewee from the case site, please also add further interviewees' names/details below:

Q1.3 Name of Interviewee 2:

_____
_____

Q1.4 Organization of Interviewee 2:

_____
_____
_____

Q1.5 Position of Interviewee 2:

_____
_____
_____

Q1.6 Role in PHUSICOS project of Interviewee 2:

_____
_____

If more than one interviewee from the case site, please also add further interviewees' names/details.

Part 2: Stakeholder Involvement as framework for the application of Tools

Q2.1 What is the exact aim of the stakeholder involvement process at your site? (*If you wish to achieve several aims, please mention them all. Which aims do have a priority?)*

_____

_____

_____

_____

_____

Q2.2 To what extent do you intend to involve stakeholders at your case site in the PHUSICOS project?

☐ We intend to involve stakeholders on an informational level.

☐ We intend to involve stakeholders on a consultative level.

☐ We intend to involve stakeholders on an active cooperation level.

☐ We intend to involve stakeholders to the maximum possible extent and create ownership.

Could you please specify why you opt to do so?

_____

_____

_____

Q2.3 In which stage(s) of the NBS innovation cycle do you feel stakeholder involvement is most needed at your case site?
(Please express the necessity with 0=Not intended; 1=not very necessary; 2=somewhat necessary; 3=Very necessary)

☐ We intend to involve stakeholders for NBS exploration.

☐ We intend to involve stakeholders for NBS selection.

☐ We intend to involve stakeholders for NBS planning / co-design.

☐ We intend to involve stakeholders for NBS implementation.

☐ We intend to involve stakeholders for NBS evaluation / up-scaling.

Remarks:_____

_____

_____

Q2.4 Would you say that there is a clear consensus in place at your site concerning the scope and aims of your intended stakeholder involvement process?

_____

_____

_____

_____

_____

_____

Q2.5 Regarding the stakeholders involved: How would you judge the readiness of your case site to begin the stakeholder involvement process?
(Please express your agreement with 0=Don't agree; 1=rather not agree; 2=agree; 3=strongly agree)

- ☐ We have already **identified all relevant stakeholders** which we need for the NBS implementation.
- ☐ **We feel secure** about the stakeholder involvement process, as we have a lot of **experience**.
- ☐ We feel secure about the stakeholder involvement process, as stakeholders have already clearly expressed their **willingness and interest** to cooperate in PHUSICOS.
- ☐ We **don't have conflicting views** in our stakeholder group, which could affect the participation process.
- ☐ We **have conflicts** in our stakeholder group, which call for external expertise to be solved.
- ☐ We **already know how** we will go about involving the different stakeholders in the planned activities, we e.g. drafted a plan or participation strategy.

Remarks

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_____

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_____

Q2.6 What socio-cultural factors, if any, do you anticipate having an effect on your site's stakeholder processes?
Please list those you find relevant and explain.

Q2.7 Do you feel that any of the following factors may influence the stakeholder interaction and co-design processes at your case site?

Factor a: ***The case site is located in a MOUNTAINOUS area.***

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

If so, how? – and what does this mean for the design of your stakeholder involvement processes?

Factor b: ***The case site is located in a RURAL area*** *(e.g. older populations, low population density, etc.).*

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

If so, how? – and what does this mean for the design of your stakeholder involvement processes?

Factor c: ***Involvement of certain economic sectors (e.g. agriculture) in the stakeholder set-up.***

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

If so, how? – and what does this mean for the design of your stakeholder involvement processes?

Part 3: Tools - desired outputs, ways to achieve them and conditions of application

Q3.1 Have you already had experiences with the application of tools for stakeholder involvement at your case site? If yes, could you please describe which tools you have used, and for which purposes?

