EVOKED

Enhancing the value of climate data

Deliverable D5.4

EVOKED Framework methodology guide

Work Package 5

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Summary

The EVOKED framework methodology places the end-user in the center as the driver of the co-creation process to ensure that the needs, wants, and limitations of a potential product or service are placed at the forefront. Furthermore, the framework places an emphasis on integrated transdisciplinary research that creates a bridge between the end-user (in the center) and climate knowledge providers through translators who operate within climate sensitive sectors (e.g. water management, disaster risk reduction and coastal management) and have experience in facilitating stakeholder dialogue.

This guide presents the tasks and provides supporting templates for each of the four steps in the framework methodology which reflect the EU's focus on the co-creation aspects of climate services:

- Co-Design places user-needs at the forefront using Living Labs for engaging end-user as a specific group of stakeholders.
- Co-Develop develops visualization tools and climate change scenarios to generate new ideas and encourages knowledge exchange.
- Co-Validate tests assumptions on climate adaptation measures and their implementation using a climate information design approach.
- Co-Evaluate assesses user satisfaction and provides feedback to bridge the process-content gap to improve each step in the framework methodology.

Furthermore, examples of climate services that have been created during the EVOKED project are provided. The examples highlight the application of the framework methodology and the flexibility it provides for tailoring climate services to a specific case or study site.

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Review and reference page

1 Background

1.1 Climate services – translating climate data to knowledge products

Climate services are defined as the transformation of climate-related data into tailored products and services that may be of use for the society at large (EC, 2015). As such, climate services are recognised as an important part of improving our capacity to manage climate-related risks. The problem facing end-users is not a "lack of knowledge", but rather (i) knowing which knowledge to use and when, as well as (ii) knowing how to deal with risks and uncertainties related to different types of climate knowledge. There is a need to engage knowledge providers, users, and translators to identify improvements to climate services through co-design, co-development, co-validation, and co-evaluation. Engaging end-users in this co-creation process is therefore necessary to identify users' needs and develop users' capacities to deliver climate services that are of high quality and relevant to better inform decision-making processes and the resulting decisions (EC, 2015). The EVOKED framework methodology aims to minimise this gap in truly being able to translate climate information into products that are both useful and usable.

1.2 End-user knowledge and needs as the driver

The EVOKED framework methodology, illustrated in Figure 1, places the end-user in the center as the driver of the co-creation process to ensure that the needs, wants, and limitations of a potential product or service are placed at the forefront. Furthermore, the framework places an emphasis on integrated transdisciplinary research that creates a bridge between the end-user (in the center) and climate knowledge providers through translators who operate within climate sensitive sectors (e.g. water management, disaster risk reduction and coastal management) and have experience in facilitating stakeholder dialogue. The four steps in the framework methodology reflect the EU's focus on the co-creation aspects of climate services recognising the need to translate existing climate knowledge (observations, forecasts and predictions, operational products), and thus add value to the climate service while also generating synergy and innovation with the final result greater than the sum of its parts:

- Co-Design places user-needs at the forefront using Living Labs for engaging end-user as a specific group of stakeholders (SGI, 2018).
- Co-Develop develops visualization tools and climate change scenarios to generate new ideas and encourages knowledge exchange.
- Co-Validate tests assumptions on climate adaptation measures and their implementation using a climate information design approach (see Chapter 4.1).
- Co-Evaluate assesses user satisfaction and provides feedback to bridge the process-content gap to improve each step in the framework methodology.

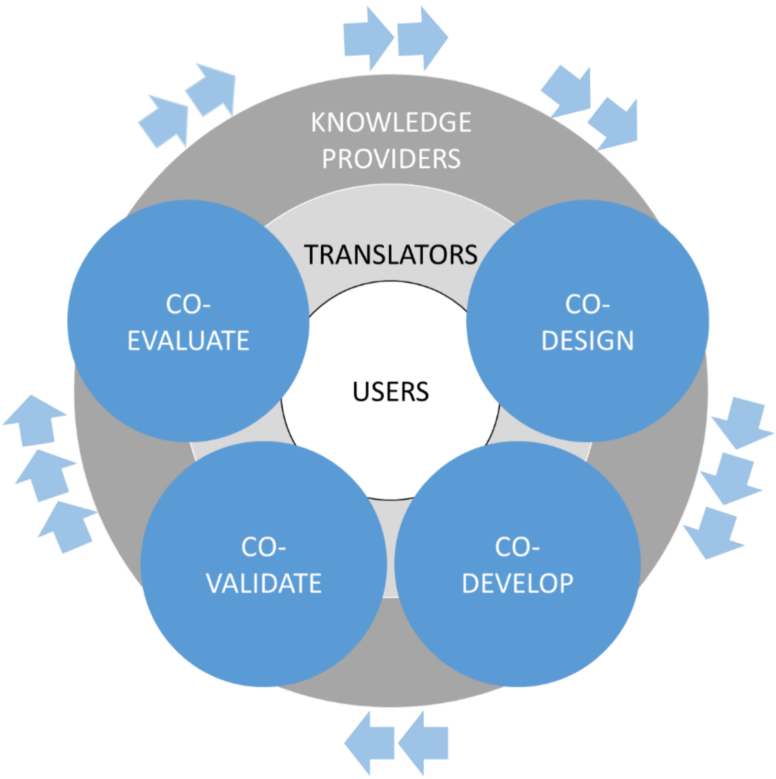

Figure 1. Conceptual model of the EVOKED framework methodology.

2 Co-Design with Living Labs

2.1 Characteristics and principles of Living Labs

Living Labs have been emerging as a form of collective governance and experimentation to address societal challenges and opportunities on many subjects for example urbanization, climate change and health. Living Labs have different goals, they are initiated by various actors, and they form different types of partnerships. Although there is no uniform Living Lab definition, the EVOKED framework methodology has established a common understanding of what a Living Lab is and how it is bound in time and space, "*…to involve a range of committed stakeholders in real-life 'laboratory' settings to test and develop alternative solutions for complex challenges, such as climate adaptation or risk and uncertainty assessments*." (SGI, 2018).

Keeping this open definition of Living Labs is advantageous as it provides room for the Living Lab to be an ongoing and iterative process. As such, it is much more than just a workshop, but are rather a collection of activities within a given time frame with the participation of various stakeholders in several events, workshops, interviews and forums for testing concepts and producing a climate service (see Figure 2). Furthermore, it allows for flexibility as Living Labs will differ depending on the climate service that is produced, the project issue at hand, the people involved and the context (geographical, social, and institutional).

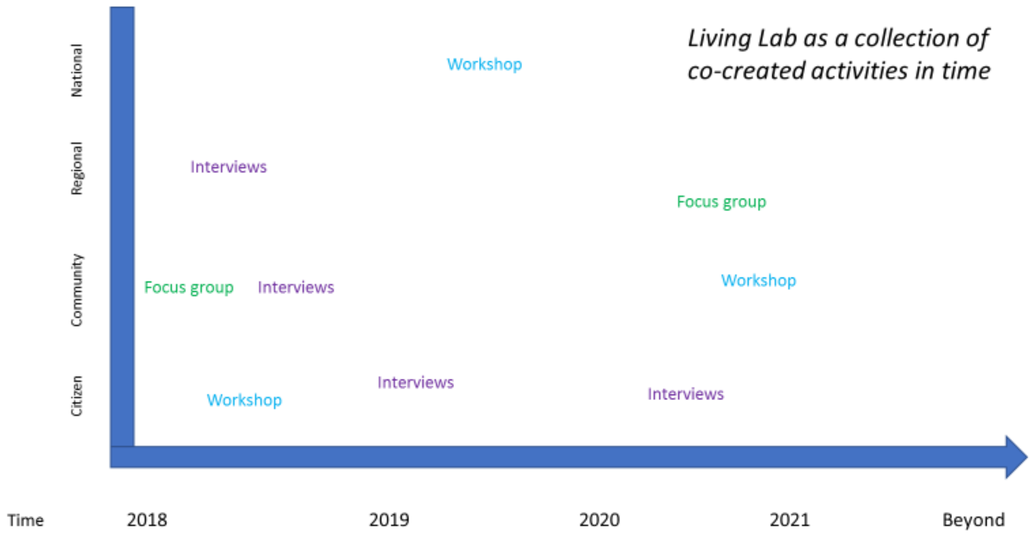

Figure 2. Example of a Living Lab as a collection of co-crated activities in time (SGI, 2018).

