Deliverable D2.3

Preliminary report on user-centred validation of the integration of climate action information

September 2023

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037293

I-CISK

Innovating Climate services through Integrating Scientific and local Knowledge

Deliverable Title:	Preliminary report on user-centred validation of the integration of climate action information
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Date	[March, 2023]
Suggested citation:	Hernández-Mora, N., De Stefano, L., Ropero, N. et al., 2023: Preliminary report on user-centred validation of the integration of climate action information, I-CISK Deliverable 2.3, Available online at www.icisk.eu/resources
Availability:	☒ PU: This report is public ☐ CO: Confidential, only for members of the consortium (including the Commission Services)

Document Revisions:

Author	Revision	Date
[Author(s)]	[Version]	[Revision date]
Nuria Hernández-Mora, Lucia De Stefano and Nikoletta Ropero	First draft	February 2023
Marije Schaafsma	Internal review / feedback WP2	February-March 2023
Nuria Hernández-Mora, Lucia De Stefano and Nikoletta Ropero	Second draft	March 2023
Micha Werner & Ilyas Masih	PI review /feedback	March 2023
Nuria Hernández-Mora, Lucia De Stefano and Nikoletta Ropero	Final Report	March 2023
Project Officer 18 month review	PO review/feedback	July 2023
Nuria Hernández-Mora, Lucia De Stefano and Nikoletta Ropero	Final revised report	September 2023

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Executive Summary

Climate services (CS) are critical elements to support decisions for adaptation to climate-related risks and climate change impacts. In order to be effective, CS need to be tailored to the knowledge, experience and needs of the users and the contexts in which decisions are being made. The goal of Task 2.3 is to map the option space and experience of end-users, and co-create a set of relevant climate risk management measures that can be informed and supported by user-centred CS. Task 2.3 aims to create an overview of local knowledge related to the possible climate change adaptation options and resulting information needs through consultation with member of the multi-actor platforms in each of the Living Labs (LL) that are part of I-CISK.

This Deliverable 2.3, *Preliminary report on user-centred validation of the integration of climate action information*, proposes a methodological approach to help I-CISK LL gather information on adaptation options, information needs to inform decision making processes, and the necessary climate services to improve the decision-making space. It also presents preliminary results gathered from the LL through a questionnaire and a variety of participatory methods already used in the different living labs – interviews, focus groups, surveys and workshops.

Acronyms

CAP	-	Common agricultural policy
CS	-	Climate service
DRR	-	Disaster risk reduction
GDP	-	Gross domestic product
KPI	-	Key performance indictor
LL	-	Living laboratories
MAP	-	Multi actor platform
RBD	-	River Basin District
RER	-	Emilia Romagna Region
WP	-	Work package

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1. Introduction

Climate services (CS) are critical elements to support decisions for adaptation to climate-related risks and climate change impacts. In order to be effective, CS need to be tailored to the knowledge, experience and needs of the users and the contexts in which decisions are being made (Hewitt et al., 2019). I-CISK recognizes that, in order to achieve behavioural change, the active use of climate information for adaptation and mitigation action requires CS users to be at the centre of the design, implementation and evaluation of CS.

The goal of Task 2.3 (T2.3), which this Deliverable pertains to, is to map the adaptation decision option space and identify current and potential climate-related adaptation measures that can be informed and supported by existing and new CS. Multiple sources of information are used when making adaptation decisions – not only CS information but also past experience, policies, norms, perceived risks, sense of urgency, knowledge, capacities and barriers, and the expected consequences of implementing adaptation measures. Thus, in T2.3 we aim to explore how local actors combine and use different sources of knowledge in the adaptation decision-making process in the different Living Labs (LL) that make up the I-CISK project (Masih, I., Van Cauwenbergh, N., et al., 2022). Using different tools, we aim to gain a better understanding of the information that feeds into the selection and implementation of adaptation actions, including the identification of barriers that obstruct the adoption of certain adaptation measures.

This Deliverable identifies the key outputs needed to characterize the adaptation options and its linkages with CS and other information sources and proposes a methodological approach to do this. These outputs include:

a) Characterise the present adaptation decision space. This requires exploring how different knowledges (including CS-related knowledge) are combined and used in the adaptation decision-making process. This step includes an overview of local knowledge related to possible adaptation measures (see also work in T2.2).

b) Identify (existing and potential) climate risk-management and adaptation measures that (existing and user-informed) CS can inform and support. Identify the barriers (such as lack of technical or financial capacity, existing power distributions, political constraints or legal obligations) and opportunities or enabling conditions that influence the adoption of certain adaptation measures. This includes understanding the interactions among actors and of the feedbacks or linkages between different information sources, adaptation decisions and their impacts (see also work in WP4).

c) Foster the identification of additional possible solutions (climate adaptation, risk reduction) by enabling knowledge exchange amongst LL users, between users and project partners, and enabling social learning among the end-users within the LL.

This deliverable (D2.3) presents preliminary results on the exploration of the integration of CS information into adaptation decisions. A follow on deliverable, *User-centred validation of the integration of climate action information* (D2.6), due in month 30 of the project (April 2024), will elaborate on the results of the application of the methodology proposed here in the different LL. D 2.6 will also refer to the KPI included in the I-CISK proposal as an output for T 2.3, which is the number of climate adaptation options and disaster risk reduction (DRR) actions co-identified, with an expectation that at least 3 options and actions per LL will be identified.

This report is structured in five sections. After this introduction, section 2 elaborates on the relationship between climate information and adaptation decisions and the need for CS to adapt to local contexts. Section 3 outlines a methodological approach that can be used by the I-CISK LL to gather information on adaptation options and related decision-making processes. Section 4 includes preliminary results from the LL. Section 5 includes conclusions and plans for future work within T 2.3.

2. Integration of climate information into adaptation decisions: T2.3 within the I-CISK Framework for co-creating climate services

The development of CS has traditionally emphasised the supply side of climate services, that is, they have often not taken user needs, preferences or capabilities into consideration when generating forecasts and projections (Vincent et al., 2020). As Carr and Ozere (2018) point out, different actors have different vulnerabilities to climate risks, which may depend on various factors such as type of activity, belief, gender, age, education or experience. They may therefore have different CS needs and requirements. These factors need to be investigated and understood so that climate information is “tailored to the contexts of the decision-making and perception of the users”, who will combine “information from models with other relevant information to enable the integration of climate risks into their decision-making processes” (Hewitt et al., 2019).

I-CISK recognizes that the active use of climate information for climate adaptation and mitigation action requires CS users to be at the centre of the design, creation, implementation and evaluation of CS. Furthermore, I-CISK acknowledges that users construct the climate information they consult to inform adaptation decisions from multiple sources of knowledge, and act within their (socioeconomic, behavioural and institutional) context, which may include incentives as well as barriers to the uptake of that information. These sources of knowledge include present and past experiences, knowledge of the local weather system and of adaptation options and their effectiveness, as well as data from climate and citizen-science (van den Homberg, Rastogi et al, 2023).

In order to generate user-centred CS and ensure these are adequate for end user’s needs and context, thus supporting society’s transition toward a more resilient and sustainable future (Hewitt et al., 2019), the I-CISK Framework for co-creating CS (I-CISK, 2022) defines a sequence of iterative steps illustrated in Figure 1.

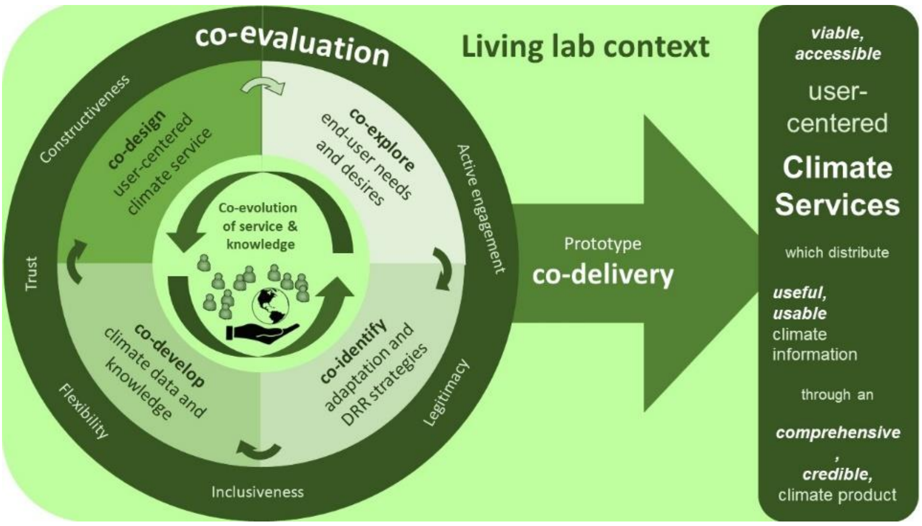

Figure 1: Co-creation of user-centred climate services: building blocks of the process that take place in a LL context (Source: I-CISK, 2022).

The process starts by co-exploring user needs and co-identifying relevant local knowledge, perceptions and concerns. This is critical in order to understand the context within which CS will be used and inform how to adapt these accordingly. This work is part of T2.1 *Co-exploring climate information and adaptation information needs and obligations* and of T2.2 *Co-identifying local knowledge on climate & its impacts* (see Figure 2) and is reflected in the corresponding deliverables (Moschini & Emerton, 2022; van den Homberg, Rastogi *et al*. 2023).

LL participants contribute to the process of identifying the climate parameters and thresholds, and the spatial and temporal scales of climate information that match with the envisioned climate adaptation actions that CS will support. The co-identification of existing and potential climate adaptation actions supported by existing as well as new CS (such as I-CISK developed user-driven climate services), is the focus of Task 2.3, and includes the co-exploration of drivers and barriers that influence the uptake of climate information in adaptation decisions. The initial exploration of how information is used to inform decisions will provide important inputs toward understanding the drivers for behavioural change and improved adaptation decision-making (see also Task 2.4 in Figure 2).

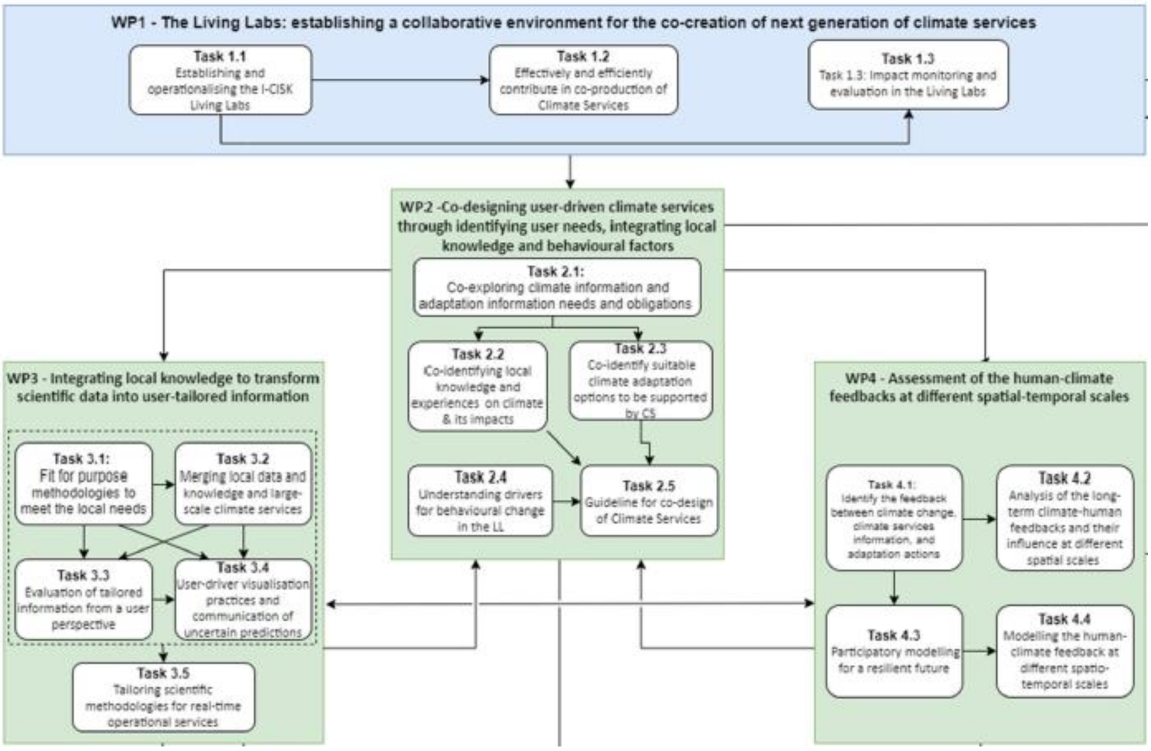

Figure 2: PERTT Diagram showing the I-CISK project structure

The information generated will lead to the co-design of tailored CS to inform the identified decision processes. The aim is that resulting user-centred CS integrate local knowledge with scientific datasets, tailored to the appropriate spatial-temporal scale, of climate risk policy and adaptation decisions needs.