_____

_____

Q3.2 Which purposes would you like to achieve with the application of the PHUSICOS Toolbox?
(Please express the importance with 0=Not intended; 1=not important; 2=somewhat important; 3=very important)

- ☐ Use tools **to identify relevant stakeholders** which we need for the NBS implementation.
- ☐ **Explore opinions** and worldviews of stakeholders (e.g. explore the acceptance of NBS).
- ☐ Elicit **knowledge contributions** of local stakeholders which we need for the realization of the NBS (e.g. by local experts, etc.).
- ☐ Use tools to **foster the group cooperation** of different stakeholders (e.g. create a good team spirit for NBS).
- ☐ Use tools to **make decisions** in complex multi-stakeholder settings (e.g. to select or compare NBS options).
- ☐ Use tools to **measure the efficiency** of NBS and monitor them in a participatory manner.

Any other purposes you'd like to achieve by the use of stakeholder involvement tools?

_____

_____

_____

_____

Q3.3 What kind of tool categories seem most useful to you to be applied at your case site?
(Please express the importance with 0=Not intended; 1=not important; 2=somewhat important; 3=very important)

- ☐ **Opinion-gathering and survey techniques** (e.g. Delphi method; online & social media fora)
- ☐ **Group discussion tools** (e.g. World Café; Focus groups; etc.)
- ☐ **Visualization & Hands-On** (e.g. Serious board games; Mind-mapping)
- ☐ **Mapping & geo-design** (e.g. Participatory GIS; community-drawn maps)
- ☐ **Modelling & scenario analysis** (e.g. computer-based, future projections of land use)

Why? / Remarks

_____

_____

_____

_____

Q3.4 How do you judge your personal familiarity with the above-mentioned tool categories ?
(Please express your familiarity with 0=Not familiar; 1=a bit, but insecure; 2=fair; 3=very good/secure in application)

- ☐ **Opinion-gathering and survey techniques** (e.g. Delphi method; online & social media fora)
- ☐ **Group discussion tools** (e.g. World Café; Focus groups; etc.)
- ☐ **Visualization & Hands-On** (e.g. Serious board games; Metaplan method)
- ☐ **Mapping & geo-design** (e.g. Participatory GIS; community-drawn maps)
- ☐ **Modelling & scenario analysis** (e.g. computer-based, future projections of land use)

Q3.5 Which of the following statements do you feel best describes your needs regarding the tools contained in the Toolbox?

In our specific situation,…

- ☐ …we need tools that can be applied in an easy manner, with small material input only (e.g. flipcharts, moderation cards, pens, no internet connection dependency…).
- ☐ …we need advanced tools with higher material input, e.g. also with special software or GIS.
- ☐ …the complexity of the task calls for sophisticated tools for which we will need training or an external expert for application.

Remarks

_____

_____

_____

_____

Q3.6 Who is supposed to apply the tools at your case site?

- ☐ I am supposed to apply the tools by myself. It is part of my task as facilitator.
- ☐ A team colleague of our organization will apply the tools.
- ☐ We intend to externalise the stakeholder involvement processes to an external expert possessing the necessary skills.

Remarks

_____

_____

_____

_____

Q3.7 If you envision the "perfect PHUSICOS Toolbox" for your case site, what should it contain – and what not?

Useful contents would be…. Unnecessary contents would be…..

Thank you very much for your cooperation!

A2 Semi-structured Interview Guideline for Tool Demand Assessments with Experts

FACILITATOR ORIENTATION DAY – NAPLES, 13th Nov, 2018
CONSORTIUM MEETING PHUSICOS – NAPLES, 14th-15th Nov, 2018

FACILITATOR & EXPERT CONSULTATION ON DEMANDS CONCERNING

STARTER TOOLBOX FOR STAKEHOLDER KNOWLEDGE MAPPING TO CO-DESIGN NATURE-BASED SOLUTIONS AT CASE STUDY SITES

INTERVIEW GUIDELINE: VERSION FOR EXPERTS

elaborated by: MSc candidate Chelsea Jones and Sandra Fohlmeister (TUM)

