I-CISK
HUMAN CENTRED CLIMATE SERVICES

Deliverable D2.1
Preliminary Report:
Information on Climate Service Needs and Gaps

April 2022

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 10103729

I-CISK

Innovating Climate services through Integrating Scientific and local Knowledge

Deliverable Title: Preliminary Report: Information on Climate Service Needs and Gaps

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Date April 2022

Suggested citation: Moschini, F., Emerton, R., et al., 2022: Preliminary Report: Information on Climate Service Needs and Gaps, *I-CISK Deliverable 2.1,* 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
Francesca Moschini & Rebecca Emerton	First draft	04/04/2022
Contributing Authors	Internal review / feedback (WP2)	11/04/2022
Francesca Moschini & Rebecca Emerton	Second draft	13/04/2022
Micha Werner & Ilyas Masih	PI review / feedback	19/04/2022
Francesca Moschini & Rebecca Emerton	Final report	25/04/2022

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Executive Summary

This report provides a preliminary overview of the current use of existing climate services (CS) in each of the seven Living Labs (LLs) participating in I-CISK (located in The Netherlands, Spain, Italy, Greece, Hungary, Georgia and Namibia), alongside our knowledge so far regarding the decision-making context in each LL, barriers to use of existing CS, and needs for improved and tailored CS. The information summarised here has been obtained through the project scoping process, initial discussion meetings in the first months of the project, the establishing of the LLs, detailed reports on the characteristics of each LL produced for D1.1, and targeted questionnaires and interviews as part of this task and deliverable (T/D2.1).

Co-exploring needs surrounding the value of CS, climate data and information is key in the design and development of CS. It is important to understand the decision-making context of CS end-users, the barriers to use of existing CS and how these issues can be addressed in the development of next-generation CS to provide CS that are useful, usable and effectively address user needs.

This preliminary report is intended to provide an overview of our initial understanding of decision-making and CS needs in each LL, for the use of other tasks and work packages within I-CISK, and to provide potentially useful information for CS providers. T2.1 will continue to explore the usability of and needs for CS throughout the process of co-development during the course of the project, and will consider effective forecast design and communication, from product visualisation to terminology used for communication of uncertain information. A final T2.1 report, Deliverable D2.4, will be completed at the end of the project, updating this preliminary report with information and experiences gained and learnt throughout the project, and providing additional discussion of key aspects related to decision-making and the effective design, communication and use of CS.

Some of the key challenges identified in the use of existing CS for decision-making include insufficient resolution (spatial and/or temporal), or for example forecasts that are aggregated over a given period in such a way that doesn't allow for CS users to identify key patterns and distributions, lack of useful variables, and accessibility of information (including several aspects such as data not being openly accessible, information being difficult to download, and challenges in disseminating CS information to the target audiences). In regards to this, the needs for improved CS range from the development of CS at additional timescales (such as extending timescales from medium-range forecasts to seasonal forecasts, or different periods of aggregation in forecasts), CS that are tailored to specific sectors (e.g. expected crop production in addition to rainfall patterns), impact-based and action-based forecasts, additional variables, and improved accessibility. While gaps remain in our understanding of the types of decisions made based on CS by stakeholders in each of the LLs, and how these decisions are made, this report provides a starting point for co-exploring the challenges and needs of stakeholders participating in the I-CISK project, and how we can begin to address the challenges faced and the needs for improved CS in the seven LLs.

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1. Introduction

Climate services (CS)[1] are crucial in empowering citizens, stakeholders and decision-makers in defining resilient pathways to prepare for hazards and extreme events and adapt to climate change. Availability of CS has improved significantly in recent years, alongside advances in scientific knowledge and data, with CS such as those from Copernicus or GEOSS (Global Earth Observation System of Systems) providing a range of data, training, access to scientific knowledge and forecasts (e.g. the Copernicus Emergency Management Service (CEMS) and Climate Change Service (C3S), www.copernicus.eu/en/copernicus-services; the GEOSS portal, earthobservations.org/geoss.php). Despite this, there are still challenges for end-users to make the best use of the potential of such CS and data, such as accessibility, local applicability and the translation of scientific data into actionable information, social and behavioural factors and varying needs of decision-makers.

The typical approach in the development of CS is the top-down approach and has often been "one-size-fits-all" (Jacobs and Street, 2020; WISER, 2020), but approaches to developing and providing CS are continually evolving and moving towards those that account for a broad range of societal challenges and potential users.

A co-creation[2] approach, such as will be used throughout the I-CISK project, including co-design, co-production, co-implementation and co-evaluation, can help to overcome challenges that lead to a lack of usability of CS, and provides the opportunity to meet climate information needs at relevant spatial and temporal scales across a range of regions and sectors (WISER, 2020; Hirons et al., 2021). I-CISK will involve and engage stakeholders[3] (including CS providers, purveyors, actors and end-users) at each step of the co-creation process, in order to co-produce tailored CS that integrate local knowledge and experiences with large-scale data and information.

Co-exploring needs surrounding the value of CS, climate data and information is key in the design and development of CS. It is important to understand the decision-making context of CS end-users, the

[1] The I-CISK *prototype framework on co-creating end-user centred climate services* (MS10, 2022) includes discussion of 'what do we mean by Climate Services?', from which the following is adapted: "climate services" is broadly defined as "the transformation of climate-related data — together with other relevant knowledge — into customized products such as projections, forecasts, warnings, trends, economic analysis, and risk assessment, which allows to deliver information on best practices, to develop and evaluate solutions, and to provide any other service in relation to climate that may be of use for the society at large" (Street et al., 2015; MS10, 2022).

[2] Co-creation is the interdisciplinary, interactive and iterative approach to developing CS, as a way to overcome the divide between climate science and decision-makers. It is often used interchangeably with co-production or co-design. In the I-CISK project, we use the term co-creation to describe the collaborative process encompassing the co-design, co-production, co-implementation, co-evaluation and dissemination of user-centred CS (MS10, 2022).

[3] ***Stakeholders*** is the general term that encompasses all CS producers, intermediaries and consumers, or others who are affecting/affected by the decisions informed by CS (or absence thereof). Within I-CISK (MS10, 2022), the following stakeholder categories are defined: (1) ***actors*** – stakeholders that play an active role in the technology, institutional and investment readiness of CS. These are the stakeholders affecting decisions, by creating either drivers or barriers. They include, for example, the project team, scientists, practitioners, decision-makers, private sector, public authorities, providers, end-users, etc. (2) ***providers*** – actors who provide the necessary data, investment, regulatory context for the CS to be sustained; they supply climate information and knowledge, operating on a range of scales and in different sectors. (3) ***purveyors*** – act as knowledge brokers providing guidance on ways that CS can address regional problems. They also ensure that products, scientific results and business opportunities are adequately communicated to end-users. (4) ***end-users*** – actors who use CS at different levels of the decision chain. They employ climate information and knowledge for decision-making, and may or may not participate in developing the CS itself, or may also pass information on to others, making them both users and providers. They include civilians, companies, developers, private organisations, local communities, governments etc.

barriers to use of existing CS and how these issues can be addressed in the development of next-generation CS to provide CS that are useful, usable and effectively address user needs.