However, more important than the definition is the ability of Living Labs to be operationalised in practice. Therefore, the EVOKED framework methodology recommends that Living Labs established for the co-creation of climate services, include the following characteristics:

- Geographical embeddedness
- Bounded in time
- Experimentation and learning in real life setting
- Multi-method approach
- Participation and multi-stakeholder involvement
- Leadership and ownership
- Evaluation of actions and impacts
- Progress towards the production of a climate service

Further to characteristics are key principles that can guide how Living Labs are practiced as shown in Table 1.

Table 1. Key principles of Living Labs (LL) in the EVOKED framework methodology (SGI, 2018).

Key Principle	Description
Continuity	• build on existing networks and actions for climate services • focus on long-term learning and trust as an output of the LL • be willing to work in small steps, but realise the urgency of some end-users • as far as possible, plan for the “institutionalization” or continuation of the climate service after the end of the project • as far as possible, strive for resulting products and processes that can be transferrable to other cases and settings • motivate stakeholders to continually share their knowledge
Openness	• create atmosphere of transparency • involve all relevant stakeholder groups and strive for a balance among ages, gender, culture, socio-economic positions • share information and insights with partners within the LL • help make sense of the uncertainty and risk associated with climate adaptation actions • provide platforms for knowledge co-production and learning about the role of climate services
Realism	• be sensitive and link to the relevant policy, governance, environmental, and social-economic contexts of the LL area • base climate service work on actual identified needs • coordinate timing of LL actions with other relevant milestones in the area (elections, planning documents, etc.) • take into consideration the available financial, human, and environmental resources (limitations and opportunities) • facilitate sustainable innovations and test climate services in real settings • strive for optimism, while maintaining realistic expectations
Influence	• encourage ownership of the process and climate service produced • connect stakeholders from various sectors and competences to work towards societal resilience • set up clear communication channels • find ways to make the LL and climate services attractive to politicians and citizens • ensure that actions and learning are two-way, and that stakeholders can contribute to the development of climate services
Value	• clarify the added value of the climate service for the prospected end-user and stakeholders – provide incentives to participate • make involvement of stakeholders cost-effective, attractive and fun • avoid the need for stakeholders to commit long hours and travel for workshops • provide concrete and measurable outcomes • ensure outcomes are framed simply and in non-academic language to be usable for stakeholders • find innovative communication channels other than reports (videos, other media, arts, etc.) • raise awareness of climate services for politicians and citizens
Sustainability	• build on existing local and epistemic knowledge of risk and uncertainty • ensure that climate services produced are ecologically, socially, and environmentally sustainable • strive for sustainability in project operations (avoid unnecessary travels, choose sustainable alternatives)

2.2 Tasks in the Co-Design process

Establishing the Living Labs is the first step in the EVOKED framework methodology Co-Design process. This first step provides flexibility such that a Living Lab can be designed according to its own preconditions. Within this flexibility, specific tasks have been identified as essential for the Co-Design of climate services and include; i) a stakeholder analysis, ii) a needs and visions analysis, and iii) a context/governance analysis (SGI, 2018).

2.2.1 Stakeholder analysis

Stakeholder involvement and participation are at the core and in all stages of most Living Lab processes (Voytenko et al., 2016). Therefore, the first task in the Co-Design process and to establish the Living Labs is to conduct a stakeholder analysis. In general, a stakeholder is characterised as any person who has a "stake" or interest in a policy question. This is a very broad category and includes both persons involved in making a decision and those affected by it (e.g. politicians, planners, administrators, home owners, knowledge providers, users, and end-users of a service, as well as private interests, civil society, and citizens of all ages). A stakeholder analysis ensures that all relevant stakeholder groups are identified and mobilised in accordance with their needs (stakes), interests, and influence (Chinyio and Olomolaiye, 2010).

Stakeholders are identified through discussions with relevant end-users (e.g. municipal representatives) and interviews, utilizing a snowballing technique, whereby identified stakeholders in turn helped to identify additional stakeholders. The goal is to identify as many stakeholders as possible (individual/group/organization) for different categories that are relevant for the case or study site in order to have a comprehensive overview. Table 2 suggests several general stakeholder categories as a guide.

Once a stakeholder is identified, their key interests in relation to the case or study site are briefly described. Then, a preliminary assessment of each stakeholder is conducted by providing a value for their influence and their interest. Influence refers to the amount of power, in any form, that a stakeholder can mobilise. For example, an interest group or non-governmental organisation may be able to mobilise media or organise a lobby to exert pressure at the political level. Interest refers to how interested the stakeholder is in the issue. For example, a landowner may have a lot to potentially gain or lose with a climate service developed for a specific study site. Alternatively, a stakeholder may be very interested in an issue for reasons that are not personal, but that refer to a collective or societal good.

The completed stakeholder analysis provides a point of departure for contacting selected stakeholders based on the Living Labs and the climate challenges to be addressed. The stakeholder analysis (Table 2) is also meant to function as a "living" document that should be updated throughout the Living Labs process.

Table 2. Stakeholder mapping template for suggested stakeholder categories (add additional lines as needed) as used in the EVOKED framework methodology (SGI, 2018).

STAKEHOLDER (name and role/position)	**CONTACT INFO** (telephone and/or e-mail)	**KEY INTEREST**	**INFLUENCE** Very high = 4 High = 3 Low = 2 Very low = 1	**INTEREST** Very high = 4 High = 3 Low = 2 Very low = 1
Government: local-regional				
Government: national				
Business/Industry *(i.e. developers, insurance agencies, tourism)*				
Interest groups: local-regional *(i.e. fishing org., landowner org.)*				
Interest groups: national				
Politicians: local-regional				
Politicians: national				
Citizens				
Technical experts *(e.g. consultants, research organisations and initiatives)*				
Media *(i.e. journalists, newspapers, television broadcasts)*				
Other *(i.e. tourists)*				

2.2.2 Needs and visions analysis

As work with climate adaptation does not occur in an institutional vacuum, it is important to understand how needs for climate data fit into the wider societal needs and visions of each case. Thus, the general needs and visions need to be taken seriously, to ensure empowerment of stakeholders (Bergvall-Kåreborn and Ståhlbröst, 2009) and to be able to discern any explicit or implicit tensions among the needs and visions (Martin et al., 2018). One of the challenges with climate services is bridging user needs with the science capability, to provide customised service and tools to make robust adaptation decisions. It is suggested that climate services should rather be of the concept of 'usable' information (what users recognise as useful in their decision-making), than 'useful' information (for example what scientists understand as information that could be useful) (Lemos et al., 2012). Information can go from useful to usable as it is translated, communicated and/or transformed to meet the users' perceived needs (SGI, 2019).

A guiding list of questions is recommended to help identify user needs and visions. The responses to these questions can be collected through a variety of methods depending on the local context (e.g. interviews or focus groups) and the preferences of the end-user representatives. One point to note is that the guiding questions do not focus on a climate service, but rather begin with visions to first understand needs as the basis for the subsequent development of climate services:

- What are the (different) long-term and short-term visions of a sustainable, resilient society?
- How are these different from the situation today?
- How is the risk perceived and understood within these visions?
- Are the visions desirable for everyone? Are there any concerns about them?
- What types of development paths would be useful to achieve the visions? How are the visions linked to actions?
- What is the expected benefit/added value to the community of the vision?

2.2.3 Context and governance analysis

Climate adaptation is an issue with strong spatial or "territorial" issue implications (Schmitt and Van Well, 2016) and spans various administrative levels, sectors and stakeholders (Forino et al., 2015). Climate adaptation work must also be adaptable to shifting organizational contexts and is highly dependent on data of spatial impacts such as flood analysis or climate scenarios risk assessments (Van Well et al., 2018; Renn, 2008). Therefore, the Co-Design process includes an additional task of conducting a context and governance analysis to understand how flexible administrative arrangements are adaptive to and learn from changing contexts, and how place-based specificities and evidence-based knowledge arguments complement local knowledge.

This task includes the description of the physical context (e.g. geology, topography, coastlines and river catchments), the socio-economic context as well as the territorial governance context with five main dimensions: i) coordinating the actions of actors and institutions, ii) integrating policy sectors, iii) mobilizing stakeholders, iv) being adaptive to changing contexts, v) realizing place-based / territorial specificities and impacts. A template for the context and governance analysis is provided in Appendix A.

This goal of the questions is to document the context and governance aspects in which the Living Labs and provision of climate services takes place. In doing so, we will better be able to identify the challenges and opportunities associated with providing the Living Lab and help to ensure that Co-Design activities are sensitive to the specific contexts within a specific case or study site.