This deliverable proposes several methods and tools to help LL co-explore climate adaptation options supported by the CS and contextualized to the needs and goals in each LL. It also aims to help understand what information is used to make adaptation decisions and the process by which decisions are made. These methods include in-depth interviews, questionnaires, focus groups, scenario planning, or decision timelines, among others.

The preliminary results presented in Section 4 of this deliverable build on initial responses to an exploratory questionnaire developed by T2.3 (see Annex 1) and an initial workshop in the case of the Andalucía-Los Pedroches LL. These results will be further developed throughout the project in an iterative process of interaction with the different I-CISK LL and other WP and tasks[1]. The result of this iterative work will be included in D2.6 (month 30 of the project).

[1] The iterative process was initially laid out in Step B of the I-CISK Prototype Framework (I-CISK, 2022, p.26) and has been further developed and adapted in this deliverable.

3. .Methodological approach to understand the adaptation option space in I-CISK living labs

As Vincent *et al*. (2020) point out, a key first step and essential component of any co-creation process is to build and maintain trusted relationships with the different user groups through continuous, transparent, bidirectional and systematic interaction and exchanges with stakeholders. The methodological approach to elicit the information necessary for the development of user-centred CS in each LL will vary depending on the socioeconomic, institutional cultural and behavioural contexts, on the type of risk and vulnerability of different user groups, and on the goals and needs of the different co-production processes. Therefore, in this section we propose a methodological approach that can assist LL to identify and map:

- Current adaptation measures supported by existing CS;
- Combination of knowledges and information used for making adaptation decisions;
- Range of adaptation options available;
- Existing barriers or enablers that impede or leverage the uptake of climate information in adaptation decisions and of improved adaptation options, and,
- User-centred climate services needed to inform these improved decisions.

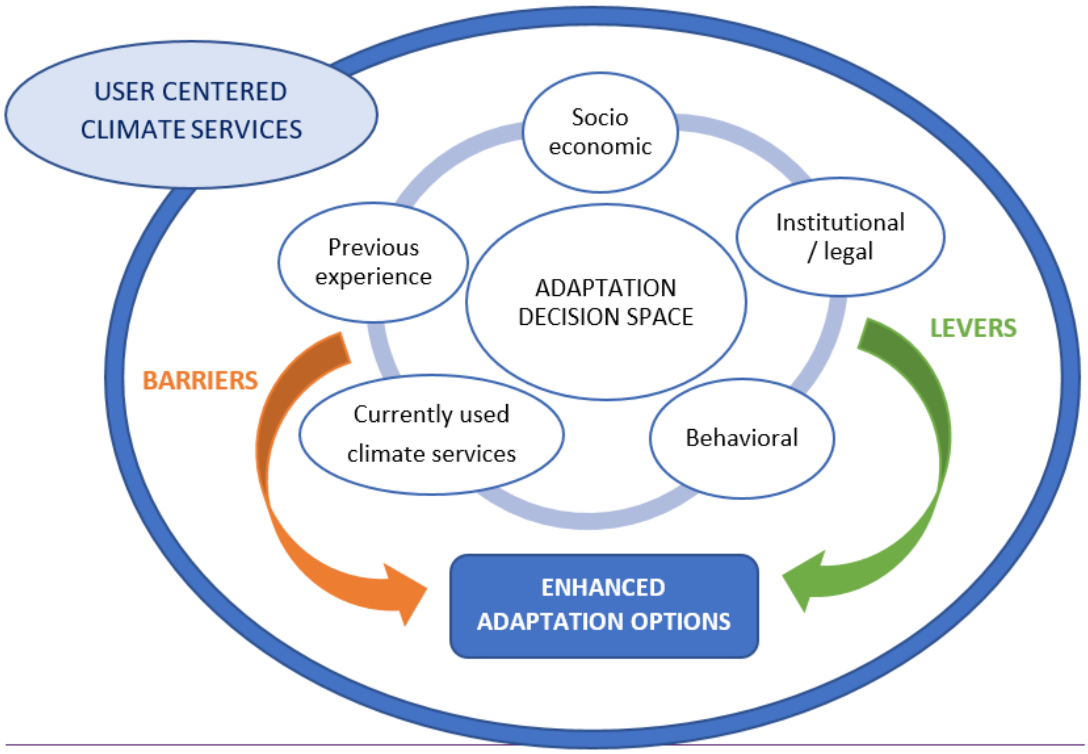

Figure 3: Conceptual framework for the investigation and mapping of the adaptation decisions option space. Source: Own elaboration.

Multi-Actor Platforms (MAP) in different LL are working with diverse typologies of actors and CS users and have different approaches for the co-creation of CS (Masih, I., Van Cauwenbergh, N., et al., 2022). In addition, other tasks within the I-CISK project will contribute to the mapping of the enhanced adaptation option space illustrated in Figure 3. This is the case of the work related to the identification of user needs and local knowledge developed in different tasks within WP2, the integration of local knowledge in the transformation of scientific data into user-tailored information, developed in WP3, or the identification of feedbacks between climate change, CS information and adaptation options, developed in WP4 (see Figure 2). Therefore, the approach proposed in this deliverable is interrelated with the work carried out in other parts of the project. It is beyond the goal of this deliverable to present the wide range of possible information gathering techniques in a co-creation process. We include some proposals and suggestions that we think are appropriate for I-CISK research goals. Existing repositories of participatory techniques can provide additional references, suggestions and resources[2].

The methodological approach described here is not linear. Information generation and understanding of the decision-making process is an iterative process with feedback loops and interactions. In this section, we attempt to structure the information co-generation process in three groups of activities that are interrelated but not necessarily sequential, and where different methods and techniques can be used in different stages depending on the needs and context of each LL[3]. In each stage, we describe the expected outcomes and the suggested methods, tools and techniques for co-generating information. The third group of activities, relating to the generation of spaces for learning and knowledge exchange, is an effort that needs to happen throughout the entire process. Different LL may have already achieved some of the outcomes indicated in different stages or phases, whereas others may still be at earlier stages of the co-creation process.

3.1. Exploratory mapping of the adaptation decision space

3.1.1. Desired outcomes

In this phase, the goal is to characterize the LL adaptation decision space, that is, to understand the context of the LL where adaptation decisions are made. Much of this work has already been carried out in the first 18 months of the project and is gathered in the LL characterization reports (Masih, I., Van Cauwenbergh, N., et al., 2022) and in the report on information on climate service needs and gaps (Moschini, F., Emerton, R., et al. 2022). The expected outcomes of this phase include co-generating the following information:

- Actor map: identify relevant actors in the decision-making process in the LL, both members of the MAP and others that are relevant at different scales (EU, national, regional, local) in the adaptation decision-making process. To the extent possible, identify the strengths and weaknesses of each actor vis-à-vis their adaptation decision-making process.
- Information used for making adaptation decisions, including socioeconomic information, institutional context, behavioural information, past experience, in addition to currently existing climate services.
- Governance context into which climate information will be communicated and used.
- Currently implemented adaptation decisions, including their temporal and spatial dimensions.
- Potential adaptation options and resulting climate information needs.

3.1.2. Suggested methods, tools and techniques for co-generating information

A variety of methods and tools can be used at this stage. Some particularly useful ones are listed below. Table 1 at the end of the section links the desired outcomes for this phase with potential methods that can be employed to achieve them. Many LL are already using these methods in their work with the MAP.

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[2] Some useful repositories include: https://naturalsciences.ch/co-producing-knowledge-explained/methods/td-net_toolbox; https://www.participatorymethods.org/. Another useful guide can be found in Brower et al. (2016).

[3] This methodology complements and adapts the proposal included in Step B *Co-identify adaptation pathways and disaster risk reduction strategies to be supported by the CS* of the I-CISK co-creation framework, based on the experience gained in the co-creation process in the Andalucía LL in the first 12 months of the project.

a) Literature review, both grey and academic literature, relevant to the LL, the climate risks and the adaptation options. Explore the implementation of additional DRR strategies in other contexts that are potentially relevant to the LL and share them with the LL users.

b) In-depth open-ended interviews. These have been used in some LL to develop the characterization reports (Masih, Van Cauwenbergh et al., 2022) and establish a baseline of shared needs and goals. While useful for the exploration of the decision-making context, open-ended interviews sometimes provide poor resolution of information needs and should be complemented by other tools.

c) Questionnaires. Questionnaires are useful tools to gather information from a large group in an efficient way. Questionnaires can gather both qualitative and quantitative information. However, information gathered is often not detailed or nuanced. An exploratory questionnaire was designed within Task 2.3 to help LL elicit initial information on the adaptation decision-making process in each LL (see Annex 1). Section 4 of this report includes a summary of the results obtained from the different LL.

d) Network maps can be used to co-explore the organizational governance context into which climate information would be communicated (Hirons et al., 2021) and map the LL institutional context (Beier et al., 2016).

e) Exploratory workshop. A workshop is a space that brings people together to seek their opinions, exchange knowledge or solve problems in a collaborative and creative environment. Different exercises, techniques and methods can be used in a workshop depending on the goals, context and participants. The flexibility and creativity afforded by a workshop space make it an ideal format for the co-creation process that is at the core of I-CISK. Many of the tools described in the online guides mentioned earlier can be used within a workshop. There are also many free online resources with tips and suggestions for organizing an effective workshop such as JISC (2014) and Chambers (2004). Ideally, LL leaders will adapt the activities and dynamics of the workshop to the specific needs and point in time in the co-creation process. Box 1 below includes some useful tips to keep in mind when organizing a participatory workshop.

Box 1. When organizing a participatory workshop, keep in mind:

- ✓ Make sure to **engage** all the actors needed for the goals of the workshop.
- ✓ Find a **location** that is large enough and allows flexibility in room organization (moveable chairs and tables).
- ✓ **Feed creativity**. Make food and refreshments available throughout the workshop.
- ✓ **Identify participants**. When there are only a few participants, make a round of introductions where each states their name and affiliation. When there are many participants, use other means of identification: providing a list of participants together with other workshop materials, use name tags, etc.
- ✓ **Manage expectations**. Explain clearly the goals of the workshop – perhaps with a concise concept note and agenda, how the outputs will be used and the next steps.
- ✓ **Let them talk**. Provide ample space for interactions among participants. Combine different activities, making sure there is space for small group work (5-8 people), but also plenary sessions for debriefing of the work undertaken in groups.
- ✓ **Make participation possible**. Be mindful of potential budgetary restrictions of participants (for instance from NGOs). Compensate their travel expenses if necessary.
- ✓ **Provide feedback**. Prepare a summary of the workshop, including materials used, photographs, participants and results. Share this document with participants for their review and agree with them on future use of this output.