Background information on the project context
PHUSICOS, meaning 'According to nature', in Greek φυσικός, is a four-year Innovation Action project that started in May 2018 and is funded by the European Union's Horizon 2020 research and innovation programme (Grant agreement No. 776681). The project consortium comprises 15 organizations from 7 countries (Norway, Germany, Austria, Italy, France, Spain and Andorra) and includes end-user partners from local and regional administrative units. The main objective of PHUSICOS is to demonstrate that nature-based or nature-inspired solutions (NBSs) for reducing the natural hazard induced by extreme weather events in particularly vulnerable areas such as rural mountain landscapes are technically viable, cost-effective and implementable at regional scale.
Multi-stakeholder participation is an overarching issue of PHUSICOS and, as such, forms a foundation to foster innovation at all levels and at all case study sites. Specifically, Work Package (WP) 3 (Service innovation – Stakeholder participation through Living Labs) is dedicated to employ a Living Lab approach as key mechanism of local stakeholder involvement for the purpose of successfully accompanying the intended NBSs' selection, design, planning, implementation and evaluation.

Interview objective
In the pursue to support the local case study sites in the initiation of participatory processes and the set-up and further work of Living Labs, WP3 is currently about to compile a Toolbox (=D3.2), which shall contain useful tools to be applied by the local facilitators of the Living Labs to capture local stakeholders' knowledge for selecting, co-designing, implementing and evaluating the planned NBSs.
To achieve this usefulness and applicability of the Toolbox to the desirable extent, WP3 relies on your feedback. The elicitation of your expertise in similar fields of application as well as your personal viewpoint concerning the local case sites' needs, expectations, but also possible limitations concerning the intended tool application will be highly relevant and helpful to be able to compile the "right mix" of Tools by WP3. All ideas and comments are thus warmly welcomed.

Hints on Interview proceedings
This Interview guideline is intended to be completed jointly and interactively with the in-person interview. However, if time does not allow for its completion within the interview, please fill in the remaining parts according to instructions given for each question and return it by 19th Nov, 2018 to team TUM.

For further questions or comments regarding the interview process, please feel free to contact us.

Thank you for your time and participation!

Part 1: Personal Data on Interviewee

Q1.1 Name of Interviewee:

_____

Q1.2 Relationship of Interviewee to the PHUSICOS project (Work Package(s); Role; Tasks, etc.)

_____

_____

_____

Q1.3 Organization of Interviewee:

_____

_____

_____

Q1.4 Position of Interviewee:

_____

_____

_____

Q1.5 Professional background and main fields of expertise of Interviewee:

_____

_____

_____

_____

Q1.6 Years of expertise of Interviewee in PHUSICOS-like contexts (e.g. stakeholder participation; Living Labs; DRR):

_____

_____

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_____

Part 2: Stakeholder Involvement in the framework of co-designing NBS in PHUSICOS

Q2.1 Have you already made experiences with stakeholder involvement in PHUSICOS-like contexts (rural, mountain areas, NBS, Disaster risk reduction)? If yes, could you please describe your most relevant experiences? (Positive/negative results/ barriers / important lessons for PHUSICOS?)

_____

_____

_____

Q2.2 How do you personally judge the capacity for stakeholder involvement at each of the case sites of PHUSICOS?
(Please express your judgement with 0=I disagree; 1=I'm not sure about it; 2=I agree; 3=I fully agree)

☐ There is capacity to involve stakeholders on information level.

☐ There is capacity to involve stakeholders on consultation level.

☐ There is capacity to involve stakeholders on active cooperation level.

☐ There is capacity to involve stakeholders to the maximum possible extent and create ownership for the NBS.

Could you please give arguments for your judgements? (You may also differentiate by Case sites!)

_____

_____

_____

_____

Q2.3 In which stage(s) of the NBS innovation cycle do you feel stakeholder involvement is most needed at the case sites of PHUSICOS? Why?
(Please express the necessity with 0=Not intended; 1=not very necessary; 2=somewhat necessary; 3=Very necessary)

☐ Stakeholder involvement for NBS exploration.