3 Co-Develop and visualisation

The EVOKED Co-Develop process builds on the outcomes of the Co-Design process and provides additional background information and content. As such, Co-Develop focuses on developing local socioeconomic scenarios as well as visualization tools using an approach that encourages knowledge exchange. Such an educative approach helps participants to value each other's input better, which increases the legitimacy of the choices made during the process.

3.1 Local socioeconomic scenario co-development

The co-development of local socioeconomic scenarios provides an opportunity for end-users to consider future climate change impacts using new predictive scenario methods. These scenarios constitute an important component for assessing the risks that climate change impacts may pose to the local populations. This exercise is based on the Shared Socioeconomic Pathways (SSPs) framework used in climate impact research using five possible pathways for society and society-influenced systems to evolve (SSP1 Sustainability, SSP2 Middle of the road, SSP3 Regional rivalry, SSP4 Inequality, SSP5 Fossil fuelled). They have been developed on global to regional scales based on socioeconomic challenges for mitigation and adaptation (Figure 3).

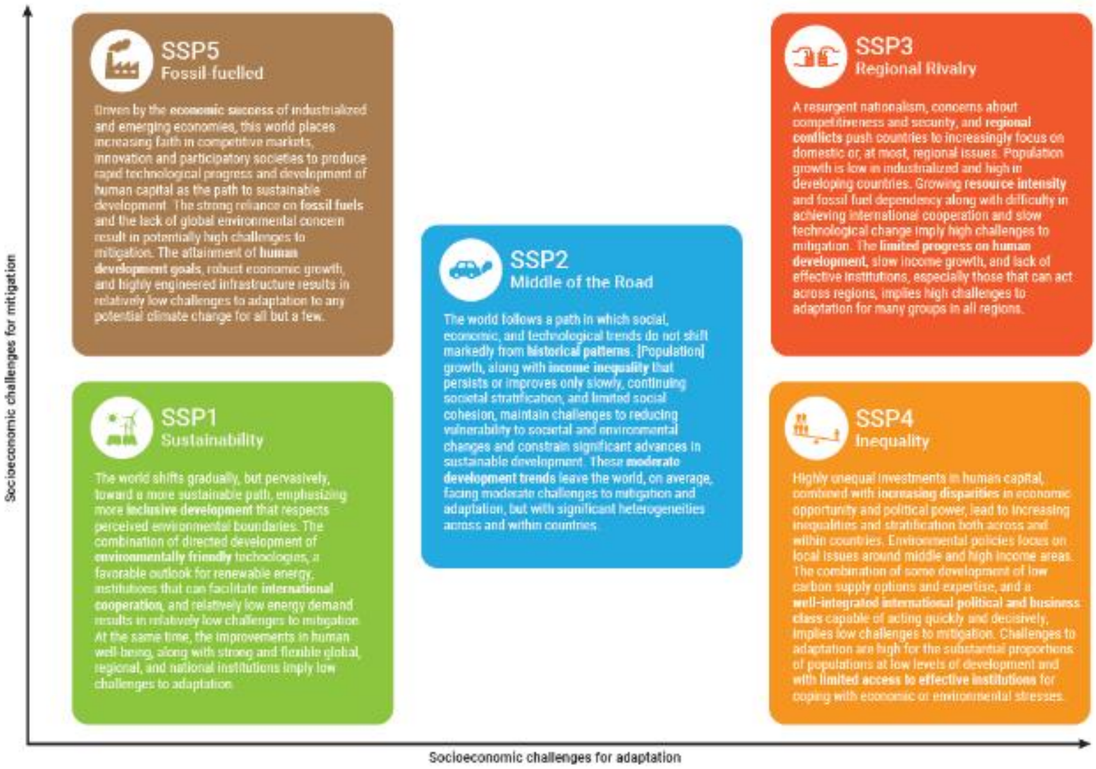

Figure 3. The five SSPs with excerpts of the global SSP narratives and their challenges for mitigation and adaptation (CAU, 2019a and based on O'Neill et al., 2017).

The global SSP elements are downscaled to the local scale in order to create local narratives (CAU, 2019a; Reimann et al., 2021). Six steps are identified for downscaling and developing relevant local scenarios.

Step 1: Determine global scenarios as boundary conditions

When drafting local-scale socioeconomic scenarios, it is important to not only account for local developments, but also to consider that each case study is embedded in developments at different spatial scales, ranging from global to European, national and regional levels. Therefore, the global-scale SSP narrative elements are adopted and used as a starting point for the local scenarios.

Step 2: Establish local scenario elements

To establish local scenario elements that are important drivers of societal development, one should review the locally relevant literature from the local and regional administrations (e.g. planning documents) and data available from statistics offices. Important elements to consider are: demographics, human development, economy and lifestyle, policies and institutions, technology and the environment (see Table 3). Some guiding questions that are useful to address include:

- What are recent population trends?
- What are the major issues of political and socioeconomic importance and/or concern in the case study region? (the Co-Design context and governance analysis is helpful)
- How are local politics embedded in regional, national and global politics?
- Which global SSP elements are most relevant for the case or study site?

Step 3: Determine plausible future developments of each scenario element

Select the most relevant SSP-scenarios and for each scenario, describe future characteristics for each of the elements established in Step 2. Brief descriptions are documented in the local scenario template as illustrated in Table 3.

Step 4: Draft scenario narratives

Create full-text narratives for each scenario based on the characteristics in each scenario. The narratives (‘storylines’) add further context to the scenario elements with the aim to facilitate stakeholders’ understanding of each scenario.

Step 5: Facilitate feedback and discussion with local stakeholders

Discuss the first draft of the narratives with stakeholders in the Living Labs to guarantee plausibility and acceptance of the local scenarios. In addition to the narrative text, other visualization tools can be used in order to improve the understanding of each scenario (e.g. pictures, illustrations, graphs, or comics, see Figures 4-6).

Step 6: Refine scenario narratives based on stakeholder feedback

Revise and refine the narratives based on feedback from the stakeholders. Depending on the end-user needs and the local context, consider additional iterative discussions to further develop the local scenarios.

Table 3. Template for the co-development of local socioeconomic scenarios (CAU, 2019a).

SSP-based scenarios / Global & local elements	*e.g. SSP1*			
DEMOGRAPHICS				
e.g. Population growth	*e.g. High*			
(add rows, if necessary)				
HUMAN DEVELOPMENT				
ECONOMY & LIFESTYLE				
POLICIES & INSTITUTIONS				
TECHNOLOGY				
ENVIRONMENT				

3.1.1 An example of local scenario co-development for Larvik, Norway

The local scenarios for municipality of Larvik were developed based on the five SSPs. For step 1 and 2 relevant literature and data specific to Larvik were reviewed and analysed to investigate challenges and potential trends visible in Larvik today. Three of the global SSP's were chosen, based on discussions with the municipality to select those SSPs having most relevance for Larvik. The SSP's selected included SSP1, SSP2 and SSP3, and plausible future developments were determined within each scenario element in step 3.

SSP1, "Sustainable Larvik", is mainly based on the municipal plans, as land-use plan and energy- and climate plan, as well as relevant strategies and action plans. This scenario reflects the Larvik that is currently planned for the future. SSP2, "Business as usual", is mainly based on relevant strategy documents and knowledge bases, discussing the situation in Larvik today. SSP3, "Regional rivalry", is also based on municipal strategies, but considered more as the scenario that could take place if the strategy "fails". Larvik and its neighbouring municipalities are already preparing for an anticipated centralization process towards the larger cities, especially in the Oslo region. Regional cooperation is therefore an important factor for the future of Larvik. However, if the regional municipalities are not able to compete at the same level as the neighbouring urban metropolitan areas, regional rivalry could result with these municipalities competing amongst one another.

In dialogue with the municipality it was considered important not to develop "doomsday" scenarios, since Norway is a welfare state with quite robust safety net system for its citizens. The municipality did not believe such scenarios would be taken seriously by the stakeholders involved in their ongoing urban development plans (that the EVOKED project is following). Here, legitimacy was an important concern for the municipality and a desire to develop scenarios that people could relate to was considered as a better approach, especially regarding interests.

For step 4 the scenario template (Table 3) was drafted with partners from the municipality of Larvik, who identified missing or non-relevant information. After the scenario template was completed it was revised and rewritten into narratives. For step 5, the narratives were transformed into illustrations for children and youth (Figures 4-6). The illustrations were then used in a workshop at a primary school in Larvik. The feedback from this group was then used for step 6, to further refine the narratives. The illustrations have been used in future Living Labs with other stakeholders, including politicians, in Larvik.