Table 1 below illustrates the different methods and tools that can be used to obtain the identified outcomes in this phase of the process.

Table 1. Relationship between desired outputs and possible tools

Tools	Desired outcomes				
	Potential adaptation options	Resulting climate information needs	Actor map and network map	Information used for adaptation decisions	Currently implemented adaptation decisions
Literature review	X				
Interviews	X	X	X	X	X
Questionnaire	X	X	X	X	X
Exploratory workshops	X	X	X	X	X

Note: cells highlighted in yellow indicate it is an applicable method to obtain the desired outcome.

3.2. Identification of enhanced adaptation options and barriers for implementation

3.2.1. Desired outcomes

The goal in this stage is to:

- Validate and characterize the adaptation options identified in the first step, as well as explore other possible adaptation options not previously considered.
- Identify barriers, windows of opportunity and enabling conditions to implement enhanced adaptation options.
- Continue to characterize the necessary user-informed climate services for enhanced adaptation decisions.
- Identify necessary and missing climate information.
- Identify the network of interactions that support adaptation decisions – partnerships, flows of information, consequences and feedback loops between climate change, CS information and adaptation options.
- Understand how decision makers deal with uncertainty, what level of uncertainty/risk is acceptable?

3.2.2. Suggested methods, tools and techniques for co-generating information

Below we suggest some potential methods, tools and techniques that can be used to co-generate the information necessary to obtain the desired outcomes listed above.

3.2.2.1. In-depth discussions with MAP members

- Meetings with individual stakeholders or members of a stakeholder organization. Following up on the initial workshops online or in-person meetings with representatives of a stakeholder group can help obtain more in-depth information and/or clarifications. Regular online follow-up meetings can serve to exchange/clarify information and update on progress.
- Focus groups discussion. Focus group discussions can involve a small group of stakeholders (4-8) within the MAP that face similar adaptation challenges – for instance hotel owners, recreational boaters, livestock breeders, farmers, etc. – and can speak comfortably together, share common problems and a common purpose. They can be used to elicit information, build consensus, validate information

gathered by other tools, identify problems and solutions, plan or review. For more information on organizing and facilitating focus group discussions see e.g. Krueger and Casey (2015).

3.2.2.2. Workshop: Scenario-based adaptation measures

The goal of this workshop would be to characterize the enhanced adaptation option space (information, barriers, levers, etc.), elicit possible adaptation measures for different climate change projections generated in the context of I-CISK, and characterize the network of interactions that support adaptation decisions.

A wide variety of techniques can be used during the workshop to help in the exploration process. Table 2 links the desired outputs with potential methods that can be employed to achieve them. Below we list some techniques that can be particularly relevant to the goals of Task 2.3.

Table 2. Relationship between desired outputs and possible outcomes

Tools	Desired outputs					
	Characterize adaptation options	Identify barriers, opportunities and levers	Characterize user-informed climate services	Identify missing climate information	Networks of interactions, consequences and feedback	Uncertainty
Follow up one-on-one meetings						
Focus groups						
Participatory scenario planning						
Participatory back-casting						
Decision or problem tree						
Timelines of decision-making						

Note: cells highlighted in yellow indicate it is an applicable method to obtain the desired outcome.

- Participatory scenario planning, a "multi-stakeholder approach designed to enable access to, and understanding and collective interpretation of, seasonal climate forecasts and associated uncertainty into locally relevant information that is useful for decision making and planning" (CARE International, 2017). This is an exploratory approach that can help integrate seasonal and sub-seasonal forecasting, and climate change projections with information on adaptation options and resulting information needs. Participants are asked to identify risks, opportunities and alternatives under different climate scenarios to develop possible adaptation actions. Scenarios are explorative and therefore allow for a discussion on the consideration of – and tolerance toward – different levels of uncertainty.

- Participatory backcasting, is a method for planning the actions necessary to reach desired future goals in a workshop setting (Vergragt and Quist, 2011). Backcasting usually takes a perspective of 25–50 years and is a useful method when there is a willingness to change behaviour to reach the desired goals. In the context of I-CISK it can serve to explore possible adaptation options and the relationship with preferable futures resulting from different adaptation action arenas (Palomo et al., 2011).

- Decision or problem tree. This is a flow diagram tool, used to identify causes and effects of key issues or decisions. In I-CISK it can be a useful tool to place adaptation decisions in their wider context, and identify the information, barriers and levers that influence the decision-making process. For more information see: https://mspguide.org/2022/03/18/problem-tree/

- Timelines of decision-making. Timelines of decision-making are a graphic method of representing a sequence of critical moments in a decision-making process that an actor, community or organization considers important. In the case of I-CISK, it is a helpful tool for the early stages of building relationships and engaging in mutual learning about past history and current identity.

3.3. Exploring opportunities for social learning and knowledge exchange

3.3.1. Desired outcomes

Throughout the co-creation process of mapping the adaptation option space it is important to actively seek and support opportunities for social learning and knowledge exchange, both among members of the MAP within LL as well as among MAP members in different LL.

3.3.2. Suggested methods

Among members of the MAP within LL:

Within the LL, knowledge exchange can occur in each of the MAP activities. Special attention should be placed to enabling these learning opportunities. It is important to try to identify and point out potential synergies and learning opportunities. LL leaders should aim to develop activities that highlight the LL as an interconnected social ecosystem where actors and actions within the LL are interrelated. Some potential activities include:

- Multi-sectoral dialogues: provide topic-specific opportunities for members of the MAP from different sectors to interact and learn from each other.
- Organize small group discussions and plenary sessions in the LL workshops to enhance cross-sectoral exchanges and learning.
- LL newsletters where all MAP members can include activities, news and other updates.

Among members of the MAP in different LL

Among LLs, I-CISK's the *Roadmap for collaboration* (Werner et al., 2022) provides a practical framework for collaboration and interrelations among partners and WP. However, an effort can also be made to create spaces for co-learning across LL and among actors in the different LL.

4. Preliminary results from the living labs

This section presents preliminary results from some activities conducted by the LL for the exploratory mapping of the adaptation decision space (Phase I described in section 3.1 above). The information was gathered through a questionnaire and an exploratory workshop in the case of the Spanish LL.

The questionnaire (see Annex 1) built on the one previously developed to identify climate information needs (Moschini, F., Emerton, R., *et al.* 2022). It has seven sections that address the following issues:

- personal information of the respondent;
- type of climate risk in the LL;
- existing adaptation measures implemented per climate risk;
- information used to make adaptation decisions;
- relative importance of the different sources of information used to inform the adaptation decision;
- additional potential new or enhanced adaptation options and resulting CS needs; and
- barriers to adopt and implement new/improved/more effective adaptation measures.

The questionnaire was shared with the LL in early September 2022. Between September 30 and December 15 2022, we received responses from all LL with the exception of Lesotho, which at the time of the survey was still under development. In some LL, like Greece, Georgia and Hungary, LL leaders responded to the questionnaire and provided one summary response for the entire LL. In the case of the Netherlands, LL leaders filled out the questionnaire based on the information gathered in meetings with MAP members. The Italian LL shared the questionnaire with MAP members. The Spanish LL did not share the questionnaire with stakeholders but, rather, obtained the information through an exploratory workshop with all members of the MAP held in Pozoblanco, Spain, on October 25, 2022.

Table 3. Questionnaire responses received and respondents

Living Lab	Responses received	Information provider
Alazani river basin, Georgia	One for the LL	LL leader
Erzsébetváros, Budapest, Hungary	One for the LL	
Emilia-Romagna, Italy	IRETI water utility	MAP member
	AREN Electric Power	
	Regional Environmental Agency ARPAE	
	Regional government - RER	
Crete, Greece	One for the LL	LL leader
Rijnland, the Netherlands	Water management	LL leader
	Recreational shipping	
	Agriculture	
Andalucía-Los Pedroches, Spain	Forestry	MAP workshop
	Livestock farming	
	Agricultural	

In the following sections we summarize the results obtained from the questionnaire in each LL, when necessary complementing it with the information gathered in Deliverables 1.1 on the Characterization of the LL (Masih, I., Van Cauwenbergh, N., et al., 2022) and Deliverable 2.1 on information of climate services needs and gaps (Moschini, F., Emerton, R., *et al.* 2022). The information is organized in the order the questions were presented in the questionnaire.

4.1. Contextual information of the living lab

In order to understand the context in which climate-risk adaptation decisions are made, the characteristics of each LL are summarised in Table 4 and in this section (extracted from Masih, I., Van Cauwenbergh, N., *et al.,* 2022 and Moschini, F., Emerton, R., *et al*., 2022).

4.1.1. Alazani river basin, Georgia

The Georgia LL focuses on the Alazani river basin, a transboundary river shared between Georgia and Azerbaijan. Due to the complex mountainous topography and diverse climate settings, Georgia is subject to various climate-related hazards. Over the last decades, the number of natural disasters has increased almost threefold. The Alazani river basin in Georgia (with a length of 205 out of 390 km) begins at 2750 m above sea level in the Main Caucasus Range and carves its way through the Alazani plateau to the Mingachevir reservoir, on the border with Azerbaijan. The region is highly dependent on agriculture (38% of the region's GDP) which in turn relies on water availability for irrigation. The number of hydropower plants in the basin has increased over the last decades, and there are several new planned projects. Water demand is likely to increase in the next decades. The LL focuses on drought and flood risks. The MAP is made up of environmental organizations, agricultural interests, water managers and representatives of research and academia.

4.1.2. Erzsébetváros, Budapest, Hungary

The Hungarian LL is situated in the Erzsébetváros district, an inner-city area of Budapest that is densely built. In Budapest, the urban heat island effect is exacerbating the effects of the summer heatwaves in the city. The inner city, where there are fewer green areas, more impervious surfaces and more buildings, can experience a difference of 7°C (2-4°C during the spring and 3-6°C during summer) in surface temperature compared to the green areas surrounding the city.

Europe has experienced an increase in heatwave frequency. Hungary is no exception, with a particularly hot summer in 2021 (the 5th hottest in history), where four heatwaves took place. In a climate change context, the severity and length of heatwaves are expected to increase. In urban areas, the urban heat island effect exacerbates the severity of heatwaves, particularly in inner-city areas where green spaces are scarce. The Erzsébetváros district is more exposed to heatwaves as it has a low percentage of green spaces, a high percentage of artificial surfaces and density of buildings, and it lacks natural ventilation. Heatwaves cause health problems, particularly for vulnerable population – e.g. pregnant women, the elderly, children, people living with chronic illness. Air quality and air pollution caused by traffic in the district are further exacerbating heat-exposure related health problems. They also negatively affect some parts of the economy, like tourism.

The MAP in the LL is made up of the municipalities of Erzsébetváros and Budapest; the National Public Health Institute (OKI), responsible for monitoring the health consequences of heatwaves and instrumental in the operation of the national heat alarm system; the Department of Meteorology of Eötvös Loránd University; and civil society organizations such as the Clean Air Action Group.

4.1.3. Emilia-Romagna, Italy

The Italian LL is located in the Emilia Romagna Region (RER), in the Po River basin district, one of the most economically productive and densely populated areas in Italy. Surface water resources from the Po River and its tributaries are used for agriculture, industry and domestic water supply. Despite its abundant water resources, the area is vulnerable to the increased frequency and intensity of extreme weather events that contribute to the seasonal variation in water availability.