☐ Stakeholder involvement for NBS selection.

☐ Stakeholder involvement for NBS planning / co-design.

☐ Stakeholder involvement for NBS implementation.

☐ Stakeholder involvement for NBS evaluation / up-scaling.

Remarks_____

_____

_____

_____

Q2.4 Based on your experience: What socio-cultural factors, if any, do you feel may have an effect on the case sites' stakeholder involvement processes (= toolbox application, co-design of NBS)**?**

Please list those you find most relevant and explain.

Q2.5 Do you feel that any of the following factors may influence the stakeholder interaction and co-design processes as well as the toolbox usage at the PHUSICOS case sites?

Factor a: ***The case site is located in a MOUNTAINOUS area.***

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

If so, how? – and what does this mean for the design of the related stakeholder involvement processes?

Factor b: ***The case site is located in a RURAL area.***

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

If so, how? – and what does this mean for the design of the related stakeholder involvement processes?

Factor c: ***Involvement of certain economic sectors (e.g. agriculture) in the stakeholder set-up***

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

If so, how? – and what does this mean for the design of the related stakeholder involvement processes?

Part 3: Tools – judgement of desired outputs and recommended tool types

Q3.1 What experiences with the application of tools/toolboxes for stakeholder involvement have you had in your hitherto project work? Could you please describe which tools/toolboxes you have most often used in PHUSICOS-like contexts, and for which purposes?

Q3.2 From these experiences, what would you say are most relevant lessons learned related to PHUSICOS?

Q3.3 Which purposes of the PHUSICOS Toolbox do you regard to be most relevant for the case sites?
(Please express the importance with 0=Not intended; 1=not important; 2=somewhat important; 3=very important)

- ☐ Use tools **to identify relevant stakeholders** who are needed for the NBS implementation.
- ☐ **Explore opinions** and worldviews of stakeholders (e.g. explore the acceptance of NBS).
- ☐ Elicit **knowledge contributions** of local stakeholders which are needed for the realization of the NBS (e.g. by local experts, etc.)
- ☐ Use tools to **foster the group cooperation** of different stakeholders (e.g. create a good team spirit for NBS)
- ☐ Use tools to **make decisions** in complex multi-stakeholder settings (e.g. to select or compare NBS options)
- ☐ Use tools to **measure the efficiency** of NBS and monitor them in a participatory manner.

Any other purposes you think are of relevance to achieve by the use of the PHUSICOS Toolbox?

_____

_____

_____

_____

_____

Q3.4 The following table illustrates tools that have thus far been highlighted as potentially useful for inclusion in the Toolbox recommendations for PHUSICOS facilitators. For each tool, please rate their applicability to the PHUSICOS context, according to your knowledge and experience, on a scale from 1-3.
(0= don't know; 1 = not applicable or useful, 2= somewhat applicable or useful, 3 = highly applicable or useful)

Tool's Name	Rating			
	Don't know	Not applicable or useful	Somewhat applicable or useful	Highly applicable or useful
Discourse Analysis				
Interest-Influence-Matrix				
Q Methodology				
Social-Network Analysis (SNA)				
Stakeholder-led stakeholder categorization				
Venn Diagram				
Yellow Pages				
4R Framework				
Consensus Conference				
Delphi Technique				
Flow Diagram				
Force Field Analysis				
Future Search Conference				
Fuzzy Cognitive Mapping (FCM)				
Geo Timeline				
Multi-Criteria Decision Analysis				
Multiple Perspectives Wheel				
Open Space Technology (OST)				
Participatory GIS & Geo-Design				
Participatory Scenario Planning				
Pebble Distribution				
Serious Board Games				
Sketch Hazard Mapping				
Social Media Forums				
Streamline				

Story Wall				
Transect				
What's Your Agenda?				
World Café				

Q3.5 Which of these tools do you feel are especially useful for the PHUSICOS context, and why?