Figure 4 Vision of SSP1, a "Sustainable Larvik", based on strategic municipal plans (illustration by Bar Bakke).

Figure 5 Vision of SSP2, Larvik in a "Business as usual" scenario, based on current growth statistics and from discussing the situation in Larvik today (illustration by Bar Bakke).

Figure 6 Vision of SSP3, "Regional rivalry" for Larvik, a potential future if targets for growth and investments are not met (illustration by Bar Bakke).

3.2 Visualising exposure and vulnerability

Exposure and Vulnerability mapping is a commonly used tool for policy makers for supporting adaptation (Patt et al. 2005; Neset et al. 2016) and land-use planning decisions, while at the same time educating the public about climate change and its interactions with coupled physical/environmental systems and motivating policy responses (Preston et al. 2011). As such it is a key tool for communicating climate information to stakeholders when developing adaptation strategies to climate change and associated hazards.

As part of the EVOKED CO-Design process, exposure and vulnerability mapping is conducted based on the methods described by de Moel (2009). Briefly, the magnitude of the hazard is estimated, and these values are used to map the exposure, usually by employing a Geographic Information System (GIS) and digital data on elevation or by using a physical model. This process leads to the estimation of the characteristics of the hazard (e.g. flood extent and depth). Finally, further spatial information, such as the distribution of population, assets, infrastructure, land-use, or economic data can be combined within a GIS with the potentially impacted areas to estimate potential exposure and impacts. Mapping vulnerability builds upon this approach by, for example, using damage curves to quantify the degree to which buildings are affected by hazards (Albano et al. 2017); or by using detailed information on population to identify the number of vulnerable individuals (e.g. people over the age of 80). Risk maps bring together information on the hazard, exposure, and vulnerability and thus define risk zones, which can be used for emergency or spatial planning as well as for prioritization of measures for risk reduction (CAU, 2019b).

The applications of exposure and vulnerability mapping include helping stakeholders to:

- visualise climate change impacts on the landscape and to place those impacts in a recognizable local context and illustrate interactions;
- further develop and validate local socio-economic scenarios (Chapter 3.1);
- understand the consequences of climate adaptation measures;
- create climate services that rely on GIS and other web-based tools (see Chapter 6.1 for examples).

3.2.1 An example of exposure and vulnerability maps for Flensburg, Germany

The City of Flensburg experiences frequent coastal flooding as a result of storm-surges. Discussions on potential adaptation strategies are starting, and to support the Living Lab process a series of exposure and vulnerability maps for different combinations of storm-surge and sea-level rise scenarios has been developed. Examples of maps of exposure and vulnerability for the different scenarios have been presented during the Living Labs with stakeholders (Figures 7-8).

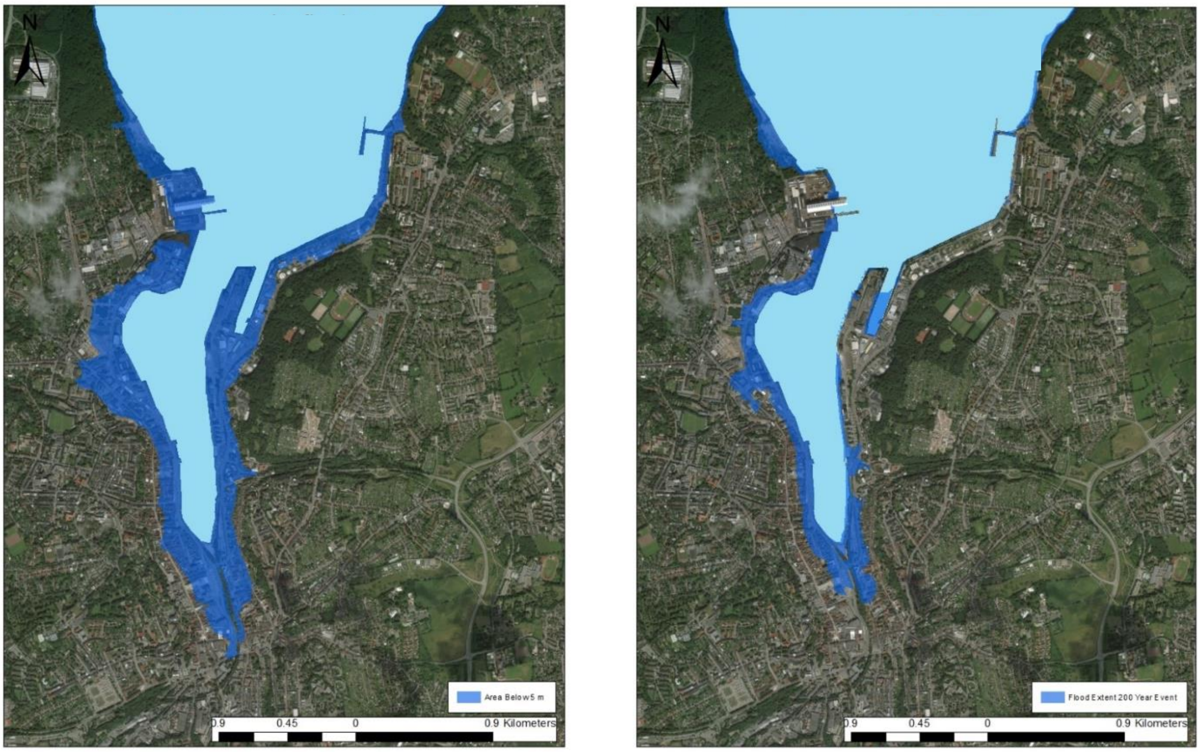

Figure 7 Land area below 5m elevation (left) and area below 200-year storm surge height (right) for the City of Flensburg.

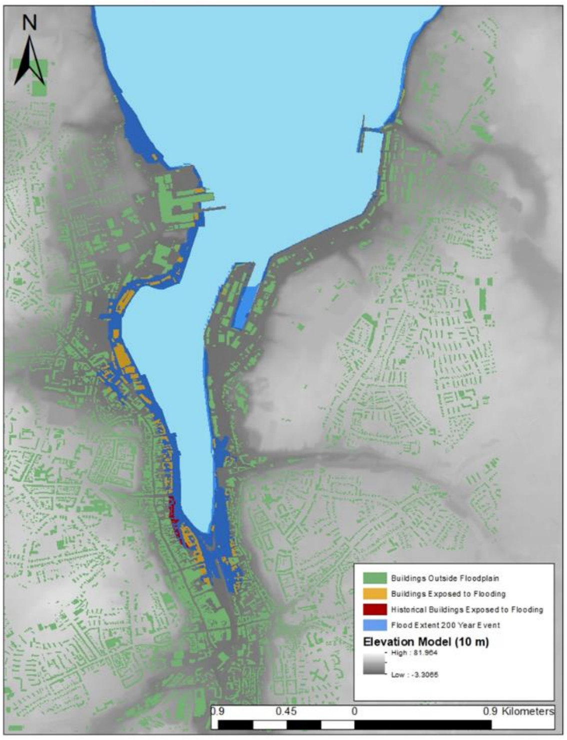

Figure 8: Residential and historical buildings situated at elevations below the 200-year surge level for the City of Flensburg.

4 Co-Validate with Field Trials

The Co-Validate process focuses on creating and testing climate services, and is carried out in the Living Labs and guided through field trials (Deltares, 2019). The methodology used to plan and carry out the field trials is unique within the field of climate services and is based on information design methodology (Raaphorst et al., 2020). Briefly, the methodology starts by identifying the information needs of the relevant stakeholders and subsequently works through steps of the desired action to be taken, and finally the graphic format in which this information is to be presented.

4.1 Climate Information Design (CID)

An important tool in co-creating climate services has been the use of the Climate Information Design (CID) template (Figure 9), which helps to deconstruct the climate service and to pinpoint what needs to be changed. As such it can be stated that this template contributes to the development of a feedback-loop between the end-users and the developers serving as a way to communicate shortcomings ('usability gaps' as defined by Lemos et al., 2012) in existing climate services and in relation to the climate information needs of stakeholders. The variety of different climate services that have been developed with this framework indicates that the process is open and not biased towards certain choices (Raaphorst et al., 2020).