Table 4. Contextual information for each living lab

Living Lab	Sectors Involved	Main hazards in focus under I-CISK	Participating Stakeholders and Relevant End Users	Key Motivations
Alazani river basin, Georgia	Hydropower, agriculture, environmental protection, forestry, tourism, water resources management, environmental protection	Drought, Water scarcity Floods	Regional governmental bodies, city councils, National Environmental Agency, Department of Environment and Climate Change, NGOs, Telavi State University, Hydropower authorities, farmer cooperatives, citizens, environmental conservation groups.	Plan economic activities in the Kakheti region. Support policy and regulations (especially the new Water Code) Plan measurements to mitigate extreme climate hazard events.
Erzsébetváros, Budapest, Hungary	Tourism, Health, Urban planning	Heatwaves, Urban heat islands	Municipality of Erzsébetváros district, mayor's office, Clean air action group (NGO) and other NGOs, residents, local authorities.	Increase preparedness and adaptation strategies for heatwaves and drought in relation to urban planning and citizen awareness, due in part to negative impacts on health and tourism.
Emilia-Romagna, Italy	Agriculture, Industry, Water allocation, Energy, Utilities Environmental management,	Drought Water scarcity	Irrigation consortia, water utility companies, regional government, regional environmental agencies, regional planners, hydropower producers.	Avoid conflicts linked to high water demand during the dry season and revise adaptation strategy.
Crete, Greece	Tourism, Energy, Transport infrastructure, Water resources management	Drought, Water Scarcity, storm surge, floods, heatwaves, wildfires, coastal erosion	The Greek National Tourism Organization, the Organization for the Development of Crete S.A , the Regional Development Company of Crete SA , the Municipal Port Fund of Rethymno, Elounda SA Hotels & Resorts and Greek tourism confederation (SETE)	Avoid conflicts linked to high water/energy demand during summer. Improve information use to support planning and adaptation for tourism. This also means including intersectoral linkages in a touristic service and adopting informed, operational decisions in the inter-linked sectors to support the touristic product. Increase preparedness and adaptation strategies in the tourist and transportation sectors.
Rijnland, the Netherlands	Water recreation, Commercial shipping, Tourism, agriculture, Ecosystem management, Water management	Drought, Floods	Rijnland water board, actors within sector organizations, water tourists, farmers.	Influence preparedness and adaptation strategies from sub-seasonal to climate change timescales for organizations and citizens.
Andalucía-Los Pedroches, Spain	Agriculture, animal husbandry, forestry, Natural area management	Drought, water scarcity	Olive farmers, livestock farmers, farming cooperatives, feed producer, natural park manager R&D, river basin authority, forestry	Impacts of changes in precipitation and temperature and water availability on agriculture, livestock farming and natural area management.

Source: Adapted from Moschini, F., Emerton, R., *et al.* 2022

Human activities contribute to exacerbate the vulnerability to water shortages in the area, threatening those sectors with low adaptive capacity. Increased water demand and lower water availability has resulted in a failure to meet water needs on several occasions. This can cause environmental problems, such as a decrease in the quality of surface water bodies, with critical impact on ecosystems and sensitive species.

As part of the "Climate Plans in Emilia-Romagna" initiative, provinces and municipalities in the region have been involved in the construction and implementation of climate adaptation plans, using a common methodology. The RER is aware that climate change necessitates economic choices and behavioural changes in every sector. In 2019, a regional forum on climate change was created, guided by the regional Directorate-General for the Care of the Land and the Environment. The aim is to share transparently its choices, efforts, and above all its results with citizens, businesses, and public administration.

The MAP of the RER LL is made up of representatives of the main actors with interests in the water sector: policy makers, business and industry, and agriculture.

4.1.4. Crete, Greece

The island of Crete LL, in southern Greece, is characterised by a variable landscape with extensive mountainous regions in the central part, and flat areas close to the shoreline. Crete is among the flagships of the country's tourism industry, with a thriving tourism sector. Being a large island, it concentrates a significant and varied economic activity and plays an important economic role for the country. As an island, it offers a good opportunity to study a region with well-defined boundaries and autonomous physical and energy resources management. This LL focuses on the tourism sector. Water availability can impede tourism as an economic activity since it is directly associated with the guest experience. Further, energy demand, especially for cooling needs during the hot summer days and nights, is an important consideration for the tourism industry. Flood impacts (coastal and river) are primarily related to transportation infrastructure (mainly ports and roads), which supports the economic industry as well as tourism related infrastructure. Crete is among regions of Greece most vulnerable to climate change, presenting high vulnerability on tourism and transportation sector, followed by health, agriculture and water resources. The MAP comprises national and local authorities responsible for planning (policy makers), authorities responsible for implementing infrastructure projects and tourism-related private businesses and business organizations.

4.1.5. Rijnland, the Netherlands

The Rijnland LL is situated on the west coast of the Netherlands, on the North Sea, between the cities of The Hague and Amsterdam. The Rijnland water authority (https://www.rijnland.net/) is the institution responsible for water management in this region. The LL area is mostly flat and below sea level. Extensive dunes along the coast are important for protection against the sea, but also for water supply to the cities through Managed Aquifer Recharge schemes. The surface water system serves both irrigation and drainage, with pumping stations discharging excess water to interconnected canals and out to the North Sea. During dry spells, fresh water is let in from the Rhine River, and supplied to low-lying polders through the same interconnected canals. The aim of the LL is to combine short and long-term climate information in one service, to facilitate the co-development of climate adaptation strategies. The Rijnland MAP involves water managers - the Rijnland water board -, research and academia, civil society organizations and representatives from the main water use sectors, mainly tourism and agriculture.

4.1.6. Andalucía-Los Pedroches, Spain

The Andalucía-Los Pedroches LL focuses in the *comarca* (region) of Los Pedroches, a primarily agricultural area located in the north of the province of Córdoba, in the autonomous region of Andalucía, Spain. It also includes the Sierra de Cazorla, Segura and Las Villas Natural Park in the upper Guadalquivir RBD as a complementary site for testing the CS developed for forest landscapes. Spain is located within the Mediterranean region, where droughts are a recurring feature. The country experiences significant climatic and rainfall variability, both seasonally—with dry, hot summers and colder, more humid winters—and interannually—with periodic drought cycles of varying intensity and duration. Climate change processes will affect the Mediterranean region. Predicted adverse impacts include more severe droughts, decrease in runoff due to increased temperature and evapotranspiration, and seasonal shift of rainfall patterns.

The agricultural sector is particularly vulnerable to drought. This is the case for both rainfed and irrigated agriculture, since climate change processes will affect the availability of both blue and green water. However, rainfed agriculture and extensive livestock farming have a limited range of adaptation options available in the short term. The Comarca is a primarily rainfed agricultural region, where different land use systems and landscapes coexist. This diversity of landscapes and land uses, the high ecological and socio-cultural value of the *dehesa*[4] and the *olivar de sierra* agroecosystems, their vulnerability to climate change and hydroclimatic risks, make Los Pedroches region a particularly relevant site for the I-CISK project.

The Andalucía MAP is composed of water and natural area managers, education community, research and academia, business and industry and civil society organizations, from the agricultural, animal husbandry and natural area management sectors.

4.2. Adaptation options currently implemented to minimize the impacts of climate-risk(s)

4.2.1. Alazani river basin, Georgia

LL leader CENN (a regional development organization), responded to the questionnaire on behalf of the MAP. The following drought adaptation decisions currently implemented in the LL were identified:

Agricultural sector current adaptation measures

- Reduce the losses of irrigation water: legalize the irrigation regime; adhere to irrigation norms, terms and frequency; preferential use of sprinkler and drip irrigation.
- Increase efficient use of irrigation water through measures such as rehabilitation and reconstruction of irrigation systems, introduction of new water-saving systems.
- Select drought-resistant agricultural crops adapted to local climatic conditions.
- Outreach to the agricultural community regarding increased drought risk, vulnerability of agricultural crops to climate change processes, and promotion of adaptation and mitigation measures.
- Improve water management properties of the soil cover (moisture capacity, water permeability, water retention) and erosion resistance.
- Inform local population (especially farmers) and local government about desertification processes.

4.2.2. Erzsébetváros, Budapest, Hungary

In terms of adaptation to heat waves and urban heat island effect risks, the municipality of Erzsébetváros has prepared a Climate Strategy. It aims to expand green infrastructures in the city – green areas, green roofs, green walls, green backyards, shading of buildings (public and private) and public transport spots (with green roofs) –, and the establishment of drinking fountains or other places to drink water during heatwaves (like

[4] A *dehesa* is a multifunctional, agro-silvopastoral system and cultural landscape of southern and central Spain and Portugal. The main tree component is oaks, usually holm and cork. It is primarily used for grazing and raising bulls, Iberian hogs, fed with the oak's acorns, and other free-ranging livestock (sheep, cattle).

requiring restaurants to provide water). It also aims to organize a heatwave alarm system and a public education campaign on adaptation strategies. The municipality has already reached some of these goals. It prepared a heatwave alarm strategy, which contains action plans, including opening cool places for citizens during heat waves. The municipality's webpage contains citizen advisories. They initiated a campaign for restaurants and pubs to provide drinking water during heat waves, but it was not very successful, primarily due to inadequate communication. The information on this initiative was not sufficiently disseminated.For their part, residents in the district followed individual adaptation practices during heatwaves: drink fluids, protect themselves with clothing, avoid certain places affected by the heat, use shading in apartments and travel to green areas/forests/watersheds.

The adaptation strategies include measures like shading or providing water for people during heatwaves, but also the improvement of green infrastructure in both public and private spaces. The establishment of new green areas is a challenge, as there is a demand for parking spaces, and in general, there is a shortage of available free space. In both strategies, the municipality has a defining role along with residents.

4.2.3. Emilia-Romagna, Italy

The members of the LL MAP that responded to the questionnaire are implementing the adaptation strategies for drought and water scarcity risks summarized in Table 5:

Table 5. Drought and scarcity adaptation options in the Emilia Romagna region LL

Stakeholder	Adaptation measures currently implemented
IRETI water utility	• Finding leaks in the water supply network, interconnecting aqueducts and improve pumping efficiencies. • River discharge control with flowmeters remotely controlled.
AREN Electric Power	Schedule maintenance intervention in the plant during summertime, in order to minimize production losses.
Regional Environmental Agency ARPAE	• The *Observatory on climate change and related impacts*, active since 2017, works to identify and document climate change processes, elaborate future climate scenarios and identify related impacts, and analyse specific intervention options for the integrated regional plans. The Observatory has been involved in the definition of the RER climate change adaptation strategy by means of climate projections provided by ARPAE. • Provision of observed and forecast meteorological and hydrological data.
Regional government - RER	• Planning through water demand management. • Decide environmental flow and related exceptions. • Set the rules for restriction to water use in case of shortage. • Set the rules for new withdrawal authorizations (including new permit requests and periodic renewal of existing permits)

4.2.4. Crete, Greece

Table 6 summarizes the adaptation measures implemented in the Greek LL for different climate risks and from the perspective of different members of the MAP (noted in bold).

Table 6. Currently used adaptation measures in the Crete (Greece) LL

Climate hazard	Adaptation measures currently implemented
Drought and water scarcity	**Water manager**: • Invest in new reservoirs. • Improve water distribution and water use monitoring. • Improve information on future possible risks (climate change impact studies). • Create an operational service for short-term forecasting of water quantity and quality in one of the reservoirs it manages **Luxury resorts manager**: • Improve water management • Close the water circle within the facilities (water reuse).
Floods	**Water manager:** Establish better communication with Civil Protection
Heatwaves	**Water manager** (increased energy consumption for cooling needs): • Install renewable energy sources systems to cover energy needs **Port managers:** • Deploy bioclimatic canopies and blinds in the wider terrestrial zone of the port, to reduce energy consumption and protect the public against extreme heat
Sea surges and sea level rise	**Port manager:** Studies and projects for port protection – new breakwater.

4.2.5. Rijnland, the Netherlands

Table 7 summarizes the adaptation measures implemented in the Rijnland LL for drought risk from the perspective of different members of the Rijnland MAP.