_____

_____

Q3.6 Which of these tools, if any, would you strongly advise against for the PHUSICOS context, and why?

_____

_____

Q3.7 Would you like to add any tools, which you regard as useful to the PHUSICOS context, but which are not part of the list of tools provided in Q3.4?

Q3.8 Of these ideal tools previously provided, what would you define as the most realistic or feasible tools that could be used by the case study sites of the PHUSICOS project, and why?

Q3.9 Which tools would you especially recommend to be used at…

DC Gudbrandsdalen

_____

DC Pyrenees

_____

DC Serchio River Basin

_____

CC Kaunertal

_____

CC Isar

_____

Part 4: Challenges to Tool application and ways to overcome

Q4.1 What challenges, if any, do you see affecting the application of stakeholder involvement tools in PHUSICOS?

Q4.2 How would you judge these potential barriers, and which ways do you recommend to overcome them?

Q4.3 Which topics should be paid special attention at the different case study sites, and why?

Case study site Gudbrandsdalen/Norway:

Why?

Case study site Serchio River Basin / Italy

Why?

Case study site Pyrenees / Spain-France

Why?

Case study site Kaunertal / Austria

_____

_____

_____

Why?

Case study site Isar / Germany

_____

_____

_____

Why?

Q5 Any further remarks, recommendations or hints you'd like to add?

THANK YOU FOR YOUR COOPERATION!

Appendix B

Outline of the Tool Corner exercise with Facilitators (Naples, November 2018)

Contents

B1 Outline of the Tool Corner Exercise with Facilitators 2

CLUSTER 1: TOOLS FOR STAKEHOLDER IDENTIFICATION & ANALYSIS

Tool's Name	What is it?	Familiarity with the tool			Further Interest
		I don't know it	I know it	I can apply it	I would like to learn more about it
Discourse Analysis	Discourse analysis can help distil contested views and frames among interest groups or advocacy coalitions, sometimes due to their different worldviews, in conflict situations. It can also describe the regime of truth that exists in interest groups which can privilege certain types of knowledge.				
Interest-Influence-Matrix	Uses a four quadrant diagram to assist in stakeholder identification and organization. The four quadrants relate to how stakeholder groups could be involved. Sticky notes or cards with each stakeholder name can then be added to each quadrant, with those placed farthest from the centre representing the extreme of each category.				
Q Methodology	Method which can be employed to group, weight or rank stakeholders or topics. The categorization of stakeholders or topics is based on an empirical analysis of stakeholder perceptions. Also discussions and discourses can be analysed and both diverse and shared perceptions can be identified.				
Social-Network Analysis (SNA)	SNA uses several methods to analyse and quantify social networks systematically to				

	understand complex networks. The aim is to describe the relative position of stakeholders in a network. Can be a powerful tool assessing stakeholder systems, roles, power distributions and also demonstrate changes over time.				
Stakeholder-led stakeholder categorization	Stakeholders categorize stakeholder groups themselves, e.g. by sorting cards with names or institutions according to own created criteria, along a gradient to show who benefits from NBS solutions most. For this categorisation task, also more sophisticated tools for sorting can be applied, for example Q-Sort techniques.				
Venn Diagram	An easy-to-use visual tool that helps participants to explore social relationships between stakeholders or find common ground. Normally, overlapping circles or other shapes are used to visualize the logical relationship between two or more sets, which helps to demonstrate where sets show differences and similarities.				
Yellow Pages	A simple and basic method for mapping stakeholders and knowledge. Like in a telephone directory, it enables to identify the location of knowledge that is needed for specific purposes. The main components are expertise and options on how to contact the respective persons that can be collected on lists or databanks.				

4R Framework	Tool assessing stakeholders' roles and resilience which tries to analyse the balance or imbalance of stakeholders using four "Rs": respective rights, responsibilities, returns, and relationships. When used in group settings, the four Rs serve as a facilitation tool to help different stakeholders negotiate their respective roles.				