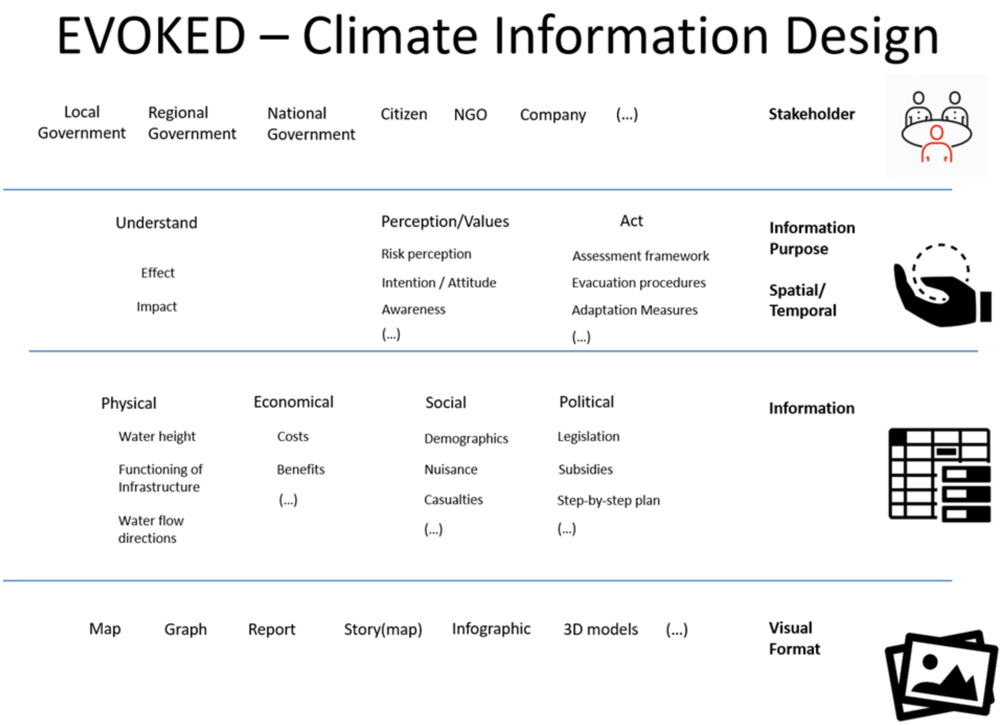

Figure 9. Operationalisation of the CID methodology (Raaphorst et al., 2020).

4.2 Steps to initiate Field Trials using CID

In preparation for initiating the field trials at the EVOKED case study sites, a series of steps have been proposed. These steps are useful for collecting the necessary data to either improve already existing climate services, or to create a new climate service, subsequently reducing the 'usability-gap' between the climate service and its user (Lemos et al., 2012). Central to these steps is the use of the CID template (Figure 9) to operationalise climate information design to reframe climate services (Deltares, 2019).

Step 1: Identify relevant stakeholders for the climate change problem
Based on the comprehensive list of all potential stakeholders (Co-Design task Chapter 2.2), select those stakeholders that are relevant for the specific climate change problem to be addressed in the field trials. Once these stakeholders are identified, invite them to participate in the Living Labs.

Step 2: Identify climate services at the case study sites
Climate services that are currently available at the case or the study site should be evaluated to determine if they are relevant. This is accomplished by considering the climate impacts that are being addressed by the climate services and by evaluating the format of the climate services.

Step 3: Identifying the information needs of the relevant stakeholders
The third step is to find out what information needs the climate service(s) hope to fulfil for the relevant stakeholders. This can be accomplished by conducting interviews and documenting user needs (Co-Design task Chapter 2.2) and problems they face in their practices. This includes information of which they already have and which information they would need to meet the challenges of climate change as well as to define the most appropriate visual formats (Co-Develop concepts in Chapter 3.2).

Step 4: Applying the operationalised CID methodology to locate potential usability-gaps
Completing the CID template gives insight into which information is required by the relevant stakeholders (Figure 9). Usability gaps can in turn be identified by comparing information needs and outcomes. This gap provides a point of departure for creating an improved information design.

Step 5: Creating an improved information design to overcome the usability gap
The results from Step 4 provide an indication on how to improve the information design of the climate service. Improvements can be made by:

- Reaching out to another stakeholder.
- Revising the purpose of the information.
- Focusing on different climate information.
- Changing the visualization format.

Step 6: Testing the improved CID

Testing the improved climate service can be accomplished by completing a survey after discussing the design with the intended stakeholder (Co-Evaluate Chapter 5). Survey results provide insight into how the climate service was perceived by the stakeholder and whether it improved the understanding or action intended by the climate service. The survey results act as a feedback loop for the Living Labs and field trials.

5 Co-Evaluate with questionnaire surveys

Embedded in each of the EVOKED framework methodology co-creation steps, is an evaluation process to assess the experience of the stakeholders involved in the Living Labs and the suitability of the developed climate services (NGI, 2021). A questionnaire is developed to assess these aspects as well as to integrate the feedback into the ongoing co-creation process (Appendix B). The questionnaire reflects the intentions and content developed in the Co-Design, Co-Develop, and Co-Validate processes. A total of 29 questions included in the questionnaire cover the following aspects:

- Living Labs process
    - The view of the actual meeting
    - The view on the Living Lab process
- Climate Service suitability
    - Knowledge about Climate Change Adaptation (CCA) in the locality of the respondent
    - Evaluation of Climate Services
    - Local Climate Services

Respondents rate each question on a five-point scale ranging from strongly agree to strongly disagree. In addition, the questionnaire includes some general information about the user as well as some information about the intention.

The questionnaire should be distributed and completed during the field trials (Co-Validate Chapter 4). The questionnaire can also be used during Living Labs workshops other than the field trials to generate feedback throughout the process.

6 Examples of co-creation of climate services

6.1 Story mapping as a climate service

Storytelling has a large potential to raise awareness for a specific topic (Harder and Brown, 2017) and can help to simplify complex information or to make it more relevant for a specific target group. In the past, web applications and web tools on climate change-related issues have been developed, but they have rarely been connected to the concept of climate services. Thus, research is very limited on how effective such web applications are as climate services. One of the first reviews that assesses web portals as climate services recommends that these should take a wide diversity of users into account, assure and manage quality of data presented, be complemented by additional services, take care of continuity also after the project, and ensure that their guidance is appropriate (Swart et al., 2017). Story maps, as web-based applications, can therefore be an efficient climate services, taking all the characteristics and challenges of climate services into account. To support this, a story map template is developed, and the source code is available for use at specific cases and study sites (CAU, 2020). Furthermore, story mapping was the climate service most often selected for co-creation within the EVOKED project and examples of their development using the EVOKED framework methodology are presented in the following chapters.

6.1.1 Story maps for citizens in Flensburg, Germany

Building on the co-design and co-visualization work with citizens in Flensburg (Chapter 3.2.1), needs of a climate service related to adaptation to sea-level rise were identified and mapped using the CID template (blue process in Figure 10):

- Raise awareness and inform about sea-level rise.
- Contribute to decisions in dealing with local sea-level rise.
- Support the adaptation process.

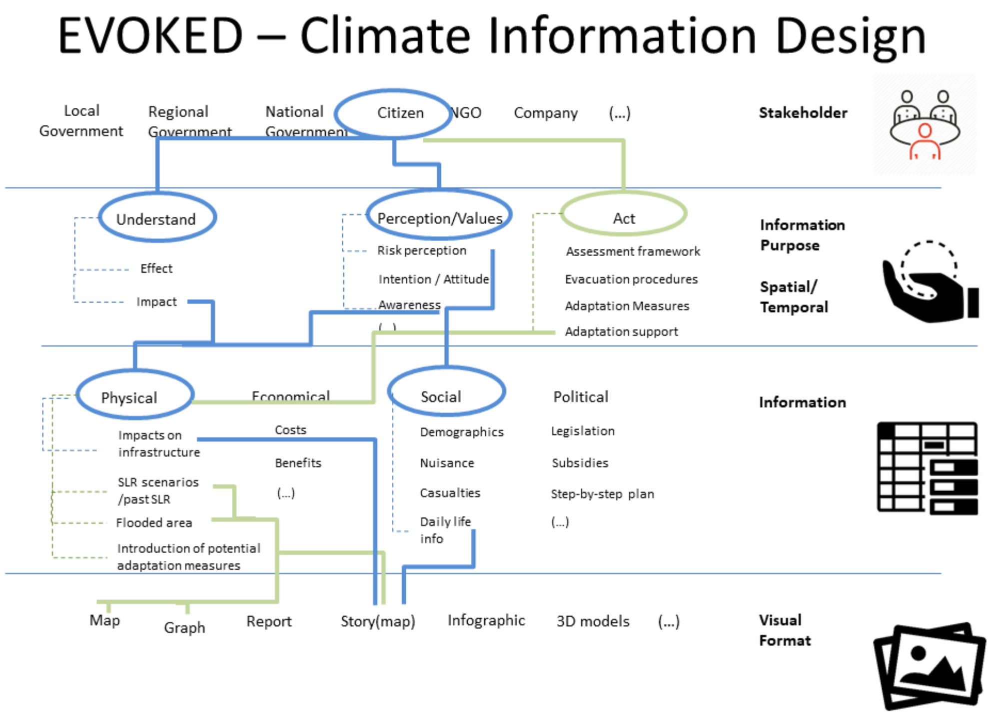

Figure 10. The CID of the climate service before and after the field trial. The blue colour indicates the characteristics of the first version of the climate service. After the field trial and based on the feedback of the stakeholders the information design changed or was rather supplemented by further components (green colour).