Table 7. Currently used adaptation measures in the Rijnland LL

Stakeholder	Adaptation measures currently implemented
Water managers	Before a drought: • Increase alert level of organization, i.e. scaling up state of preparedness, e.g.: starting meetings of drought response team; planning meeting of regional drought management team; assessing/planning personnel availability in case inspections of embankments for drought damage will be needed. • Increase frequency of drought monitoring reports. • Prepare drought risk management measures, e.g. limit ship lock operation. • Inform water users in the area of upcoming measures. During drought: • Activate alternative freshwater inlet route (Klimaatbestendige wateraanvoer or KWA, a small-scale water supply, recently upgraded to climate-robust water supply). • Monitor to decide on need for further drought event measures, continue present measures, or to stop measures (end of drought).

	• Organize think tank meetings with water user groups to inform and discuss measures, why measures are needed, impacts and predictions on how much longer the drought and measures will last. Climate change intensified / more frequent drought: Increased capacity of alternative route for freshwater supply. Engaging with stakeholders to explore if current sensitivity of their activities to summer droughts can be reduced in the future. Details to be confirmed by Water Board MAP members
Recreational shipping	Before a drought: the 2018 drought is still ongoing (in March 2023). In 2022, in response to alerts that the drought may further intensify and water management measures may further restrict recreational shipping, re-routing or change of holiday plans may have been done. During drought: reactive, when ship-locks are closed/restricted for recreational shipping, boat owners change their timing and/or route/location for planned water holidays. Events by boating-clubs may be cancelled/postponed. Many boat owners were stuck and/or delayed in a boat-traffic jam before the ship-locks.
Agriculture	During drought: intensive irrigation campaign and, sometimes, close gates to hold water/prevent saline water from reaching the fields.

4.2.6. Andalucía-Los Pedroches, Spain

In the Andalucía-Los Pedroches LL, MAP members identified adaptation measures for the different sectors and drought-related impacts. Participants in the workshop worked individually to fill out information-gathering sheets designed by LL leaders (see Annex 2). The information was then discussed and validated in a plenary session. The results are summarised in Table 8. Below we also include some pictures of the workshop.

Figure 4: Individual work (A and B) for identification of adaptation measures, barriers and climate service needs, and plenary session (C, D and E).

Table 8. Currently used adaptation measures in the Andalucía LL

Stakeholder	Primary drought and climate change impacts	Adaptation measures currently implemented
Livestock farmers	• Drop in groundwater levels • Increased temperatures and duration of heatwaves • Lower pasture productivity (acorns and grasses) • Holm oak mortality • Need for complementary corn and other fodder	• New wells or deepening of existing wells • Install showers for milk cattle (cooling) • Buy feed to supplement rangeland cattle feed • Manage supplementary livestock feed • Rotational grazing • Redistributing the stocking rate (sell cows and buy sheep) • Transhumance[5] • Advance sale of hogs • Adapt stocking rate • Education and outreach to ranchers on adaptation options
Agriculture and olive growers	• Increased frequency and intensity of extreme weather events • Phenological changes in the flowering periods of olive trees • Reduction in the frequency and amount of rainfall and change in soil moisture • Decreased production	• Increase organic content of the vegetation cover (ecological agriculture) • Change tillage practices (grass) for soil conservation • Grazing management • Proper management of herbaceous cover
Forestry and natural areas management	• Changes in seasons and snow periods • Phenological changes • Changes in the distribution and abundance of forest species • Increased tree mortality • Reduction of surface flows • Increased fire risk period • Reduced production of forest resources	• Appropriate silvicultural treatments (pruning, thinning) • Control of tree density/reduce harvesting intensity • Removal of decaying trees and dry fuel • Monitor populations of threatened plant and animal species • Monitor and support natural/artificial regeneration • Control of diseases in riparian trees and oaks • Pasture improvement (native species) • Optimize the use of water resources • Require environmental impact report on new proposed wells

4.3. Information used to make adaptation decisions

In order to better understand the existing decision-making space, respondents were asked to identify the information they relied on when making adaptation decisions. The information is summarized in Table 9 below for all LL.

[5] Seasonal movement of livestock between summer and winter pastures.

Table 9. Information used to make adaptation decisions

Living Lab	Stakeholders	Information used
Alazani river basin, Georgia	N/A	Local meteorological data Expert support based on meteorological and field work based situational analysis Traditional knowledge.
Erzsébetváros, Budapest, Hungary	City climate strategy	Climate projections (ALADIN-Climate and REMO models) Data of the National Adaptation System (NATÉR), which contains information of exposure, vulnerability, sensibility and adaptation capacity of the urban buildings. It also uses data on green infrastructure, demography, health, socio-economic status of the residents and businesses, infrastructure and urban planning.
	Residents	Meteorological information. Information and advice of the city's heat-wave warning system.
Emilia-Romagna, Italy	IRETI	Internal service that deals with the networks' segmentation by districts and leakages' research related to the aqueduct pipelines. Regional services of ARPAE and RER and some internal monitoring (info from the ARPAE Hydro-meteorological site and hydrological annals).
	AREN	Public weather forecast services
	ARPAE	The Climate Observatory supports public authorities/private entities/farmers in these tasks providing observed hydro-meteorological data and weather forecasts
	RER	Climate services from ARPAE (meteorological forecasts) Real-time discharge/level data from the gauging stations monitoring network (actual data) plus current versions of the *Piano di Tutela Ambientale* (a regional environmental management plan) masterplan and related rules (dated back to 2005)
Crete, Greece	N/A	Meteorological information, past experience and personal knowledge. Some stakeholders contract climate change impact assessment studies.
Rijnland, Netherlands	Water management	**Before drought**: up to two-week predictions of potential local and national precipitation, deficit and streamflow of the River Rhine at Lobith (station at the border where the river enters the Netherlands). **During drought**: monitoring of potential precipitation deficit, discharge of the River Rhine at Lobith, salinity at a number of locations throughout the Rijnland water system and of the receiving and supplying waterways. **Climate change:** intensified/more frequent drought: KNMI '14 climate change scenarios (https://www.knmi.nl/kennis-en-datacentrum/achtergrond/knmi-14-klimaatscenario-s)
	Recreational shipping	**Before drought**: drought monitor of Rijnland water authority with 2-week outlook **During drought**: announcements from the Rijnland water authority on active and upcoming ship lock restriction measures.
	Agriculture	Observations from farmers of the field status of crops and land (based on past experience). Salinity measurements in Surface water.
Andalucía-Los Pedroches, Spain	Livestock farming	Groundwater measuring gages 15-day predictions of the National Meteorological Service (AEMET) REDIAM and CICAP Meteorological stations Local meteorological stations 15 day predictions (eltiempo.es) Traditional knowledge-based meteorological calendar (Cabañuelas)
	Agricultural	Daily and 15-day climatic predictions (AEMET and eltiempo.es) Digital data on pasture stress (drones and Sentinel) Traditional knowledge Historic climatic information
	Forestry	AEMET predictions and projections Historic climatic information

Respondents were then asked to rank the relative importance (rank 1 for low to rank 5 for high) of the different sources of information from a predetermined list of possible sources. Table 10 summarizes the results of this ranking in those cases in which respondents made this information available. In the Spanish workshop, this issue was not addressed.

Table 10. Relative importance of different sources of information in making adaptation decisions

Living lab	Stakeholder category	Meteorological information	Hydrological information	Past experience	Existing regulations	Economic information / situation	Climate projections	Knowledge transfer from institutions or other actors	Traditional knowledge
Georgia		5	5	4	4	4	4	3	3
Hungary	Municipality	5	1	3	5	5	4	-	-
	Residents	5	1	4	2	5	1	3 [1]	-
Greece		3 [2]	3	5	4	4	1-4 [3]	4 [4]	2
Italy	AREN	3	4	5	5	5	2	2	3
	RER	3	4	4	5	5	4	4	3
Rijnland	Agriculture	2	3	5	4	5	1	5 [5]	5
	Recreational shipping	1	1	4	3	1	1	5 [6]	1
	Water management	4	4	4	4	2	3	4 [7]	2

[1] Heat wave warning system of the Hungarian National Centre for Public Health
[2] For micro-management adaptation.
[3] Depending on the familiarity with climate change impact assessments
[4] Only for those who have assigned to consultants the assessment of climate change impact assessments.
[5] Information from water authority on ongoing drought and water management measures.
[6] Information from water authority on ongoing drought and water management measures
[7] Information on potential precipitation deficit now and two weeks a head from KNMI and Rhine discharge at Lobith now and up to 2-weeks lead-time from Rijkswaterstaat
Note: 1 is hardly or not important and 5 is very important. Shaded in grey the highest ranked source of information.

Figure 5 shows the ranked importance of the different sources of information as an average of the value assigned to each by survey respondents. It shows that experience is a determining factor when making adaptation decisions, closely followed by the financial considerations and existing regulations. Traditional knowledge ranks low, but was the most important source of information for the agricultural sector in the Rijnland LL. In the Spanish LL, representatives of the agricultural and livestock farming sectors also highlighted the importance of traditional knowledge for making decisions. Furthermore, the questionnaire did not include a definition of each term so that it is possible that “traditional knowledge” and “past experience” can be understood differently by different respondents and, in some cases, can be viewed as complementary.

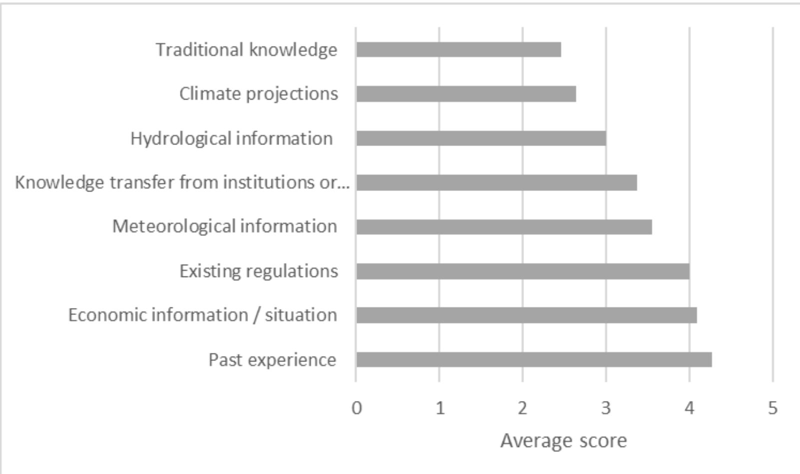

Figure 5: Ranking of the relative importance of different sources of knowledge for adaptation decisions

It is worth noting that there are certain discrepancies between the information summarized in Table 9 above and the relative importance given to the different sources of information shown in Table 10 and Figure 6. Whereas some LL mention hydrological and meteorological information as key for making adaptation decisions, when asked to rank the relative importance of different sources of information, past experience, economic information, or the existing regulatory framework, are ranked higher. The questionnaire did not allow for a more nuanced explanation of these choices, and these apparent discrepancies will be evaluated in the coming months.

4.4. Potential additional adaptation measures and required context-adapted climate services

This part of the questionnaire aimed to identify what climate services would be necessary to implement improved climate change adaptation measures, as well as identify those measures. The results are summarized in Table 11. Initial results suggest that at times it can be difficult to separate the adaptation measures from the climate services needed to implement them. This information will need to be refined in the following months in collaboration with the stakeholders.