The I-CISK project is working with seven so-called 'Living Labs' (LLs) in Europe and Africa, located in climate change hotspots with specific geographical and climatic settings. LLs are defined as "places for innovation - multidisciplinary ecosystems in which the I-CISK co-creation process will take place. They are an experimental setting and a safe space for stakeholder involvement (Fuglsang et al., 2019); real-life environments in which multiple heterogeneous stakeholders are connected through public-private-people partnerships and in which innovation-development activities can be conducted (Hossain et al., 2019)" (MS10, 2022). These LLs will provide the space where CS will be co-produced with stakeholders from multiple sectors to meet their climate information needs. They are located in The Netherlands, Spain, Italy, Hungary, Greece, Georgia and Namibia. This preliminary report summarises the decision-making context for stakeholders in each of the seven LLs, and provides an overview of the initially identified current use of CS, barriers to effective use of existing CS, and needs for improved and tailored CS. This information is intended to provide an overview of our initial understanding of decision-making and CS needs, for the use of other tasks and work packages within I-CISK.

The report is structured as follows:

- Section 2 – Task objectives & context within I-CISK: summary of the objectives of Task 2.1 and how this fits with the wider I-CISK project.
- Section 3 – Methods: details how the information in this report was collected.
- Section 4 – Decision-Making Context: an overview of who is involved in each LL, the types of decisions they are making, and the associated climate hazards.
- Section 5 – Use of existing CS: summarises the types of weather and climate information/services that are being used by those involved in each LL.
- Section 6 – Barriers to use and limitations of existing CS: an overview of the key challenges those involved in each LL face in using weather and climate information/services.
- Section 7 – CS needs: describes the needs for improved and tailored CS in each LL.
- Section 8 – Concise summary of CS use, barriers and needs: provides a table summarising the information discussed in sections 5, 6 and 7
- Section 9 – Preliminary conclusions, lessons learnt & future work.
- Appendix 1: Glossary
- Appendix 2: The interviews/questionnaires used as part of this report.

2. Task Objectives & Context within I-CISK

The content of this preliminary report is based on information and experiences of stakeholders within each LL, provided as responses to initial interviews and questionnaires (see section 3 for more information) during the establishing of the LLs at the start of the project. These interviews/questionnaires form the first step of Task 2.1 (T2.1) of the I-CISK project, which focusses on "co-exploring climate information and adaptation information needs and obligations of the stakeholders in the living labs". T2.1 takes place as an iterative process throughout the 4-year project (see Figure 1, which indicates the planned timeline and concept), using a participatory approach to ensure the centrality of user needs to the development of CS within I-CISK. As discussed in the prototype framework on co-creating end-user centred CS (MS10, 2022), "by evaluating the processes throughout the project cycle, WP1 and WP2 will lead the process of identifying […] best practices and lessons learnt", which will be added to the co-creation framework throughout the project, resulting in "a blueprint for the participatory development of other CS within Europe and beyond" (Task and Deliverable 2.5). T2.1 will design participatory activities such as meetings, workshops, focus group discussions and interviews, which will be facilitated by WP1. Examples of tools that may be used to co-explore climate information needs and CS desires include use case modelling, questionnaires and interviews, user stories, sector-themed focus discussion groups and decision-making activities such as serious games. Other tasks within WP2 will focus on co-identifying local knowledge on climate and its impacts in the LLs (T2.2), co-identifying suitable climate actions that can be supported by the CS, customised to the LLs (T2.3), and understanding drivers for behavioural change (T2.4). These tasks will work in collaboration with all other WPs, with information from WP2 feeding into other WPs, and outcomes from other WPs feeding into the iterative activities of WP2 and T2.1. A detailed overview of the interaction and collaboration between tasks and WPs is shown in Figure 2.

T2.1 will continue to explore the usability of and needs for CS throughout the process of co-development during the course of the project, and will consider effective forecast design and communication, from product visualisation to terminology used for communication of uncertain information. This will involve collaboration with other WPs to make use of ongoing research and developments (for example, forecast design mock-ups or user-driven evaluation metrics from WP3) within T2.1. Using ongoing research as part of participatory workshops and other activities with stakeholders in the LLs will allow us to understand the benefits and limitations as the work develops, therefore allowing iterative feedback to the other WPs throughout the project to refine and improve the tailored CS and other aspects of I-CISK research. A final T2.1 report, Deliverable D2.4, will be completed at the end of the project, updating this preliminary report with information and experiences gained and learnt throughout the project, and providing additional discussion of key aspects related to decision-making and the effective design, communication and use of CS.

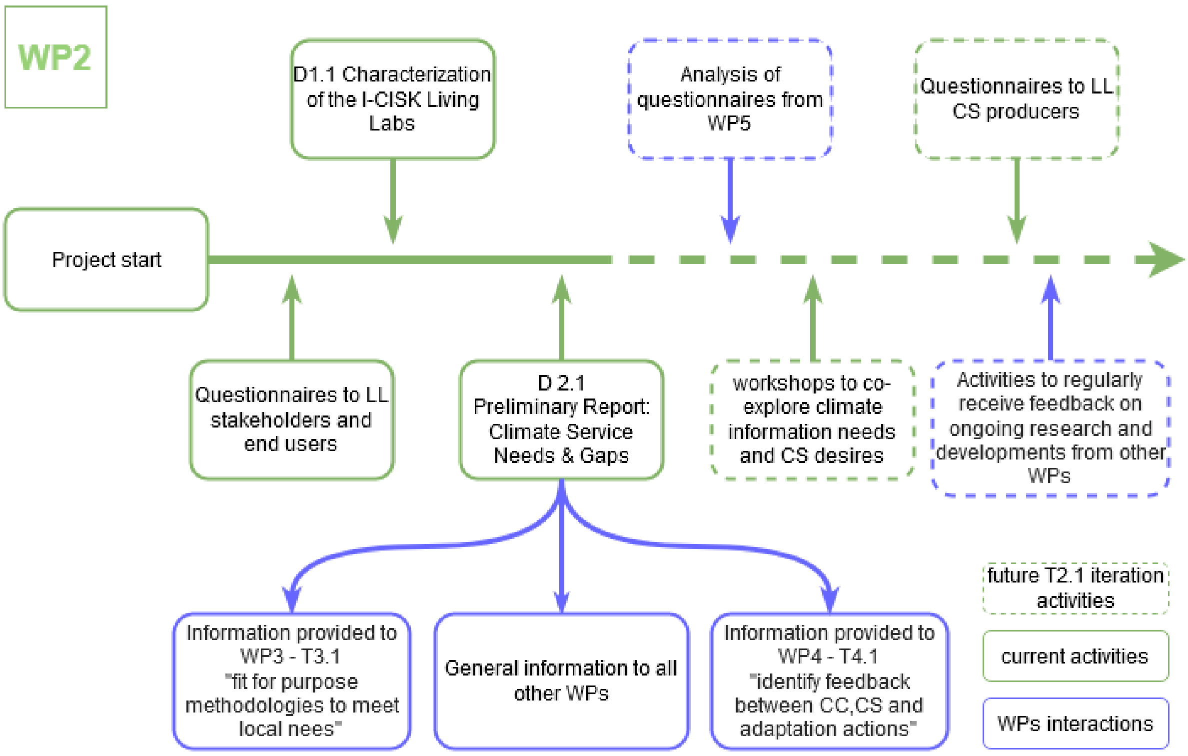

Figure 1. Planned timeline and context of Task 2.1 and Deliverable 2.1 within the I-CISK project