The first part of the story map includes short information on the scientific background, such as global mean sea-level rise trends, and defines specific terms such as uncertainty and risk. The second part visualises coastal flood risk and provides information on areas vulnerable to coastal flooding with assistance of a flyover map. The last part of the story map contains information on adaptation options in general, primarily in text-based form and for specific locations in Flensburg. To increase the usability of the climate service a feedback process was initiated, and the story map was subsequently revised (green process in Figure 10). Flood maps considering different sea-level rise scenarios were included and more details on adaptation measures were given (Figure 11).

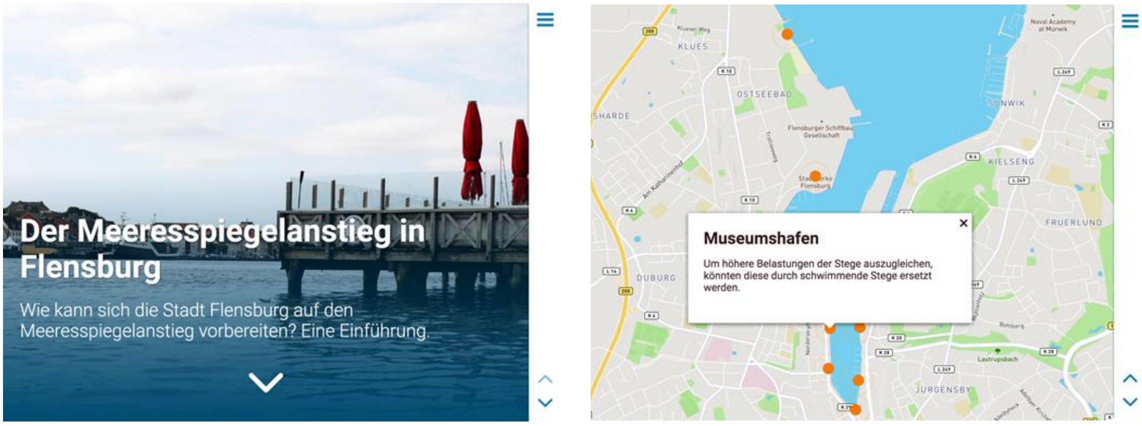

Figure 11. Title slide of the Flensburg story map (left) and one section of the story map (right), emphasizing potential adaptation measures for Flensburg (http://meeresspiegelanstieg-in-flensburg.info/).

6.2 Improving an existing climate service in the Netherlands

The Fluvius-region (northern part of the Netherlands) municipalities, provinces, and water board are responsible for the climate adaptation policy and for implementing measures in the public space. As the region is quite rural, agriculture is an important sector and thus the region is vulnerable to both extreme precipitation and drought as these can both lead to crop failure. Towns in the region have also experienced pluvial flooding several times. In addition to extreme precipitation in the more urban areas, heat stress, especially in the summer, is also becoming an increasing problem.

In 2014, the collaborating governmental agencies launched a program 'Living with Water in the IJssel-Vechtdelta'. One aim of the program is to improve the awareness of the communities within the region on the effects of climate change. Therefore, the key need is to understand how (and to what extent) the collaborating governmental agencies can shape the preparedness of communities at risk through effective communication strategies. Thus, the point of departure of the Fluvius field trial was based on an existing climate service of the local version of the Dutch 'Nationale Klimaateffectatlas' (the 'Fluvius Klimaatatlas') and their upcoming 'stress test'.

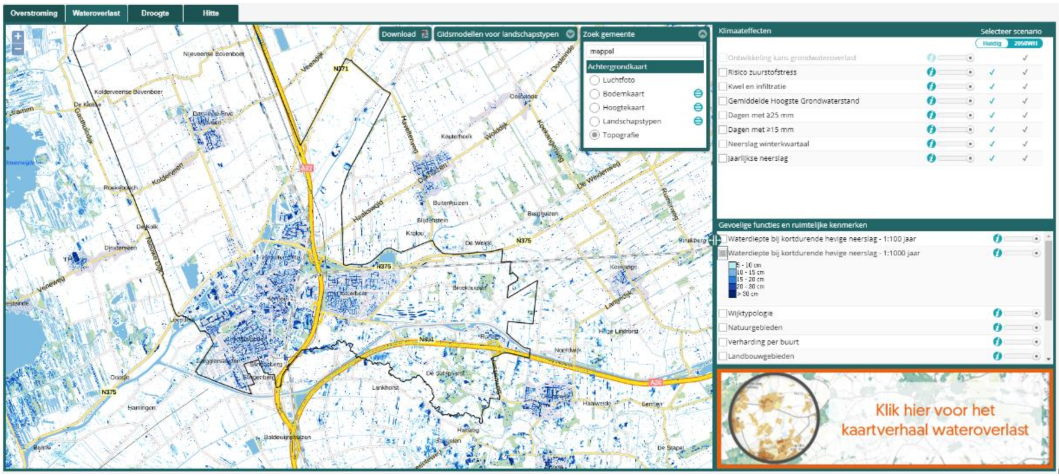

Figure 12. A screenshot of the original climate service in the Klimaateffectatlas (showing water nuisance).

The field trials focused on the existing 'Klimaateffectatlas' climate service (illustrated in Figure 12). The information needs for the governmental stakeholders (municipalities, water board, provinces, and safety region) were collected during a Living Lab workshop. Generally, the information needs included information on:

- climate impacts in the built-up areas (e.g. potential damage, vulnerable houses)
- climate impacts in the rural areas (e.g. impact on agricultural activities or nature)
- potential adaptation measures as well as the costs

Based on these user needs, the Fluvius region work group hired the consultancy firm ‘Nelen & Schuurmans’ to, among other things, update the 'Klimaateffectatlas' maps. These updates created a new climate service showing the impact of extreme weather (extreme precipitation, drought, heat stress, and flooding from the regional water system) in the region (example illustrated in Figure 13).

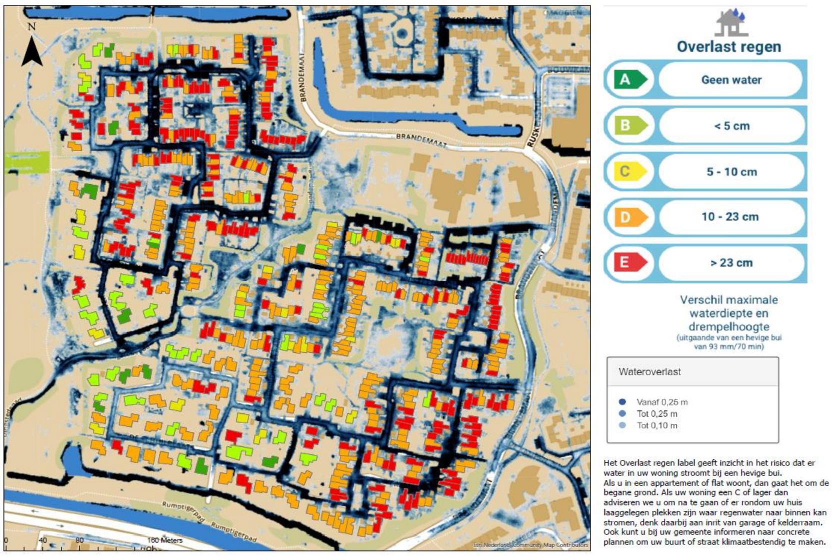

Figure 13. The improved pluvial flooding map that also shows the potential impact of flooding on private properties.

6.3 'Climate menu' to engage in dialogue in Larvik, Norway

An area of 200 hectares situated about 1 km from the city centre is to be developed in Larvik municipality. Climate risks in this area are related to flooding and the area's current capacity to hold and infiltrate large volumes of water in the event of extreme rainfall. Development of this area will result in changes in the landscape and all changes that influence the runoff of surface water must be thoroughly examined to avoid increased risks to adjacent land areas (NGI, 2016).