CLUSTER 2: TOOLS FOR PARTICIPATORY NBS INNOVATION DEVELOPMENT: PHASES: NBS EXPLORATION; SELECTION; CO-DESIGN; EVALUATION

Tool's Name	What is it?	Familiarity with the tool			Further Interest
		I don't know it	I know it	I can apply it	I would like to learn more about it
Consensus Conference	This group discussion technique focuses on integrating a representative set of citizens as jurors in complex policy or planning issues. It is highly structured, requiring a week of deliberation in which citizens choose expert witnesses to call to give information, on which judgements and opinions are then formed.				
Delphi Technique	Survey technique suitable for expert consultation comprising four rounds of iterative questionnaires sent out to stakeholder groups. Each round is compiled into a feed-back report and resent to the stakeholders. In this way, judgements are enabled based on own and other participants' opinions anonymously recorded.				
Flow Diagram **Causal Diagram** **Cause & Impact Diagram** **Problem Tree** **Resource Flow Diagram** **Systems Diagram**	Stakeholder Knowledge Mapping tool which offers alternative ways to represent cause-impact relationships and processes.				
Force Field Analysis	A diagram used to identify forces for or against an intended change. The main forces, for and against, are separated on left and right sides, which can be done with a pre-drawn diagram				

	or interactively with sticky notes. These are then assigned strengths (1-5) depending on their level of influence. The resulting values on each side measure the relative inertia for or resistance towards the issue at stake.				
Future Search Conference	This is a framework for group discussion scheduled over a three-day period with different phases conducted in each day. This framework combines various other tools, such as timeline and mind mapping, to get a large cross-section of stake-holders in one room and discuss "the future of..." the topic at hand. As it focuses on the future, it is useful in clarifying what the shared vision should be among stakeholders.				
Fuzzy Cognitive Mapping (FCM)	FCM represents knowledge by defining three characteristics of a system: i) system components; ii) positive or negative relationships; iii) degree of influence that one component can have on another. The analytical mechanics of FCM are based on examining the structure and function of concept maps, using graph theory-based analyses included in a model. These can be used to examine perceptions of an environmental or social problem or to model a complex system where uncertainty is high and little empirical data available.				
Geo Timeline	A tool using a web-based map where stakeholders can collectively pool local				

	knowledge regarding historical changes in topography, infrastructure, and values of place, both tangible and intangible. Stakeholders can add events and points along the timeline and enter additional information regarding why the change was important.				
Multi-Criteria Decision Analysis (MCDA)	Method used to compare multiple options on the basis of several criteria at once. This is particularly useful to evaluate several policy options with stakeholders. Collaborative processes can be used both to define the criteria, as well as to score the options according to them.				
Multiple Perspectives Wheel	In this technique a central topic is discussed and written on a card. Cards are then distributed to each stakeholder indicating which perspective they should take on based on other stakeholders to be considered. Participants then verbally comment on the topic at hand, thinking from the perspective assigned to them. This is repeated for several rounds until all stakeholders have been addressed.				
Open Space Technology (OST)	Participants in this group discussion technique self-identify important themes for discussion and then utilize separate rooms or circular seating formations to discuss each theme, freely moving among the different themes. Notes are kept, and compiled at the end into a plenary discussion and comprehensive report.				

Participatory GIS (PGIS) & Geo-Design	PGIS refers to the creation and modification of both 2D and 3D models of landscape changes by participating stakeholders. For this tool, access to GIS software is necessary. It can also be combined with physical methods, such as digitizing citizen drawn maps and combining them with the help of GIS.				
Participatory Scenario Planning (PSP)	PSP combines quantitative models on issues such as land use and natural processes with narrative methods that can help stakeholders to visualize how landscapes on infrastructure may look and change under various future conditions. Using PSP requires access to data, knowledge of implementing quantitative models, and computer software that can allow for extrapolation and visualization of the data.				
Pebble Distribution	Pebble distribution is a flexible diagnostic scoring procedure that clarifies both the understandings and the priorities of the participants. It can be applied for several situations, e.g. to preselect NBSs. The tool is suitable for weighting or ranking of issues but does not draw relations between items. It can also serve to generate information about stake-holder preferences for uses in more complex tools such as MCDA.				
Serious Board Games	Games which help to facilitate dialogue among stakeholders and allow them to see an issue from various perspectives by "gamifying" the experience				