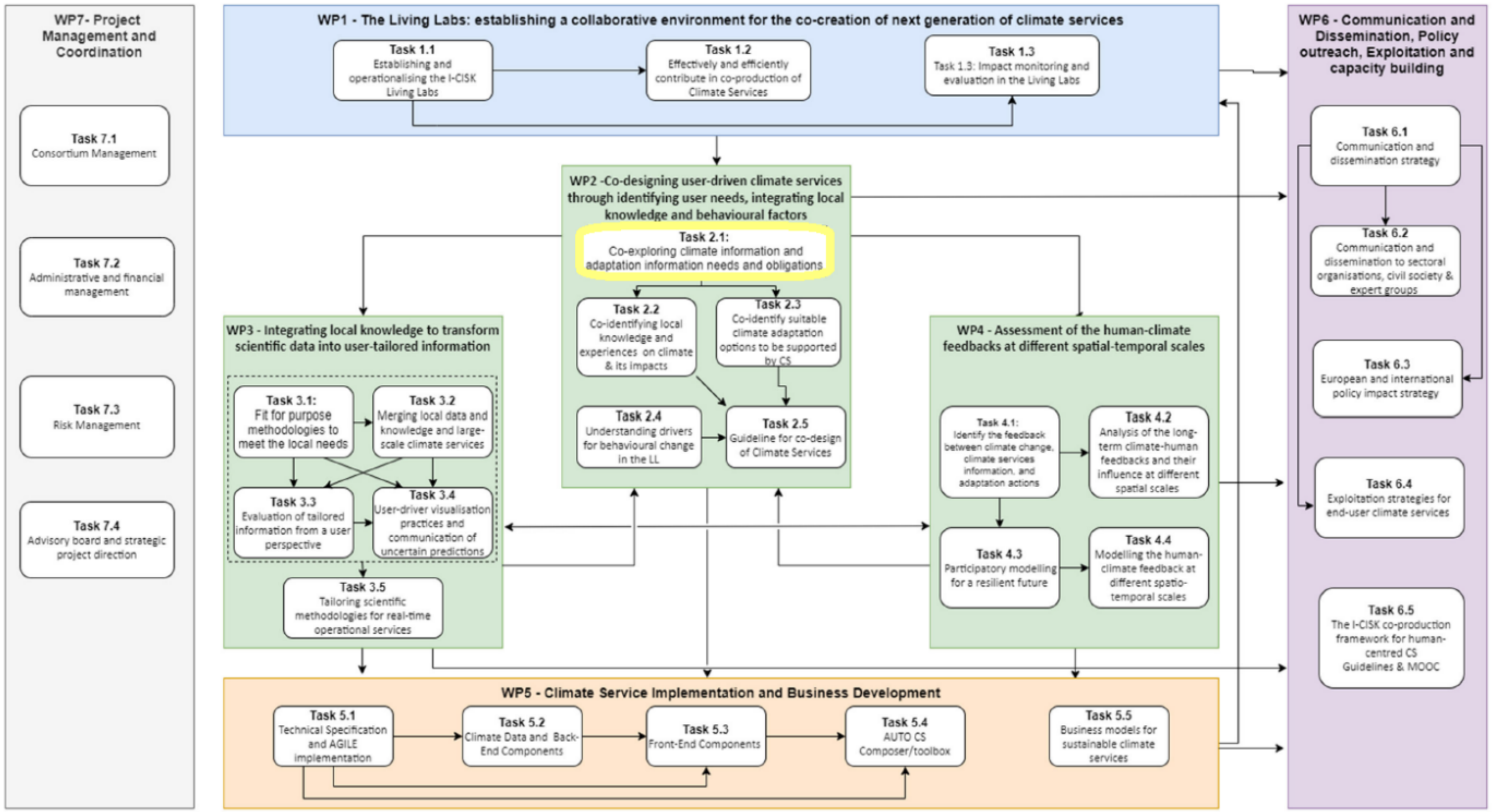

Figure 2. I-CISK PERT diagram showing interaction and collaboration between WPs and tasks, with task T2.1 highlighted.

3. Method

The content of this report is primarily based on information and experiences from stakeholders in each of the seven LLs, provided through interviews or online responses to two questionnaires designed as part of T2.1. The objectives of the two distinct questionnaires were as follows:

(1) *"Information on Climate Service Needs and Gaps"* – this questionnaire was designed to allow the I-CISK project team to gain an understanding of the current use of various CS and climate information, barriers to use of existing CS, and needs for improved CS, for stakeholders in each LL. Questions focussed on the role of the stakeholder, the types of decisions they make, how weather/climate affects their activities, the type, accessibility and format of CS they use, challenges faced when using existing CS, and additional information that would be useful for the types of decision they make. Such questions aimed to allow the project team to better understand the decision-making context of each stakeholder, thereby providing useful contextual information when considering the use of and needs for CS. This questionnaire was designed with relatively open-ended questions, to allow them to be answered by a broad range of stakeholders with different perspectives and experiences related to the use of CS and their decision-making context.

(2) *"Climate Service Details"* – this questionnaire was designed as a space for stakeholders to provide additional technical details about the CS they are using in their decision-making, if they were interested and able to do so. The aim was to investigate further, where possible, the characteristics and types of CS being used in each of the LL. Questions included where and how the CS/data/information is retrieved from, format of the information (data, maps, charts…), the variables used, timescales of the information, and whether uncertainty and performance/skill information is provided (or if not, whether it would be useful).

The two questionnaires are provided in Appendix 2. These were provided to the project team LL leads as google forms, and as a word document that could be used to interview stakeholders in each LL and collect the responses. Both formats contained the same set of questions, with the preferred method for collecting responses decided by the LL leads during the process of establishing the LLs. While the questions were provided in English, LL leads were also able to translate the questionnaires to a more relevant language where necessary/useful. The questionnaires were targeted at stakeholders that are collaborating with I-CISK in each of the LLs, who make use of CS in their decision-making (who may or may not also produce some or all of the CS information themselves). Future iterations will also focus on perspectives and experiences of stakeholders who are solely CS producers, but in this preliminary report we aim to further understand key elements of the use of CS. Future activities will also take into account any feedback on these questionnaires, regarding the accessibility, length, question style, terminology, format, ease to answer questions etc., alongside changing perspectives of CS needs and gaps as the project evolves.