Maps illustrating potential flooding is perceived as a useful climate service. However, since the study site focusses on the development of a new area, the municipality is interested in exploring a climate service that could serve as a planning tool to select interventions and specify requirements prior to building. Relevant stakeholders for such a tool could include landowners, building developers, and contractors as well as decision-makers.

The first version of the climate service for building developers and contractors with a potential interest in developing the area was presented as either i) the "blue green factor" tool for blue-green infrastructure interventions included in building development projects, or ii) a checklist of selected sub-categories from the BREEAM Communities assessment method for integrating sustainable design in the planning of new communities (Figure 14).

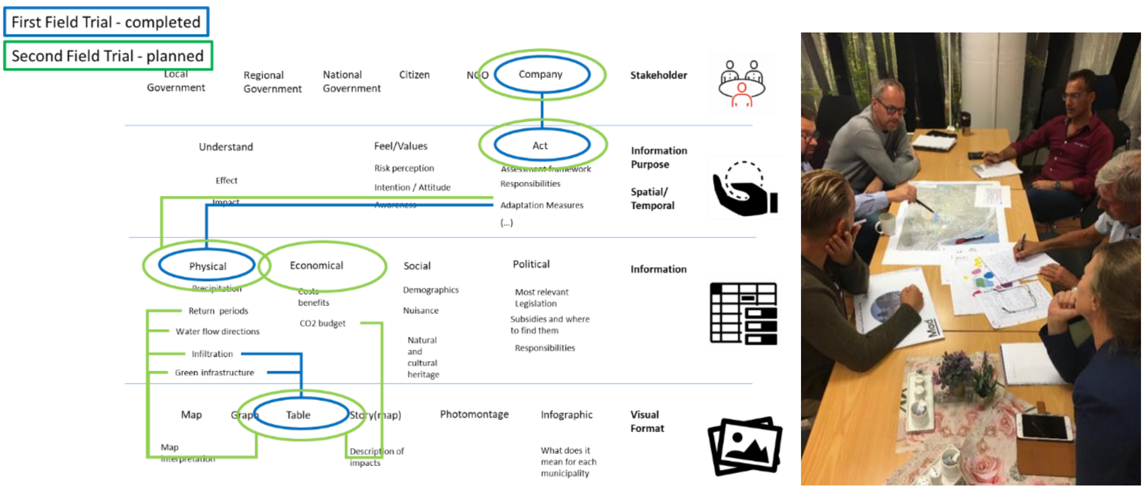

Figure 14. The CID of the climate service for the first and second field trial. The blue colour indicates the characteristics of the first version of the climate service. After the field trial and based on the feedback of the stakeholders, the information design changed or was rather supplemented by further components (green colour). The photo was taken during the break-out group discussion during the first field trial.

Based on the discussions with the building developers and contractors during the first Field Trial, the climate service is being revised with the second version that is inspired by the BREEAM Communities sub-categories that incorporates additional aspects for climate adaptation as well as climate mitigation and costs. This "Klimameny" (Climate menu) was presented to the same group of stakeholders in a second field trial (Figure 15). There was high interest and participation during the second field trial, resulting from an increased understanding that climate change impacts must be considered in building and development projects. The "Climate menu" received positive feedback and the municipality aims to test the menu in an ongoing planning process before finalising the climate service.

TEMA	Eksempler på problem-stilling	Skala	Krav/veiledere	Eksisterende kunnskapsgrunnlag	Manglende analyser/ kunnskap	Eksempler på tiltak	Klima-verdi (1-5 der 5 er gunstigst)	Kostnad investering (1-5 der 5 er billigst)	Kostnad drift (1-5 der 5 er billigst)	Vekt (1-5 der 5 er viktigst)
Nedbør	Flom/ Overvann Styrtregn Snøfall Stormflo/springflo Havnivåstigning	Regional/ lokal	Plan- og bygningsloven Blå-grønn faktor Overvannsplan – Godkjenning KMT Ingen økt avrenning Lindholm m.fl. (2008): Veiledning i klimatilpasset overvannshåndtering. Norsk Vann Rapport nr. 162.	Fare/ aktsomhetskart. Lardal og Larvik kommuner – tilpasning til klimaendringer (NGI) Mulighetsstudiet vann og vannsystemer (Rambøll)	Detaljerte flomanalyser	Grønne tak				
						Fordrøyningsbasseng – åpent eller lukket				
						Etablering eller gjenetablering av utflommingsområder ut fra bekker og elver				
						Bekkeåpning. Åpne bekker som er lagt i rør for å øke fordrøyningskapasiteten.				
						Erstating av tette overflater med porøse eller vanngjennom -trenglige flater				
						Regnbed eller våtmarks anlegg				
						Tradisjonelle løsninger: Etablering av kummer og lukkede overvannsløsninger Flomsikringtiltak/Landhevning				
	Skred Snøskred Steinskred Kvikkleire	Regional/ lokal	Plan- og bygningsloven	Fare/ aktsomhetskart. Lardal og Larvik kommuner – tilpasning til klimaendringer (NGI)	Detaljerte skredanalyser	NBS tiltak (vegetasjon) – bevaring eller nyplanting				
						Drenering				
						Skredvoller				
						Skredsikring – tradisjonelle løsninger? Nett				
Vind og temperatur	Generelle vindforhold	Regional	Vindstandard (NS-EN 1991-1-4:2005+NA:2009)	Værstasjoner www.selarvik.no www.vindsiden.no		Overordnet arealplanlegging				
	Lokalklimatiske vindforhold	Lokal		Analyse av lokale vindforhold ved utbygging på Martineåsen (Outdoor Environment Technology as)		Bevaring av eksisterende vegetasjon				
						Plassering og orientering/volum bygg				
						Etablering av skjermingstiltak (vind, nedbør, snø, sol)				
						Utforming av detaljer (spesielt takkonstruksjoner).				
	Tørke	Regional/ lokal		Nedbør registreringer Temperaturmålinger www.selarvik.no		The main summertime requirements of a space are likely to be provision of shade, cooling, air movement and prevention of glare. In winter conditions the focus will be on protection from wind and rain. (BREEAM comm.)				
Økologi og biologisk mangfold	Tap av biologisk mangfold	Regional/ Lokal	Plan- og bygningsloven M100 (2014): Planlegging av grønnstruktur	Grøntstruktur kartlegging Landskapsanalyse	Detaljerte analyser	Reetablering av kvaliteter Bruk av landskapsøkologiske arealprinsipper (liten avstand mellom grøntarealer, større arealer med diverse form, korridorer som ivaretar sammenhenger mellom grøntområder, buffersoner)				

Figure 15. Draft version of the "Climate menu" to be tested in local area development projects in Larvik, Norway.

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Appendix A

Context and Governance Analysis Template

Contents

A1 Context and governance aspects analysis for EVOKED Living Labs

This template is to document the context and governance aspects in which the Living Lab/provision of climate service takes place. In doing so, we will better be able to identify the challenges and opportunities associated with providing the living lab, and help to ensure that our actions are sensitive to the specific contexts within each case study.

This is also a living document and may be updated as contexts and circumstances change within the case study area. The questions below should be seen as suggestions for understanding the five main dimensions of territorial governance and what they mean for climate services. As such, they do not necessarily all have to be answered, and they may give rise to other more relevant questions. Some of the questions can be answered in the beginning of the Living Lab (LL) process while others might be answered later in the process.

A2 The Physical Context

- Geography
- Water courses
- Main soil types
- Climate service to be produced
- Critical infrastructure
- Other relevant physical factors

A3 The Socio-economic Context

- Area of the Living Lab main space
- Population
- Age structure
- GPD/capita
- Other relevant socio-economic factors

A4 The Territorial Governance Context

Below follow questions meant to help understanding the five main dimensions of territorial governance and what they mean for climate services.

A4.1 Coordinating the actions of actors and institutions

- Which governance levels (local, regional, national macro-regional) are involved in climate adaptation policy, risk and vulnerability analysis, dealing with natural hazards and promoting community resilience?
- How are their efforts coordinated? Does it work well? What are the challenges in such co-ordination?
- Are there any power conflicts involved in implementing climate service measures? Other challenges?
- Which level has main responsibility for implementing the measures?
- Who bears the financial responsibility?
- How are they coordinated?

A4.2 Integrating policy sectors

- Which sectors are involved in climate adaptation policy, risk and vulnerability analysis, dealing with natural hazards and promoting community resilience?
- How are these actions integrated? What works well? What are the challenges?