Table 11. New and improved adaptation options and required context-adapted climate services

Living lab	New / improved adaptation measure	Climate services needed
Alazani river basin, Georgia	Based on ongoing climatic patterns and hydrological modelling, revise information regarding water resource availability, seasonality and distribution. Therefore, provide data to target stakeholders to improve water usage efficiency and minimize risk of disaster.	Streamflow prediction system for hydro power plants
		Seasonal or sub-seasonal information about possible water accumulation in the irrigation channel for agriculture
		Flooding prediction system for DRR
Erzsébetváros, Budapest, Hungary	Construction of green infrastructure	Scale relevant climate information (temperature)
		Urban planning information
	Mapping urban micro heat island spots and buildings	Scale relevant climate information (temperature)
	Adaptation of housing conditions	Apartment and / or building level data
ARPAE (Italy)	Integrate ARPAE products with new forecasts	River discharge forecast
AREN (Italy)	Plan year-round maintenance, lowering risk of production losses.	Forecast average daily discharge at 1 or 2 gauging stations in order to plan maintenance interventions
RER (Italy)	Anticipate restrictions to water abstractions and alert users, by linking drought management rules to forecasts and observed data	In the context of water resources policy making (e-flow, restrictions to water abstraction, river water balance maintenance)
	Revise water abstraction rules and, in case of water curtailments, reward users that prove making tangible efforts to improve water management, including planning of water abstraction based on water availability forecasts.	Set up rules for environmental flow reductions; restrictions to water abstractions (management of pre-emergency, pre-alarm and pre-scarcity situations), typically during drought (The compelling challenge is the management of conflict situations among different users such as industry, irrigation, and hydropower).
	Update of the next masterplan including climate change projections	Climate change projections for long-term water resources planning towards final water "users": this information will be fundamental to update masterplans and define future water allocation rules. To show they have made all reasonable efforts to efficient resource

Living lab	New / improved adaptation measure	Climate services needed
		use (rewarding element in case of resource reallocation). Variable of interest: river discharge at selected river gauges for long term projections
IRETI (Italy)	Identify the arrival of extreme drought situations and anticipate the peaks	Domestic water supply operators require forecast models that can help anticipate the arrival of extreme situations (peaks) that, in conjunction with intraday demand peaks, can determine critical situations on the network
	Anticipating drought emergency measures	A service to forecast and collect historical data Variables of interest: River discharge and precipitation
Water management (Greece)	Improve reservoir management during winter	A service to forecast seasonal surface water availability
	Improve reservoir management during extreme (flood) events	Better forecasting of floods and intensity of events, preferably at longer scales than a week
	Improve reservoir management during summer season	a service to forecast pressure on water resources – seasonal forecasting (water demand, water needs of rivalling uses such as agriculture, surface water availability)
	Long term adaptation	Long term surface water availability
Port management (Greece)	Improve port road and parking management	A service to inform on sea surging and wave conditions to support decisions of management service regarding port accessibility, even better if adapted to local port characteristics (elevation of protective measures and marina access roads)
	Improve port sewerage system management (saltwater intrusion problems)	A service to forecast sea surging in the port area
Resort management (Greece)	Long term adaptation measures for coastal protection	Long term predictions/projections regarding coastal erosion
	Planning of winter maintenance and expansion projects/works	Seasonal or monthly forecasting of intense and extreme weather conditions – need for less uncertainty and better communication of uncertainty
	Planning of client/residents' outdoor activities	A forecasting service – seasonal or monthly – regarding conditions relevant outdoor activities (e.g. sailing, hiking, urban tourism, etc.)
Agriculture (Rijnland)	Before a drought: buy and plant less drought/salinity sensitive crops for upcoming season, prepare for intensive irrigation campaign	Seasonal forecast of drought
		A good weather and drought forecast coming days/week(s)
	During drought: improved irrigation, improved field surface water operation (not hold/hold, let-in, not let-in), apply shade covers if needed	Crop water demand perhaps but also strong confidence and value in field observations
		More locations salinity observations, water board announcements on surface water management measures, radiation/temperature observations and forecasts
	If climate change intensifies/more frequent droughts: change main crops to less salinity-sensitive crops, invest in shade covers over fields/crops	Localised climate change scenario's and impact on meteorological and hydrological drought
		Time horizon expected: 5, 10, and 25 years (to be discussed with MAP)
Water management (Rijnland)	Before a drought: Infrastructural new and maintenance project planning; Plan personnel availability, e.g. for dike	Seasonal predictions of local meteorological (potential precipitation deficit) and European (Rhine) hydrological droughts

Living lab	New / improved adaptation measure	Climate services needed
	inspections; Plan and conduct regional meetings to decide and prepare measures (Logistically) prepare measures; Pre-announce measures potentially to be taken to water users, e.g. from water tourism and agricultural sectors.	Sub-seasonal (up to a month lead time) predictions of local meteorological (potential precipitation deficit) and European (Rhine) hydrological droughts
		Climate change scenarios and their potential impact on frequency, seasonality, duration, and intensity of droughts
	During a drought	More frequent drought prediction/updates to communicate and prepare for expected duration of measures and need for further measures
	If climate change intensified/more frequent droughts:	Localised climate change scenarios and impact on shipping restricting measures
		Impact on bathing water quality and maintaining minimum navigable water depth (to be discussed with MAP).
		Time horizon expected: 5, 10, and 25 years (to be discussed with MAP)
Recreational shipping (Rijnland)	Before a drought: Change/adjust boating holiday plan, (potentially change/adjust dates of boating club activities. e.g., date of entering boats in winter dry-dock and date back into the water in spring. But also social events of the boating club)	A sub-seasonal to seasonal drought prediction with expected need for water management measures that restrict recreational shipping. To allow for timely adjustment of plans (lower tariffs for booking). (To be discussed with MAP).
		A good weather and drought forecast, with expected need for water management measures that restrict recreational shipping for the coming days/week(s)
	During: change route for boating holiday and/or postpone. (Cancel boating holiday? Not mentioned, but to be double-checked)	Using the drought monitoring and website announcements of measures, with colour codes indicating the level of restrictions, of the Rijnland water board
	If intensified/more frequent droughts: Potentially change investments, e.g. for types of boats (from in-land to also handle coastal-zone waters), seasonality of activities and servicing for these, new additional locations e.g. for harbouring and anchoring club-member boats	Localised climate change scenario's and impact on shipping restricting measures
		Not discussed yet, but potentially also impact on bathing water quality and if applicable maintaining minimum navigable water depth.
		Time horizon expected: 5, 10, and 25 years (to be discussed with MAP)
Livestock farmers (Andalucía)	Build new wells or deepen existing wells	Hydrologic characterization and expected evolution in line with climate change projected impacts
	Install new water storage facilities infrastructures	Climatic predictions (3-6-12 months) Historic climatic information
	Design and install rainfall collection and use infrastructures	Climate change projections Hydrologic characterization and climate change impacts
	Reuse and reduce water consumption for cattle feed production	Climate predictions (3-6-12 months) Climate change projections
	Buy feed to supplement rangeland cattle feeding	Climate predictions (3-6-12 months) Predicted impact of climate on plant productivity
	Produce feed for cattle (cereals and forage)	Climate predictions and climate change projections Predicted impact of climate on plant productivity Hydrologic characterization and climate change impacts
	Adapt the management of the *dehesa* to future climatic conditions	Predicted impact of climate on plant productivity
	Rotational grazing	Climate predictions (3-6-12 months)

Living lab	New / improved adaptation measure	Climate services needed
	Redistributing the stocking rate (sell cows and buy sheep)	Climate predictions (3-6-12 months) Predicted impact of climate on plant productivity Historic climatic information
	Transhumance	Climate predictions (3-6-12 months)
	Advance sale of hogs (to decrease forage needs)	Climate predictions (3-6-12 months) Historic climatic information Predicted impact of climate on plant productivity
Agriculture and olive growers (Andalucía)	Adapt calendar of cultivation operations (pruning, fertilizer, pest control) with a longer lead time (several months)	Climate predictions (3-6-12 months) Climate change projections Historic climatic information Predicted impact of climate on plant productivity Hydrologic characterization and climate change impacts
	Agreements with other regions to ensure timely and economic access to feed	Climate predictions (3-6-12 months)
	Adapt harvesting dates (influences product quality) with a longer lead time (several months)	Climate predictions (3-6-12 months) Historic climatic information
	Plant new species (olive trees, pasture) adapted to new conditions	Climate change projections Predicted impact of climate on plant productivity Hydrologic characterization and climate change impacts
	Close agreements for the purchase of inputs for olive trees cultivation with a longer lead time (several months)	Climate change projections Historic climatic information Predicted impact of climate on plant productivity
Forestry and natural areas management (Andalucía)	Change in the programming, calendar and type of activities (forest management, training activities, tourist activities)	Climate predictions (3-6-12 months) Climate change projections Hydrologic characterization and climate change impacts Predicted impact of climate on plant productivity
	Reforestation with tree species adapted to new climatic conditions	Climate change projections Hydrologic characterization and climate change impacts Climate predictions (3-6-12 months)
	Appropriate silvicultural treatments (pruning, thinning)	Climate predictions (3-6-12 months) Predicted impact of climate on plant productivity Hydrologic characterization and climate change impacts
	Adapt the Common Agricultural Policy (CAP) to climate change through agro-environmental measures, eco-schemes and incentives for farmers who carry out these measures (Good Agricultural Practices = GAP)	Climate change projections Hydrologic characterization and climate change impacts
	Inventory and production of tree and shrub species resilient to local current and expected climatic conditions	Climate change projections

Those respondents that identified a need for user-centred climate information for improved adaptation decisions were asked to characterize the climate information needed for improved decision-making. The responses are summarized in Table 12, Table 13 and Table 14 below. In the case of the Andalucía LL, the information was gathered through interviews and validated in follow-up meetings with members of the MAP and in the October workshop. The information gathered in the different LL will be further developed and refined in the coming months.

Living Lab	Alazani river basin, Georgia	Erzsébetváros, Budapest, Hungary	Emilia-Romagna, Italy				Crete, Greece
			AREN	ARPAE	RER	IRETI	
Spatial resolution	Living lab territory Identified agriculture lands	Mapping urban micro heat island spots and buildings	Single hydrometric station (with publicly available historical discharge measurements)	Single hydrometric station	Single hydrometric station, replicable to other stations at catchment closures	Single hydrometric station and other points of interest	From regional level to basin level and up to local, as a port
Time scale / horizon	Sub seasonal, seasonal	If no change in the urban setting, (green areas/artificial surface) heat emission data can be used for forecasting the subsequent year.	Up to 15 days, also sub-seasonal prediction up to 4/6 weeks would be of interest	Up to 15 days	Up to 15 days, mid and long term climate projections	Up to 15 days	Weekly, Sub seasonal, seasonal, mid-long term
Temporal resolution	Monthly data corrected based on local data to fill the gaps	Twice a day during heat waves	Daily/weekly	Daily	Daily, weekly, mid-long term	Daily	Daily, weekly, monthly, seasonal
Triggers or thresholds	Daily, weekly information	Heat alarms are issued when in three consecutive the daily average temperature is more than 25 °C.	-	-	-	-	-
Lead times required	seasonal and sub-seasonal	Possibly real time data, but it depends on who will operate the data, we can update it time to time.	up to 15 days, also up to 4/6 weeks would be of interest	up to 15 days	Up to 15 days for water management, climate projections for planning	Up to 15 days	Weekly, Sub seasonal, seasonal, mid-long term
Accuracy / uncertainty of the CS	For “Streamflow prediction for hydro power”: monthly average flow. For “flooding prediction system for DRR” Daily extreme precipitation	Not relevant	if data allow Statistic forks, otherwise error metrics	boxplot with statistical distribution of forecast	Error metrics, not only average, but specific for flow regimes, eventually statistic forks if feasible	Do not know. Comparison between expected and real could be of interest.	Depending on the service. Uncertainty provision of some form is required

Table 12. Characterization of required climate services for the Alazani, Budapest, Emilia Romagna and Crete living labs