Figures 3 and 4 summarise the number of responses provided for each LL through these two questionnaires (either directly through the questionnaires or through interviews), and some key information regarding the decision-making context. In total, 12 unique responses were provided by 21 participants (Figure 3) for questionnaire 1, as in some cases interviews were held with groups of participants from the same organisation and submitted as one summarised response (one interview in the Spanish LL (forestry sector) and 4 interviews in the Italian LL (water resources and utilities sectors) were conducted with 2 participants per organisation, and one interview in the Italian LL (environmental protection sector) was conducted with 4 participants from one organisation). Responses to both questionnaires were received from four of the LLs, Georgia, Spain, Greece and Italy, and two additional responses to questionnaire 2 were received from Georgia. Information from the remaining three LLs will be incorporated as the project and T2.1 develop, further building on this preliminary report. The responses received covered a range of different sectors and relevant organisations (see Figure 4), including tourism, NGOs, forestry, rural development, regional public sector environment agencies, environmental protection, agriculture, and water management. Two thirds of the participants are currently involved in climate adaptation and/or disaster risk reduction strategies, although this only represents the subset of participants from four LLs and may not reflect all sectors in all regions. Figure 4 also highlights that while the majority of participants and stakeholders are concerned with drought, other weather/climate hazards of interest and concern to stakeholders participating in the I-CISK project include water availability, flooding, thunderstorms, hail and forest fire.

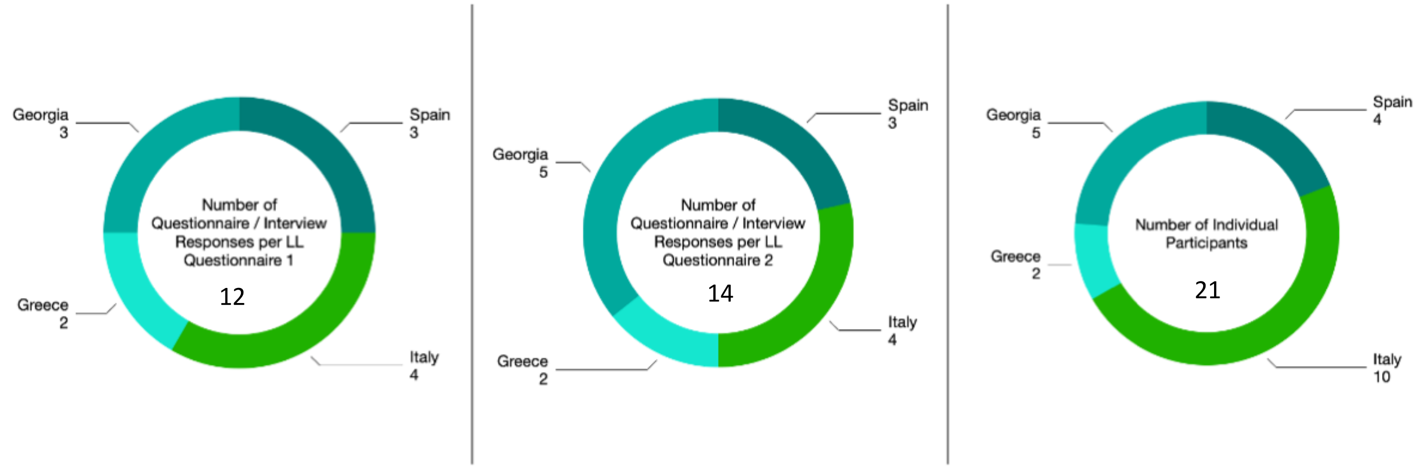

Figure 3. Number of questionnaire / interview responses for each of the two questionnaires, per Living Lab.
In some cases, the questionnaires were completed by, or the interviews were conducted with, multiple people together and submitted as one response. This is counted as one response in the left and centre plots. The number of individual participants per Living Lab is also shown (right).

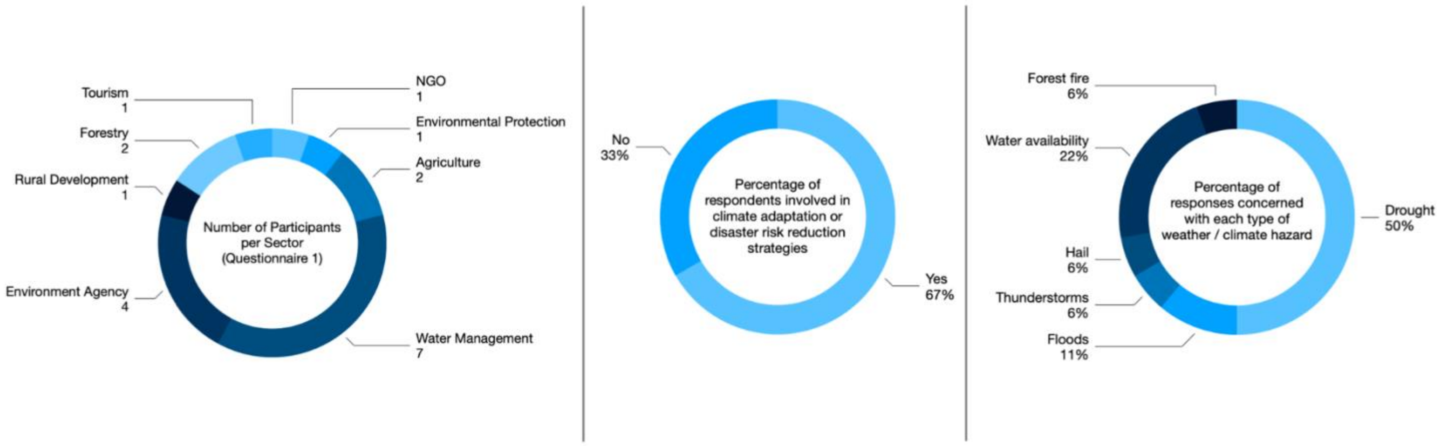

Figure 4. Number of questionnaire / interview participants per sector / type of organisation (left), percentage of participants involved in climate adaption and/or disaster risk reduction strategies (centre), and percentage of responses concerned with each type of weather/climate hazard (right).

The following sections discuss the information and responses received through these questionnaires, alongside relevant information gathered during the design of the project or provided by the LLs for the LL characterisation reports (D1.1, 2022). The LL characterisation reports will be made available in due course via the I-CISK website (*www.icisk.eu*).

4. Decision-Making Context

This section provides a brief overview of the LLs that participate in the I-CISK project. The information summarises the geographical location of each LL, climate hazards of interest, stakeholders and end-users involved, their involvement in Climate Change (CC) adaptation and/or disaster risk reduction (DRR) plans, the type of decisions related to climate they have to take and the timescale on which these decisions are typically made.