A4.3 Mobilizing stakeholders

- Which stakeholders are currently involved in climate adaptation policy, risk and vulnerability analysis, dealing with natural hazards and promoting community resilience?
- How have stakeholders already been identified and mobilized by decisionmakers and others within the stakeholder area?
- What problems and possibilities exist in getting a stakeholder mobilized?
- How are risk and uncertainty communicated to stakeholders?

A4.4 Being adaptive to changing contexts

- What is the room for manoeuver or scope of flexibility to work with innovative climate services?
- What climate adaption projects, actions and strategies are already in place and how can EVOKED build on these?
- How do those involved in determining risk and uncertainty learn from one another?

A4.5 Realizing place-based / territorial specificities and impacts

- What types of epistemic/technical and consensual/local knowledge exist on risk, uncertainty and climate adaptation?
- Who provides the knowledge and is it currently seen as sufficient?
- How is this knowledge gathered and managed?
- What types of knowledge are further needed to provide the climate service?

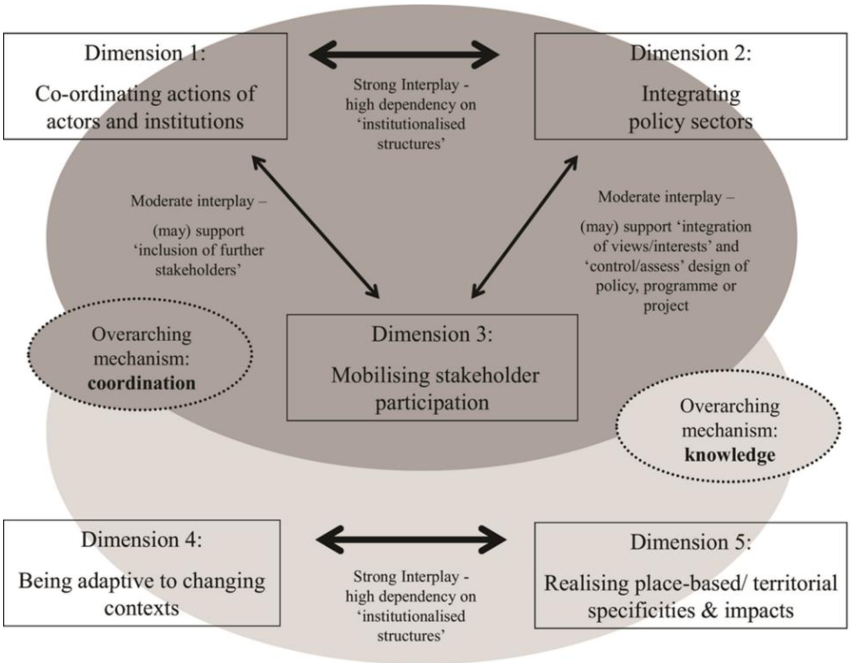

Figure 1: The Territorial Governance Framework (Schmitt and Van Well, 2016)

Appendix B

Questionnaire

Contents

Evaluation of [name of event]

Dear Living Labs participant,

In order to improve the Climate Services in your local area, we need to learn from your feedback. With this survey, you have the possibility to take part in the development of the Living Labs process and of the Climate Services (see definitions below). The aim of the questionnaire is both to be able to analyse your evaluation of this meeting and the workshop process as such, and to analyse your evaluation of the amount and effect of the climate services available in your local community.

We would kindly ask you to answer the questions below. It will only take a few minutes. Your answers will be analysed anonymously and kept confidential.

Thank you for your cooperation!

[insert names of EVOKED team members]

Definitions:

Living Labs (LL):

EVOKED definition of Living Lab: "The general idea is to involve a range of committed stakeholders in real-life 'laboratory' settings to test and develop alternative solutions for complex challenges, such as climate adaptation or risk and uncertainty assessments".

The Living labs

- are bounded in time
- have multi-method approach
- do experimentation and learning in real life setting

Climate Services (CS):

EVOKED definition of Climate services: "'Climate services' has a broad meaning: transforming climate-related data and other information into customised products such as projections, trends, economic analysis, risk assessments, advice on best practices, development and evaluation of solutions, and any other climate-related service liable to benefit that may be of use for the society".

1. Living Labs Workshop/date xx.xx.xxxx*.
To what extent do you agree or disagree with the following statements?

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
My view on this meeting	1.1 The aim of **this** meeting was clear at the start of the meeting	☐	☐	☐	☐	☐
	1.2 The presentations (talks, maps, diagrams, other data) at **this meeting** were clear	☐	☐	☐	☐	☐
	1.3 The meeting was well organized and led	☐	☐	☐	☐	☐
	1.4 I could voice my ideas in an open-minded and friendly atmosphere	☐	☐	☐	☐	☐
	1.5 The conclusions from this meeting with respect to the way forward are clear	☐	☐	☐	☐	☐
	1.6 The information discussed will have practical implications within my field of work	☐	☐	☐	☐	☐
My view on the Living Labs process	1.7 The Living Labs provides a good platform for sharing knowledge and experience	☐	☐	☐	☐	☐
	1.8 The Living Labs provides a good platform for experimentation and innovation	☐	☐	☐	☐	☐
	1.9 I think the number of stakeholder and sectors present in this Living Labs is balanced	☐	☐	☐	☐	☐
	1.10 The communication tools (reports, presentations, videos, art, etc.) used in the Living Labs are exciting	☐	☐	☐	☐	☐
	1.11 The items discussed in the Living Labs are relevant for our local climate adaptation needs	☐	☐	☐	☐	☐
	1.12 I share this Living Labs intention of producing sustainable services; ecologically, socially and environmentally	☐	☐	☐	☐	☐
	1.13 The Living Labs will produce positive impacts for the climate adaptation awareness in our local community	☐	☐	☐	☐	☐

2. Climate services (CS), date xx.xx.xxx*.
To what extent do you agree or disagree with the following statements?

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Climate change and adaptation in my area	2.1 I observe climate related challenges in my local area	☐	☐	☐	☐	☐
	2.2 I am aware of local policy initiatives in climate adaptation	☐	☐	☐	☐	☐
	2.3 I am aware of specific climate adaptation measures (completed or planned) in my local community	☐	☐	☐	☐	☐
	2.4 I am aware of the responsibilities of other parties to take climate adaptation measures	☐	☐	☐	☐	☐
	2.5 I am motivated to take climate adaptation measures myself	☐	☐	☐	☐	☐
Climate Services from my point of view	2.6 I have basic knowledge about Climate Services (CS)	☐	☐	☐	☐	☐
	2.7 The CS promoted in the meeting today are relevant for me	☐	☐	☐	☐	☐
	2.8a The CS promoted in the meeting today are understandable	☐	☐	☐	☐	☐
	2.8.b This is primarily due to the:					
	Visual mode (map, graph, photograph, etc.)	☐	☐	☐	☐	☐
	Spatial scale	☐	☐	☐	☐	☐
	Level of detail	☐	☐	☐	☐	☐
	Textual explanation (title, legend, etc.)	☐	☐	☐	☐	☐
	2.9 The CS promoted in the meeting today are useful	☐	☐	☐	☐	☐
	2.10 The CS promoted in the meeting today is advantageous/beneficial for local climate adaptation	☐	☐	☐	☐	☐
Common practice of climate services for the local community	2.11 I know where to find CS appropriate for the local community	☐	☐	☐	☐	☐
	2.12 It is easy to understand CS currently available for the local community	☐	☐	☐	☐	☐
Concepts related to climate services	2.13 Addressing climate driven challenges will profit from integrating the concept of risk	☐	☐	☐	☐	☐
	2.14 Using uncertainty in climate services is important	☐	☐	☐	☐	☐
	2.15 Using frequencies/return intervals in climate services is important	☐	☐	☐	☐	☐
	2.16 Addressing uncertainty will help the decision making process in local adaptation	☐	☐	☐	☐	☐

Identity (2 last letters of father's name + 2 last numbers of mother's year of birth)									
Sex	Male	Female							
Age (yrs)	10-20	20-30	30-40	40-50	50-60	60-70	70-100		
Representing	State or municipal government	Business/ industry	Interest groups (local/national)	Citizens		Schools and academia	Politicians	Media	Other interests (please name):
How did you get involved in EVOKED? (multiple answers possible)	By invitation	By interest	Work						
Specific interest in climate adaptation work (multiple answers possible)	Local action	Global concern	Nature/environ mental protection	Economy		Education and research	Other (please name):		

Please add other comments you may have (optional):

Review and reference page

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Document control

Quality assurance according to **NS-EN ISO9001**

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