Living Lab	Rijnland, Netherlands		
	Agriculture	Water management	Recreational shipping
Spatial resolution	local for Rijnland (40 by 30 km whole area or higher resolution) (To be discussed with MAP)	Local for Rijnland at drainage unit ('peilgebied') and area average, in combination with national NL: drought outlook for the whole of the Netherlands with expected impact on water allocation measures according to pre-fixed national drought event management plan with list in order of priority of water usage. , and Rhine catchment in particular streamflow at location of Rhine entering the NL	local for Rijnland (point and line/feature information), in combination with national NL: restrictions and expected delays on ship locks and recreational shipping routes
Time scale / horizon	Up to 15 days, seasonal, and climate change have been mentioned. Sub seasonal not yet discussed, and specifics of the time horizons in each class also not yet	1) Sub seasonal forecasts. In particular, sub seasonal has been mentioned as useful for better planning of personnel, cross-institutional decision making in anticipation of and during drought events, and or earlier and better communication to and with water users in the area, e.g. from water tourism and agricultural sector. 2) Decadal and climate change projections local to Rijnland and for NL as a whole, and for Europe concerning the Rhine catchment and expected impact on low streamflow entering NL. Preferred horizons of projections have not been discussed. To be specified by the Water Board	Up to 15 days has been mentioned. Sub seasonal to seasonal not yet discussed
Temporal resolution	Not explicitly discussed, but from the measured/ operation during drought discussed: daily	Daily	Not explicitly discussed, but from the discussion I expect at least at daily, perhaps hourly temporal resolution
Triggers or thresholds	For salinity surface water, farmers have threshold in mind, for weather variables not sure. Details have not been discussed yet	Coincidence of a potential precipitation deficit over a threshold with a Rhine discharge below a threshold defines drought for the Rijnland water board. Thresholds per month are defined. Duration thresholds are not pre-fixed. Duration and subsequent need for measures to be further detailed by the water board. The drought thresholds serve as alert level after which based on additional measurements, e.g. salinity, and additional information, e.g. experience with effectiveness of measures, in committee meetings decisions are taken on a weekly basis on which measures to take, continue, and stop. Drought event management by the Rijnland water board follows detailed protocols and guidelines, in-line with national regulations	Triggers or thresholds have not been discussed yet. Rather it appears that users would like to know when, where, and how long recreational shipping restrictions will take place in combination with expected delays (like in a traffic-app) and then decide themselves on whether and how they would adjust their planning
Lead times required	1-Day up to 1-year lead time for irrigation optimisation and next season seeds ordering 5-25 Year climate change impact on droughts, for crop-choice and related infrastructural investment strategy	Lead times from two weeks up to 1 month for operational management of the dry season including drought event management if needed (e.g. planning of staff's availability for embankment inspections, preparing request for alternative water supply route in regional drought event management committee). 10-25 Year climate change impact on droughts, for investment strategy in salinity management technologies, freshwater storage, and increasing capacity of alternative fresh water supply routes	1-Day up to 3 months lead time for planning and adjusting of ongoing season's sailing events and holidays' timing, destinations and routes. 5-25 Year climate change impact on droughts, for recreational shipping clubs and marinas' investment planning for maintenance, redesign, and replacement of harbors, and membership policy and targeting e.g. for ship types more flexible in taking alternative navigation routes during droughts

Accuracy / uncertainty of the CS	Not yet discussed	The water board would like to have information on the accuracy and reliability of meteorological and hydrological sub seasonal drought predictions, both in research-focussed metrics as well as in use-case metrics, e.g. confusion matrix on ability to predict past drought events (hits, false alarms, missed events, and correct rejections). With respect to climate change information any insight that can be given on variability of impacts on drought between different scenarios and climate models and on how well the climate models replicate the current climate would be valuable	Not yet discussed

Table 13. Characterization of required climate services for the Rijnland living lab

Climate service	Temporal scale	Spatial scale	Variables	Variable components	Temporal aggregation
Climate predictions	3, 6, 12 months	250m - 1 km	Temperature	Max, min, average, number of days over a threshold	Monthly, maybe bi-weekly
			Precipitation	Temporal distribution Accumulated precipitation	Monthly, seasonal, annual
			Beginning and end of seasons	Definition of seasons in terms of solar radiation, Temperature, Precipitation and phenological data	Seasonal characteristics for each use (wildlife reproduction cycles, pasture cycles, etc.)
Downscaled climate change projections (10-30 years)	10-30 years (the latter particularly relevant for protected areas)	1 km	Temperature	Max, min, average, number of days over a threshold	Seasonal / annual
			Precipitation	Temporal distribution Accumulated precipitation	Seasonal / annual
Historic climatic data	50 - 100 years 25 years – collective memory	Prototype for the region of Pedroches	Precipitation Temperature Hydrologic variables	Historical series for T / P, hydrology, dendrology, combining with local actors' memories (perception of changes)	Depending on available data
Predicted impact of climate on plant productivity	20-30 years	1 km	Based on indicators that correlate T and P with ideal agronomic conditions for pasture (extensive livestock and wildlife) and olive production	Historical series for T / P / solar radiation, combined with historical data of plant productivity	Agronomically relevant periods
	6-12-24 months	1 km		Minimum temperature (pests), accumulated solar radiation (start and end of season)	
Hydrological characterization and climate change impacts	12 months 10-30 years	Surface and groundwater bodies	Temperature, precipitation, Surface flows, recharge, water quality (specially Nitrates)	Water storage, water recharge, water flows	Hydrologically relevant time spans

Table 14. Characterization of required climate services for the Andalucía living lab

4.5. What are the barriers to adopt and implement new, improved or more effective adaptation measures?

A majority of respondents identified lack of information as the main barrier for improved adaptation decisions, followed by institutional or administrative barriers, lack of resources and lack of technological expertise. Below is a summary of the responses provided by each LL.

Table 15. Barriers to adopt and implement improved adaptation measures in the Georgia, Hungary, Italy and Netherlands LL

Living lab	Barriers to adopt and implement improved adaptation measures
Alazani river basin, Georgia	Financial Lack of information and knowledge Limited data availability Limited qualification of local experts
Erzsébetváros, Budapest, Hungary	Financial and political (conflict between parking spaces and green infrastructure). Lack of information – availability of information on micro heat island
Emilia-Romagna, Italy	Rating curves are only available for some river sections and there is significant uncertainty with relation to the higher values of the rating curves . There is no available estimate of discharge, even when quite accurate rainfall predictions are available. Institutional barrier: Lack of coordination of main stakeholders for shared decision-making in case of drought. Information barrier: the regional model does not provide forecasts for the Apennine upper catchments.
Crete, Greece	Lack of trust on climate change projections and climatic information. Lack of awareness on need to adapt. Lack of maturity on climate adaptation and therefore lack of willingness to take action. Financial limitations. Lack of in-house technical skills.
Rijnland, the Netherlands	<u>Agricultural sector</u> • Economic and market barriers – decisions next season's crops will determine the chemicals and fertilizers needed • Regulations, e.g. on irrigation-stops and holding surface water near field/blocking inlet of surface water <u>Water managers</u> • Insufficient lead-time and lack of information on the reliability of drought forecasts. • Lack of awareness and confidence in long-term climate change impact projections (50 years) rather than 5 or 10 years, may be a limiting factor for policy and investment planning <u>Recreational shipping:</u> Lack of awareness and confidence in long-term climate change impact projections (50 years) rather than 5 or 10 years, may be a limiting factor for policy and investment and business strategy measures

Below are the main barriers that hinder the implementation of improved adaptation measures in each sector identified by participants in the Andalucía-Los Pedroches LL workshop. In parenthesis, we include the number of participants that highlighted each barrier in relation to each sector.

Livestock farmers

- Economic or financial limitations (18)
- Administrative or institutional barriers (15)
- Lack of information (hydrological, climatic, relation between climate and pasture production) (7)
- The common agricultural policy (3)
- Technical (lack of technical capacity, lack of flexibility of production systems) (3)

Agriculture sector

- Lack of information (5)
- Technical (lack of technical capacity or lack of tools) (4)
- Economic or financial limitations (1)
- Structural adaptive limitations (1)
- Administrative or institutional (for instance lack of protection from nitrate pollution) (1)

Forestry sector

- Economic or financial limitations (lack of incentives for adaptation) (17)
- Lack of information (e.g. on status of water resources, on local climate variables, of best adaptation options) (15)
- Administrative or institutional barriers (e.g. slow administrative process; lack of effective control of water uses) (12)
- Technical limitations (lack of adequate species, lack of technical skills) (3)
- The common agricultural policy (2)
- Political (2)
- Uncertainty (2)

4.6. Enablers that leverage the implementation of new, improved or more effective adaptation measures

The questionnaire did not investigate this aspect of the decision making process that will be included in the collaborative work within the MAP in the LL in the months to come.

5. Conclusions and future work

This Deliverable proposes a methodological approach to explore the relationship between different sources of information and climate adaptation decision-making processes, the resulting climate information needs, and existing limitations and enablers that hinder or leverage the implementation of improved adaptation decisions in the context of the I-CISK project. It also presents preliminary results of the current climate adaptation decision-making space in the different LL that make up the I-CISK project.

Information from the LL was gathered through a questionnaire that was distributed among LL leaders in September of 2022. LL used a variety of tools and techniques to gather the requested information – sharing the questionnaire with members of the LL, interviews, meetings with stakeholders, focus groups and workshops. The Deliverable does not include information from the Lesotho LL, which was in the development stage in autumn 2022.

Preliminary results show that actors in the different LL implement a wide range of climate-risk adaptation measures, but easily identify new and improved adaptation options that they could implement with improved CS as well as with the elimination of some clearly identified barriers.

While all users have access to climate information, and use publicly available daily meteorological information, preliminary results show that past experience is the primary source of information when making adaptation decisions. In order to make better use of this experience, actors in some LL identify the need to access historic climate information in their region to contrast with personal memories from past climate extremes. Financial considerations are also a determining factor, often considered a primary limitation in the implementation of adaptation measures. The institutional and regulatory framework – and the common agricultural policy in the case of stakeholders from the agricultural sector – is considered a major barrier to successful adaptation decisions. Preliminary results also would seem to indicate that meteorological and hydrological information does not currently prominently feature in decision-making processes. However, these results are preliminary and have not been sufficiently analysed

On the other hand, improved climate information is also identified as key input to improved adaptation decisions – downscaled climate projections offered with sufficient lead times and in a seasonal and sub seasonal (1-3-6 and 12 months) time scale. In the first 12 months of the project, all LL have advanced in the characterization of the necessary climate services, providing some preliminary indications on the spatial resolution, time scale, temporal resolution, triggers or thresholds and tolerance to uncertainty.

The role different sources of information play in the decision-making process, and a more clear understanding of what these sources of information are – for instance clearly identifying what is understood as local knowledge, past experience or traditional knowledge – will need to be further investigated in the next months. It will also be necessary to develop a more nuanced understanding of barriers and levers for enhanced decision-making and to improve the characterization of the enhanced decision making space.

Ongoing interactions with the LL in the following months will make it possible to gather this additional information. The questionnaire prepared in to inform this deliverable was useful to obtain preliminary information. However, additional tools are needed to generate more nuanced information from the co-creation process in the different LL. Some options include individual follow up meetings with LL leaders to present the methodological approach developed in D 2.3 and/or an online workshop with LL leaders to gather this information and devise other information gathering methods to collaboratively contribute to D2.6. These will need to be selected and planned in coordination with project coordinators and WP leaders.

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Annex 1. Living Lab Stakeholder / Participant Questionnaire: Information on climate actions to be supported by climate services

I-CISK
HUMAN CENTRED CLIMATE SERVICES

Task 2.3
Living Lab Stakeholder / Participant Questionnaire: Information on climate actions to be supported by climate services

July 2022

Clarification for Living lab leaders:
This questionnaire has been prepared so that it can be translated and shared with stakeholders in the different Living Labs. Before doing so, LL leaders need to make some adjustements following the indications marked in red in the document. If LL leaders already have the information requested in this questionnaire through previous interactions with stakeholders, they can fill it out themselves.