While this preliminary report draws on relevant information from D1.1 related to CS use, barriers and needs, more information on each LL can be found in the "Characterization of the I-CISK Living Labs" reports, produced by each LL as part of D1.1 (2022). These contain detailed information and figures related to climatic settings, hazard analysis, climate exposure of key sectors, CS availability, governance and stakeholders analysis, participants of the LL and stakeholder involvement, CS ambitions, expected impacts and potential for upscaling. Table 1 provides an overview of the contextual information for each LL, followed by a subsection for each LL with further information and details.

Table 1 Contextual information for each Living Lab

Living Lab	Region	Sectors Involved	Hazard(s)	Climate	Participating Stakeholders and Relevant End Users	Key Motivations
The Netherlands	Rijnland Delta	Water recreation, Commercial shipping, Tourism, Agriculture, Ecosystem management, Water management	Drought, Flooding	Temperate oceanic, delta exposed to hydrological drought	Rijnland water board, actors within sector organisations, water tourists, farmers.	Influence preparedness and adaptation strategies from sub-seasonal to climate change timescales for organisations and citizens.
Spain	Guadalquivir River Basin	Agriculture, Forestry, Eco-tourism, Ecosystem management	Drought, Heatwaves, Forest fires.	Mediterranean, hot/dry summers, wet/mild winters	NGOs, oil production cooperative, farmers (irrigated and rain-fed), livestock grazier, feed producer, natural park R&D, river basin authority, forestry	Agriculture & forestry linked to water availability, region experiencing farmland abandonment, increased risks of forest fires, impacts of land use trends combined with climate change
Italy	Emilia Romagna	Agriculture, Industry, Water allocation, Energy, Environmental management, Utilities	Drought	Temperate: high seasonal variability, dry summers wet autumn and springs	Irrigation consortia, associated farmers, water utility companies, regional government, local authorities, regional planners.	Avoid conflicts linked to high water demand during the dry season
Hungary	Budapest	Tourism, Health, Urban planning	Drought, Heatwaves, Urban heat islands	Humid continental (warm-hot summers, cold winters)	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.
Greece	Crete	Tourism, Agriculture, Energy, Transport infrastructure, Water resources management	Drought Storm surge, Flooding, Heatwaves, Wildfires	Mediterranean, hot/dry summers, wet/mild winters	Greek tourism confederation (SETE), Hellenic hotel federation and other hotelier associations, citizens, tourism service professionals, infrastructure support bodies, water supply and energy sector users, farmers.	Avoid conflicts link to high water/energy demand during summer. Improve the exploitation of information to support planning and adaptation for tourism. Increase preparedness and adaptation strategies in the tourist and transportation sector.

Georgia	Alazani river basin, Kakheti region	Hydropower, Agriculture, Environmental protection, Forestry, Tourism, Water resources management, Environmental protection	Drought, Flooding, Landslides	Humid subtropical/continental climate	Regional governmental bodies, city councils, the National Environmental Agency (NEA), Department of Environment and Climate Change, NGOs, Telavi State University, Hydropower authorities, farmers cooperatives, citizens, environmental conservation groups.	Plan economic activities in the Kakheti region (and expand to the other 5 regions of Georgia). Support policy and regulations (especially the new Water Code) Plan measurements to mitigate extreme climate hazard events.
Namibia	Kunene, Erongo and Kavango West Region	Agriculture, Humanitarian aid, Government (various scales), Disaster risk reduction, Forestry	Drought	Arid desert / steppe climate; high variability	Three local communities, National government, humanitarian and development agencies including WFP and Red Cross, research teams including from University of Namibia and the Namibia University of Science and Technology, National Farmers Union, national meteorological service, local actors, herders and farmers.	Moving from a reactive to a proactive approach to tackle drought impacts on agriculture and humanitarian sector at all levels (local to regional/national).

4.1. The Netherlands

Rijnland is the area that compromises the Rhine delta where the Rijnland water board is mainly responsible for the water governance of the area. The main climate hazards in this region are floods and drought, with drought being the key focus of this LL. Droughts strongly impact water tourism (by limiting recreational shipping) and agriculture (by affecting irrigation water management). Examples of the decision-making required include whether to inlet water from a neighbouring water board, whether to limit ship-lock operation, and management decisions such as changing drought alert levels and inspecting dikes. The two key sectors impacted by drought are agriculture, in terms of water supply, and water tourism. Additionally, in times of drought, there can be negative impacts on nature conservancy areas and freshwater lakes in the region.

CS are used by the water board for monitoring and operating the water system according to current and future forecast state up to 15 days ahead. After the 2018 drought, more stakeholders from the water recreation/tourism sector and the agriculture sector have been invited to participate in the co-creation of CS. The stakeholders that potentially will be involved in I-CISK are: five sail and motor boating clubs, Marinas in and around Spaarndam, tree nurseries "Boskoop", Horticultural farmers (flower bulbs) from Rijnland and organisation from the agricultural sector representing farmers in the Haarlemmermeer polder.

4.2. Spain

In Spain, the focus region of the LL is the Guadalquivir and Guadiana in northern Andalusia. Within this region, Los Pedroches is the primary focus area, where key economic sectors include agriculture, livestock farming, olive groves and agro-industry, all of which are vulnerable to droughts and other climate-related hazards. A second sub-region within the LL is involved, providing a test site for CS developed as part of I-CISK, is the Sierra de Cazorla, Segura and Las Viñas Natural Park. Rainfall patterns are the preliminary interest for CS, as these impact all sectors, and there is intense pressure on water resources due to drought, alongside risks from forest fires. The LL characterisation report (D1.1 NL, 2022) highlights that initial interviews with stakeholders point out broad environmental impacts affecting natural areas, wildlife and agriculture due to "increased temperatures and sustained rainfall pattern disruption", with the cumulative effect of this disruption reducing resilience.

Key stakeholders involved in the LL are the Guadalquivir River Basin Authority, the government service responsible for REDIAM (see section 4.2), the Cardeña and Montoro Natural Park, the Centre for forest management experimentation and training for Cazorla, a local action group for Los Pedroches, two cooperatives, a family farm and WWF Spain. Interview responses from stakeholders provided detailed information on challenges in the region, particularly in regards to olive groves and livestock farming, with climate change greatly impacting the agriculture and livestock sector and challenges exacerbated by depopulation, and competition between those farmers who have been able to mechanise and irrigate their olive groves, and those who have not. As an area where the agriculture and livestock sectors are primarily rainfed, they are vulnerable to periods of drought, and decreased precipitation / water availability due to climate change, in a time when there is a growing need for more water. In regards to the tourism sector, it was highlighted that the number of tourists visiting the Natural Park is influenced by the climate, particularly relating to the flow of water in the rivers, streams and pools. Changes to the tourist season have also been noticed, with activities possible earlier in the year due to reduced presence of snow and ice in the headwater catchments.