	using a traditional board game format.				
Sketch Hazard Mapping, also: **Social Mapping** **Resource Mapping** **Hazard Mapping** **Sketch mapping**	These types of maps relate a geographical area with an inventory of social features, resources or vulnerability perceptions. May be drawn by hand or with the help of aerial photographs. Sketch mapping was conducted e.g. in the Alpine region of Switzerland to visualize stakeholders' knowledge on natural hazards.				
Social Media Forums	Groups on social media networks where both organizers and stakeholders can post and answer to each other's questions, media can be shared and opinion polls can be generated in an easily accessible manner for all involved parties. Additionally, different social media platforms can reach different types of stake-holders.				
Streamline	Scientific interview tool using graphics and templates in a storyline format with cartoon type illustrations. Different card sets are provided for different types of problems and topics. Participants answer questions on the canvas using graphics and explain their ideas to other members. It is useful for collecting visions from many participants and facilitating dialogue.				
Story wall	This tool is used to retrospectively look back on progress made and key events in the collective story of a co-design group. A horizontal timeline is drawn on a poster or flipchart, and participants				

	jointly mark important events and turning points in the order they occurred, thereby outlining a "joint-story".				
Transect	A transect walk is a systematic walk along a defined path across a project area together with the local stakeholders to explore the issue at stake by observing, asking, listening, looking and producing a transect diagram. It is normally conducted during the phase of exploration and might be a means of participatory problem analysis and rapport-building. The information collected during the walk is used to draw a diagram or map based on which discussions are held.				
What's your Agenda?	This is an illustrated template that encourages participants to identify what they would consider to be both the best-case and worst-case scenario for a particular project, and then identify ways to avoid or achieve these scenarios. It can be completed using words and drawings, and is intended to be interactively discussed among participants.				
World Café	Group discussion format focused on general know-ledge co-production and sharing. Multiple tables are set up and participants are divided among them. At regular intervals, partici-pants are told to move to the next table. Useful for initial stakeholder processes, such as building consensus and a shared knowledge pool.				

CLUSTER 3: **FURTHER TOOLS: ROOM FOR YOUR IDEAS, DEMANDS, INTERESTS…**

FACILITATOR ORIENTATION DAY: Tool Corner

To support the local case study sites with initiating participatory processes and further work of their Living Labs, WP3 is currently compiling a Toolbox, which shall contain useful tools to be applied by the local facilitators of the Living Labs to capture local stakeholders' knowledge for selecting, co-designing, implementing and evaluating the planned nature-based solutions (NBSs).

Objective of the Tool Corner

To achieve this usefulness and applicability of the Toolbox to the desirable extent, WP3 relies on your feedback. We have prepared a preliminary set of participatory tools that you find on the presented sheets in the Tool Corner. To further elaborate the Toolbox, it would be helpful for us to get an idea of how familiar you are with these tools.

Instructions for the Tool Corner

The Tool Corner is subdivided in the two groups of tools which are given in alphabetical order.
Cluster 1 presents tools for S*takeholder identification and analysis*, Cluster 2 lists tools for *Participatory NBS innovation development*; Cluster 3 offers room for your own ideas.

How familiar are you with the listed tools in the Tool Corner? Please provide us with your anonymous feedback on this question **by applying one of the provided glue dots in the field that indicates your level of familiarity**.

Another glue dot can be applied in the last column **in case you want to learn more about the specific tool** during PHUSICOS.

Any **other Tools are of interest** or importance to you, which are not included in the list? Please **write down your ideas** on the white sheet.

Many thanks for your help!