Context

Definitions

Climate Services: The transformation of climate-related data – together with other relevant information – into customised products such as projections, forecasts, information, trends, economic analysis, assessments (including technology assessment), counselling on best practises, development and evaluation of solutions and any other service in relation to climate that may be of use for society at large.

Adaptation: Adapting to climate change means taking action to prepare for and adjust to both the current effects of climate change and the predicted impacts in the future.

Climate risk management: Climate risk management aims to manage climate change impacts along the entire risk continuum, from short-term extreme weather events to long-term gradual changes.

Goals of this questionnaire

Effective climate services support decision-making on targeted measures to manage climate risks. The goal of this questionnaire is to map the experience of end-users and co-identify relevant climate risk management measures that can be informed by the climate service. We aim to:

- Obtain an overview of local knowledge related to the possible measures that are available to manage climate risks.
- Explore how different sources of information – past experiences, policies, norms, perceived risks, sense of urgency, knowledge, capacity, barriers, expected consequences of implementing adaptation measures, climate service information – are combined and used when making adaptation decisions.
- Identify barriers – such as capacity, existing power distributions or legal-political obligations – that obstruct the consideration of certain adaptation measures,
- Expose the link between different information sources, adaptation decisions and their impacts.

Participation in the questionnaire / interview is voluntary, and it is not a requirement to answer all questions. Data / responses will be stored securely and will not be shared beyond the project consortium, and all responses and personal data will be anonymised in the report. Participants will be asked to confirm their consent for use of their responses for the outlined purpose(s) using the consent form on the following page. If you have any questions about this interview/questionnaire, please contact your LL lead who shared these questions with you and/or Nuria Hernández-Mora (the contact person at UCM who will be collecting the responses): nurher03@ucm.es

Please send any completed questionnaires to nurher03@ucm.es and luciads@geo.ucm.es

Thank you for your collaboration!

Specific point for the consent	Yes/No	Not Applicable
I am an adult (≥ 18 years of age) and able to provide an informed consent		
I agree to provide some personal data to the I-CISK's consortium members as part of my participation in this interview. I understand that processing of personal data follows relevant laws (e.g. EU GDPR) and best practices on research integrity and ethics. I am aware that the details on personal data and research ethics are available in the two public documents prepared under I-CISK: Data Management Plan (Deliverable D7.2) and the Gender Action Plan (Deliverable D7.1), and these documents are publicly available through the I-CISK website.		
I understand that, in general, my personal identity will not be revealed in the project results, as the project aims to present the findings in an anonymized or pseudo anonymized way. In case my personal identity needs to be revealed, I will receive more information about the purpose and will be able to choose to agree or disagree to reveal my identity.		
I agree that my personal data can be transferred to the I-CISK project partners in the European Union Region (minimum personal data or with pseudo anonymization) following regulations of my country and the data receiving country in the EU region. (This point is only applicable for participants who do not reside in the EU).		
I agree that my personal data will be stored by the I-CISK's consortium in the internal project databases only until deemed necessary, however, until the end of the project or maximum five years after the project completion.		
I have received the copy this consent form duly signed by the project representative		

I reserve the right to ask the I-CISK consortium to rectify or erase my personal data or restrict processing or portability of it at any time. Moreover, in case of questions or complaints I am advised to contact the I-CISK data protection officer (Lorena Gonzalez Duarte; Tel: +31152152358; Email: l.gonzalezduarte@un-ihe.org) or chair of the I-CISK ethics committee (Dr. Ilyas Masih; Tel: +31152152340; Email: i.masih@un-ihe.org) or a principle researcher undertaking a specific project activity.

Section 1 – Personal information

[To be filled out by stakeholders, if the questionnaire is shared with them].

1. Please confirm that you give consent to use your responses.

2. What is your name?

3. What sector do you work in?

4. What organisation do you work for?

5. What is your role? Please briefly describe it.

Section 2. Climate risk adaptation options and resulting information needs

1. Please confirm the main climatic risks that are the focus of the I-CISK project in your living lab.

   [To be filled out by LL leaders. Not to be shared with stakeholders.]

Climate risk	Yes	No	Remarks
Drought			
Water Scarcity			
Flood			
Heatwave			
Wildfire			
Other (please specify)			

2. What adaptation options have you/your organization implemented in the past to minimize the impacts derived from the climate-risk(s) identified in your living lab

   [LL leaders, before sharing with stakeholders, please include as many possible response spaces below as are necessary for each climate risk identified in question 1 above for your living lab].

   a) Name the identified risk here: ___________________________, and identify and briefly describe adaption actions implemented to address the risk.

   b) Name the identified risk here: ___________________________, and identify and briefly describe adaptation actions implemented to address the risk

3. What information do you / your organization use to make those adaptation decisions?

For instance: meteorological information, climate projections, past experience, existing regulations, economic information or situation, knowledge transfer from institutions or other actors, personal knowledge, traditional knowledge other information.

4. What is the relative importance of the different sources of information and knowledge (e.g. traditional, scientific, others) in making adaptation decisions?
   Please assess the relative importance of the different type of information sources for your decision making process evaluating each between 1 and 5, being 1 small or not important and 5 very important.

Type of information	Evaluation
Meteorological information	
Hydrological information	
Past experience	
Existing regulations	
Economic information / situation	
Climate projections	
Knowledge transfer from institutions or other actors (if possible specify the type of knowledge / information	
Traditional knowledge	
Other (please specify)	

5. What additional adaptation measures would you / your organization like to implement if you had improved context-adapted climate services? What type of climate services would you require to implement those new / improved measures?

New / improved adaptation measure	Climate services needed [1]

[1] The required information can be climate information (please specify what variables – temperature, precipitation, etc.) or other type of information, for instance, information on social, economic or environmental impacts of different adaptation options, agronomic information, etc.

6. If you have identified a need for improved climate information in question 5 above, please characterize the type of information necessary for improved decision-making:

    a) Spatial resolution: ____

    b) Time scale / horizon: ____

    (For instance, ***Weather forecasts****: up to 15 days;* ***sub seasonal predictions****: up to 6 weeks;* ***seasonal predictions****: up to 7 months;* ***decadal****: short term climate projections; mid and long term* ***climate projections****)*

    c) Temporal resolution: ____

    (For instance, *daily, weekly, bi-weekly or monthly information on different climate variables such as temperature or precipitation)*

    d) What triggers or thresholds should be incorporated in the CS to inform decisions (for instance, number of days above a certain temperature, precipitation/hour, etc.)

    ____

    ____

    ____

e) What lead times are necessary for climate services to inform decisions?
That is, how far enough in advance do you need that information for your decision-making process?

____

____

f) What would you like to know with respect to the accuracy / uncertainty of the CS?
Accuracy: refers to how close a predicted measurement is to the true or accepted value, or how well an event was predicted (timing/magnitude/missed event...). For instance, would you like to know how well the model could predict past extreme events and/or how long in advance?

____

____

____

7. What are the barriers to adopt and implement new / improved / more effective adaptation measures?

   These barriers could be lack of information, institutional barriers, political barriers, financial barriers, lack of technical skills, lack of experience or knowledge about options, etc.

Thank you for your time!

Annex 2. Worksheets used in the Andalucía Living Lab multiactor platform workshop to identify adaptation options and climate service needs

I-CISK

Proyecto I-CISK. Los servicios climáticos: Una herramienta para adaptarnos a los riesgos por sequía en contexto de cambio climático

Primer taller - 25 octubre 2022

Actividad 1: Validación de resultados y medidas de adaptación

Nombre		
Organización		

Sector y relación con los servicios climáticos

Por favor, marque con una "x" el/los sector(es) en el que desarrolla su actividad profesional. En caso de desarrollar estas actividades (agrícolas, ganaderas, gestión cinegética) en su tiempo libre, marque también esa casilla.

Sector	Ganadero	Extensivo		Agrícola		Gestión de espacios naturales	
		Estabulado					
	Gestión del agua			Gestión cinegética		Capacitación y educación	
	Otro (especificar)						

Relación con los servicios climáticos	Productor	Usuario[1]

[1]Usuario en relación con alguna de los sectores / actividades señaladas.

Primera parte: Servicios climáticos en uso

Por favor, marque con una "x" los servicios climáticos que utiliza en el desarrollo de su actividad profesional, o particular en relación con la(s) actividad(es) señaladas en el apartado anterior.

En caso de utilizar otros servicios climáticos no identificados en la tabla que se presenta a continuación, añada los servicios que utiliza en las filas en blanco.

Servicios climáticos en uso	Marcar con "x"
Previsiones a 15 días de eltiempo.es	
Boletines meteorológicos de radio y televisión	
Boletines meteorológico diario de AEMET	
Boletines de riesgo de incendios de INFOCA – REDIAM	
Informes mensuales de sequía de confederaciones hidrográficas	
Saberes tradicionales: refranes, cabañuelas, calendario zaragozano	
Observatorio ciudadano de la sequía (https://observasequia.es/)	
Monitor de sequía del CSIC (https://monitordesequia.csic.es/)	
Foro Cazatormentas (https://cazatormentas.com/foro/index.php)	

Nombre:

I-CISK

SECTOR GANADERO

IMPACTOS	Medidas de adaptación	Barreras de implementación (p.ej. institucionales, económicas, de información, tecnológicas)	Servicio climático I-CISK que ayudaría a implementar o mejorar la implementación de la medida					Qué servicios climáticos están utilizando ahora para implementar la medida
			SC1	SC2	SC3	SC4	SC5	
Menor productividad de la dehesa (bellotas y pastos)	Venta anticipada de los cerdos							
	Redistribución de la carga ganadera (vender vacas y comprar ovejas)							
	Compra de pienso para complementar alimentación del ganado							
	Producción de cereales para alimentar ganado							

Nombre:

SECTOR AGRARIO (olivar y pastos)

IMPACTOS	Medidas de adaptación	Barreras de implementación (p.ej. institucionales, económicas, de información, tecnológicas)	Servicio climático I-CISK que te ayudaría a implementar o mejorar la implementación de la medida					Qué servicios climáticos están utilizando ahora implementar la medida
			SC1	SC2	SC3	SC4	SC5	
Cambios fenológicos – en los períodos de floración del olivo	Adaptar el calendario de operaciones de cultivo (poda, abono, control de plagas)							
Aumento de la frecuencia e intensidad de eventos climáticos extremos	Adaptar el calendario de operaciones de cultivo (poda, abono, control de plagas)							

Nombre:

SECTOR FORESTAL (espacios protegidos, gestión cinegética)

IMPACTOS	Medidas de adaptación	Barreras de implementación (p.ej. institucionales, económicas, de información, tecnológicas)	Servicio climático I-CISK que te ayudaría a implementar o mejorar la implementación de la medida					Qué servicios climáticos están utilizando ahora implementar la medida
			SC1	SC2	SC3	SC4	SC5	
Mortandad de árboles	Reforestación con especies adaptadas a las nuevas condiciones climáticas							
Cambios fenológicos y cambios en la distribución y abundancia de especies forestales	Cambio en los programación de actividades							
	Reforestación de árboles							

Colophon:

This report has been prepared by the H2020 Research Project "Innovating Climate services through Integrating Scientific and local Knowledge (I-CISK)". This research project is a part of the European Union's Horizon 2020 Framework Programme call, "Building a low-carbon, climate resilient future: Research and innovation in support of the European Green Deal (H2020-LC-GD-2020)", and has been developed in response to the call topic "Developing end-user products and services for all stakeholders and citizens supporting climate adaptation and mitigation (LC-GD-9-2-2020)". This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037293.

This four-year project started November 1st 2021 and is coordinated by IHE Delft Institute for Water Education. For additional information, please contact: Micha Werner (m.werner@un-ihe.org) or visit the project website at www.icisk.eu