4.3. Italy

The focus region of the Italian LL is in the upper part of the Panaro and Secchia rivers, in Modena and Reggio Emilia provinces. The area is vulnerable to droughts and floods, due to a change in precipitation seasonal patterns and increase in temperature. The sectors affected by droughts and the resulting water shortage are the tourism, agriculture, infrastructure, energy, manufactory and production sectors, all competing for water and energy, especially during the warmer season.

Stakeholders involved are the regional government, the regional environmental agency (ARPAE) responsible for sectoral planning and water rights assignment, the Land reclamation and irrigation Consortia responsible in water provision, Ireti and HERA multiutilities companies, responsible for water exploitation from surface bodies and managing human and industrial water usage. Finally, the Burana consortium, managing the hydraulic network of the downstream Panaro and Secchia rivers, located outside of the LL focus area but with a consolidated experience in EO and CS research activities for water management strategies.

A challenge noted in questionnaire/interview responses is the management of water resources, particularly in relation to managing conflicts of interest around withdrawals from users. This is something that is likely to increase further with impacts of climate change on water availability.

4.4. Hungary

The focus of the Hungarian LL is on urban heat islands, in particular in Erzsébetváros, an inner district of Budapest and the most populated. This district has a low percentage of green spaces, with a high density of buildings, and therefore is particularly exposed to heat waves, which are already causing issues for a range of sectors in the city. Key motivations for this LL include the consequences of climate change that are observed and projected, including an increase in the mean annual temperature and sunshine duration, alongside more frequent temperature and precipitation extremes. In Budapest, the urban heat island effect exacerbates the impacts of summer heat waves, with temperatures in inner parts of the city reaching up to 7°C above the greener areas surrounding the city (D1.1 Hungary, 2022; Budapest SECAP, 2021). The district aims to implement adaptation strategies including increasing the percentage of green areas (including green roofs, green walls), shading buildings and adding drinking fountains or other places to provide water during heatwaves, alongside developing a heatwave alarm system and educating the public on adaptation strategies (D1.1 Hungary, 2022; Climate Strategy Erzsébetváros, 2020).

In Erzsébetváros, small businesses are a key part of the economy, which is based primarily around tourism, and alongside the impacts on the tourism sector, a significant impact of heatwaves in Budapest is on the health sector. Stakeholders participating in, or collaborating with, the LL include the municipality of the Erzsébetváros district (responsible for maintenance of healthcare institutions and public spaces), the national public health institute, the Clean Air Action Group (an NGO), and local community groups (for example ‘Friends of Compost’). This LL will also, while including the perspectives and experiences of all genders, emphasise in particular the needs and perspectives of women, who have been identified as holding much of the responsibility for care work and concern with green issues.

4.5. Greece

The Island of Crete is the focus area of the Greek LL where the main weather/climate hazards are heatwaves, floods, wildfires and droughts. The stakeholders involved are from the tourism, energy, agriculture, transportation, and water management sectors. From the public sector The Greek National Tourism Organisation (tourism), the Organisation for the Development of Crete S.A. (transport, hydraulic/agriculture/water supply infrastructure) and The Municipal Port Fund of Rethymno (port management and activities) are involved. The Regional Development Company of Crete SA. (infrastructure, tourism, energy) operates in the private sector and the Greek Tourism Confederation (tourism) operates in the non-governmental sector. The main end users of the Climate Services (CS) include tourism enterprises, tourists, citizens, and users from the water supply and energy sectors.

Decisions related to climate hazards are linked to water allocation in periods of droughts, heatwaves and wildfires for the planning of tourist activities and energy demand (due to higher usage of cooling systems), and tourism and transportation disruption related to flash floods.

The above-mentioned stakeholders have been part of public consultations concerning climate change adaptation plans but at the moment are generally not directly creating climate related risk reduction plans.

At the moment the available climate data are at climate projection timescales, alongside data at daily resolution from weather forecast services. Stakeholders take different decisions on a daily, weekly and seasonal basis in relation to the activities of their sector.

4.6. Georgia

Georgia is affected by several climate-related hazards, including floods, flash floods, landslides, avalanches, hailstorms, windstorms and droughts, and according to the National Disaster Risk Reduction Strategy of Georgia (2017; D1.1 Georgia, 2022), the number of natural disasters has increased threefold in recent decades. The LL characterisation report for Georgia (D1.1 Georgia, 2022) provides detailed information on the expected impacts of climate change, such as a reduction of glacier runoff (which is key for the country's hydropower-dependent electricity generation), increased temperature and precipitation (which may exacerbate water shortages for hydropower and agriculture), and more severe extreme events such as flooding, landslides and glacier lake outburst floods.

Stakeholders involved include the Climate Division and National Environment Agency (NEA) of the Ministry of Environmental Protection and Agriculture (MEPA) from the central government, alongside local level government representatives including the Akhmeta Municipality, the Regional Administration of Kakheti and the Information Consultation Centre in the Kakheti Region. Four NGOs are involved, the Kakheti Regional Development Foundation (KRDF), the Civil Society Development Association *Spektri*, the Akhmeta Innovation Centre and the Association of Women Farmers. Alongside government and NGOs, the Akhmeta WASH council, the Telavi State University, the Administration of Khadori Hydrower Plants, the Telavi Service Centre of Kakheti Regional Branch of the United Water Supply of Georgia, and the Chaduna Farmers Cooperative, are all involved.

Responses to the questionnaires highlighted that climate-induced disasters, such as droughts, are the biggest challenge currently faced by decision-makers at an NGO, where the type of decisions made include restoration of forests, protection of river banks, and the use of renewable energy sources. Therefore, the timescale of such decisions tends to be either shorter-term emergency management timescales, and the associated preparation of action plans. They are also involved in climate adaptation measures such as installing renewable energy infrastructure (e.g. solar energy), and the preparation of climate change preparedness and response teams. For their decision-making context, climate and weather information is seen as "very important and necessary". Other stakeholders are not yet involved in climate adaptation strategies, but aim to activate such activities through this project, and two participants noted that decision-making can be challenging due to a lack of awareness of climate change and its impacts.

4.7. Namibia

The predominant climate hazard of the Namibian LL is drought, affecting the three communities that are part of the LL: Okombahe in Erongo, Otjivero in Kunene and Sharukwe in Kavango West regions. The communities are located in different agro-ecological zones of Namibia and represent the socio-geographical conditions of the country areas affected by drought. These regions are reliant on dryland crop or livestock subsistence farming and are vulnerable and exposed to drought. The LL characterisation report for Namibia (D1.1 Namibia, 2022) provides detailed information on the impacts of drought on water supply, agriculture and livestock.

Stakeholders that will be directly involved in the Living Lab include the Namibia Red Cross Society, the three communities mentioned above, the Department of Disaster Risk Reduction of the Office of the Prime Minister, and the Namibia Meteorological Services. Other stakeholders who will be involved and consulted during the project include the local MEFT (Ministry of Environment, Forestry and Tourism) office, the World Food Program, UNESCO, the University of Namibia, the Namibia University of Science and Technology (NUST), the Namibia Water Corporation Ltd (NamWater), the FAO, the National Farmers Union, the Ministry of Agriculture, Water and Land Reform (MAWLR), the Southern African Science Service Centre for Climate Change and Adaptive Land Management (SASSCAL), and the National Commission on Research Science and Technology. The end users of the CS identified are social and governance actors involved in, disaster risk management, climate change adaptation and humanitarian response (including early action).

5. Use of existing climate services

This subsection summarises the CS used by stakeholders in each of the seven LLs. Where more detailed information was available through the questionnaires and LL characterisation reports (D1.1, 2022), the CS currently used are summarized in a table that focuses on the CS type (e.g. weather forecast), its characteristics (left side of the table) and usage (right side of the table). The characteristics are described in terms of provider, data format, variables available, timescale and uncertainty and reliability information; the usage information summarises who uses the CS, the type of decision that may be made based on the CS, and in relation to which hazards. These tables may not represent the full scope of information available from every CS or provider mentioned, but aim to summarise the CS highlighted by stakeholders in each of the LLs. Additionally, it is often the case that all users of CS are not known, and while this report aims to provide an overview of the current use of CS, some of the information in this section lists the CS currently available with limited information regarding their current use. A summary of the type of CS used in each LL, alongside the barriers to their use and CS needs, is also provided in Table 8.

The level of detail and information available so far varies by LL, according to the progress in establishing the LLs and the stakeholders involved so far in the project that were able to provide additional information towards this deliverable. Therefore, the information presented here and in the summary tables has some gaps that we aim to fill during following iterations of Task2.1 and further participatory activities with stakeholders in each of the LLs.

Some stakeholders provided additional information on evaluation of their decision-making processes, particularly focussing on post-event evaluation of the CS information used. Where this information was available, a section on post-event evaluation performed by stakeholders of the LL is included. This does not include any information on routine evaluation of services by the CS providers, and is only available for a subsample of the stakeholders participating in the I-CISK project.

5.1. The Netherlands

The Dutch LL characterisation report (D1.1 NL, 2022) mentions a key CS used by the water board of Rijnland, which consists of an advanced information and decision support system that monitors the water system's state with an observation network for precipitation, water levels, discharge and salinity. This CS also provides 15-day forecasts based on forecasts from KNMI (the Royal Netherlands Meteorological Institute), which include predictions from ECMWF (the European Centre for Medium-range Weather Forecasts) ensemble forecasts, and MeteoGroup. Further details related to this CS are provided in table 2.

Table 2 Overview of the use of Climate Services in the Dutch Living Lab

characteristics				CS	usage		
CS uncertainty and reliability	**CS time scale**	**CS variables**	**CS provider and format**	**Type of CS**	**Used by**	**To decide what**	**In relation to which hazard**
	Bulletins are produced every week and provide 15-days lead time forecasts	**Observing Network:** Precipitation, Water levels, River discharge, Salinity **Forecasts:** Spatially distributed rainfall deficit	Water board of Rijnland, using forecasts of KNMI, ECMWF, MeteoGroup and water balance model of HydroLogic Provided as bulletins assessing drought condition, and drought warnings colour-coded according to water use restrictions for various sectors	**Drought monitoring system**	Water board of Rijnland Rijkswaterstaat	Water allocation, water supply, drought alert level, ship navigation	Drought
	2-week predictions	Streamflow	Ministry of Infrastructure and Water	**Streamflow Predictions for Rhine at Lobith**			

5.2. Spain

In the Andalusia region in Spain, the network REDIAM (the Andalusian Environmental Information Network), run by the Ministry of Agriculture, Livestock, Fisheries and Sustainable Development of the regional government of Andalucia, is responsible for integrating and disseminating environmental information produced by various centres. They produce and update information regarding a range of environmental issues and climate change. The Ministry also maintain a tool, *Subsistema Clima,* for the compilation and standardisation of climate and weather information generated in the region, including 3000 meteorological observation stations (of which ~1/3 are currently active).

Initial interviews highlighted that the most-used CS in the region, for both forest and agriculture sectors, are AEMET (the State Meteorological Agency of the Spanish Government), TV, press and media channels (elTiempo.es and meteo.es are given as examples of frequently used sites), alongside traditional knowledge based on historical observations and experience. It was also considered that the 14-day forecasts available from AEMET and elTiempo.es are generally reliable, whereas longer-range predictions lack sufficient spatial and temporal resolution and are unreliable. A summary of the information provide related to the use of existing CS is provided in table 3. While we are not currently aware of the specific use of several of these CS, they are included to provide a complete overview of the information we have regarding the CS available for decision-making in the region. Interviews with stakeholders also provided the opportunity to understand their experiences in more detail, with responses noting for example the types of decision made, such as when to prune olive trees based on 15-day forecasts, alongside details of some of the ancestral local knowledge that is used for decision-making. As local farmers know their land well, it was noted that they may see that weather forecasts online predict it will rain, but with the air coming from a certain direction, they are aware that based on experience, it won't rain on their land. Another example of a proverb was provided by one participant, which translated indicates that if the local river is dry at a certain time, you know which decisions to make regarding buying food or selling livestock, for example. A challenge noted here is the impact of changes due to climate change.

Table 3 Overview of the use of Climate Services in the Spanish Living Lab

characteristics				CS		usage	
CS uncertainty and reliability	**CS time scale**	**CS variables**	**CS provider and format**	**Type of CS**	**Used by**	**To decide what**	**In relation to which hazard**
	1981-2010	Drought indices, land use, …	AEMET Provided as statistics, extreme values, threshold exceedances, event reports and maps.	**Climatological data**			
			AEMET Web viewer	**Reservoir management support**			
Probabilistic	Produced monthly out to 3 months	Precipitation Temperature	AEMET	**Seasonal forecasts**			

Multimodel	Monthly and daily out to 2100	Precipitation Temperature (max and min)	AEMET Monthly and daily data, map & graphs of regionalized projections	**Climate projections**				
	The bulletins indicate periods when the risk of fire is considered high.		Andalusian Environmental Information Network (REDIAM). Provided as bulletins	**Forest fire risk management plans and forest use restrictions**	Forest Training and research centre			Forest fire
	1961 to 2099	Temperature Precipitation PET Hydric balance Hot days Tropical nights	Andalusian Environmental Information Network (REDIAM) Provided as spreadsheets, graphs and maps	**Andalusian Climate Scenarios Viewer**				
	1961 to present weekly	Current drought conditions	Higher Council for Scientific Research (CSIC) Provided as maps, csv, netCDF and bulletins	**Drought monitoring** *monitordesequi a.csic.es*	Farming			Drought
	Daily, up two weeks ahead	Temperature Precipitation	AEMET, meteo.es, eltiempo.es	**Meteorological Forecasts**	Farming Forest			Drought
	Historical - present Hourly/ daily/ monthly	Reservoirs Flow rates River levels Floods Rainfall Irrigable areas	Guadalquivir River Basin Authority Provided as a geoportal, text & graphs	**Guadalquivir River Basin Monitoring**				Drought Floods
		Hydrogeological situation Water quality Ecological status Flood risk assessment	Guadiana River Basin Authority Geoportal	**Guadiana River Basin Monitoring**				Drought Floods

5.3. Italy

The CS used and available in the Italian LL are those produced by ARPAE, the regional environmental protection agency. ARPAE produces and distributes climatic, meteorological and hydrological data such as: climate projection summary reports and bulletins, historical data and data from monitoring. Questionnaire responses were received from four private local institutions that are primarily involved with water allocation and management in different sectors. In general, based on the sample of responses received, it was perceived that CS information is not considered to be completely reliable, due to the effects of climate change and unexpected events related to this. Further details and some examples of the use of these CS are provided in Table 4.

Post event evaluation

As expected, the post event evaluation process differs across stakeholders. While we are not currently aware of the evaluation undertaken by each stakeholder or CS provider, it was highlighted that ARPAE evaluates the magnitude of past events, and the regional government and the multi-utility company IRETI evaluate the decisions taken during critical events in order to improve future decision-making.

Table 4 Overview of the use of Climate Services in the Italian Living Lab

characteristics				CS	usage		
CS uncertainty and reliability	**CS time scale**	**CS variables**	**CS provider and format**	**Type of CS**	**Used by**	**To decide what**	**In relation to which hazard**
			ARPAE Provided as summary reports and bulletins	**Regional climate projection**			
	Daily monthly yearly	Temperature Soil moisture Precipitation River discharge	ARPAE Provided as maps, tab, graph, charts, text, raw data	**Historical and current hydro-meteorological data from monitoring network**	Emilia Romagna regional government	Ecological flow, withdrawal limitations, river water balance maintenance	Drought Floods
					Multi-utility company (water distribution)	Water allocation for industries	
Seasonal forecasts are provided with uncertainty information.	Weekly seasonal	Water deficit on the first meter of soil Rainfall Crop evapotranspiration Seasonal irrigation demand anomaly Irrigation demand	ARPAE Provided as maps, FTP, tabulated values of irrigation demand.	**Icolt: agriculture water demand forecast**	Burana water irrigation consortium	Water management and allocation for agriculture	Drought

5.4. Hungary

The LL characterisation report for the Hungarian LL (D1.1 Hungary, 2022) mentions different services on climate, air quality, urban classification, earth observations, green areas and climate adaptation. At this preliminary stage, we have not been able to receive responses to the questionnaires from stakeholders in the Hungarian LL, and as such it is not yet clear which stakeholders are making use of the various CS described in the LL report (D1.1 Hungary, 2022). We aim to further our understanding of the decision-making based on these CS as the project moves forward.

Key information regarding the main CS available to stakeholders in the LL is provided in Table 5. In addition to these, other CS are available and noted, but are not yet included in Table 5 due to a lack of detailed information. For example, eEarth space remote sensing portal https://fir.gov.hu, Copernicus Climate Change Service (C3S), the National Adaptation Spatial Information System (NATér) for facilitating climate change adaptation legislation and strategy building, and the National Geospatial Base Map.

Table 5 Overview of the use of Climate Services in the Hungarian Living Lab

characteristics				CS	usage		
CS uncertainty and reliability	**CS time scale**	**CS variables**	**CS provider and format**	**Type of CS**	**Used by**	**To decide what**	**In relation to which hazard**
	Available years: 2006, 2012, 2018	land use	Copernicus Land Monitoring Service (CLMS) Urban Atlas	**Land cover and land use data for urban areas**		How to influence urban planning and the increase of green areas green spaces	Urban heatwaves
			MeteoAlarm Alerts for multiple hazards	**Heat-health Warning System**			Multi-hazard (heatwaves, floods, thunderstorms, winds, forest fire, fog, snow, extreme cold, avalanches, tides…)
		Trees, Park register, Tree belts,	Fatár Provided as maps	**Green areas monitoring**			Urban heatwaves
		Observations of birds, insects, and plants	INaturalist Provided as maps	**Biodiversity monitoring**			

	Hourly	Historical land surface temperature	Copernicus Global Land Service	**Global land surface temperature**			Urban heatwaves
	Daily	Temperature, Air quality	Hungarian Meteorological Information Service	**Meteorological data**	OKI- National Institute of Public Health	Issue warnings	heatwaves
	Not specified	Precipitation, Snow (skiing), Pressure, Temperature (min & max), Solar flares, Humidity, Pollen, Wind, Smog, Tornadoes, Lightning, UV, Water temperature	idokep Provided as maps, graphs	**Meteorological & related data**			Multi-hazard (snow, rain, solar flares, tornadoes, lightning…)
		Air quality (citizen data collection)	Sensor.Community Maps	**Air quality monitoring**			
		Air quality, Annual emissions from reporting parties	OKIR National Environmental Information System	**Air quality information module**			

5.5. Greece

Stakeholders in the Greek LL, based in Crete, noted that available CS include daily weather forecasts, Climate Change impact assessments on Crete's surface and ground water, and climate change vulnerability analysis at district level for the entire country.

According to the questionnaire responses received from two Greek LL stakeholders, one from the tourism (hotel) sector and one from water management, the CS used for daily activities are daily weather forecasts available for the area, and the Climate change impact assessment are used for more long-term development plans.

The stakeholder from the tourism sector offered more detailed information on the daily weather forecasts, whereas the stakeholder from the water management sector described the climate change impact assessment products. Both stakeholders use weather forecast and climate change related information. However, it appears from the questionnaires that in the tourism sector, decision-making is typically based weather forecast information, whereas water management decisions may be made based on current conditions, experience, conditions during previous years, and past managing practises, rather than on forecast information.

Post event evaluation

Both stakeholders that provided responses to the questionnaires highlighted that they undertake regular post-event evaluation. In the tourism management and planning sector, the post-event evaluation is a daily process used to reflect on the decisions made according to the available data. In relation to water management, analysis of the previous year's climate conditions and water demands are used to understand any challenges and issues in the decision making, and provide useful insight for decisions in the coming year.

Table 6 Overview of the use of Climate Services in the Crete (Greece) Living Lab

characteristics			CS	usage		
CS uncertainty and reliability	**CS variables**	**CS provider and format**	**Type of CS**	**Used by**	**To decide what**	**In relation to which hazard**
Information is trusted	Precipitation Temperature Wind	National services via internet and mobile applications Maps, charts and tables	**Weather forecast**	Public water management	Water allocation	Drought Extreme precipitation
				Private tourism sector	Planning of outdoor activities / which facilities to use for clients	Heatwaves
					Outdoor construction activities	Not specified
Confidence is higher on short term projections, at larger timescale with higher reliability and uncertainty	River flow Precipitation Temperature Drought index WEI index	National and Regional, climate change adaptation plans, research institute studies, private companies (consultancy) studies. Mainly maps, charts, text	**Climate change impact assessment and vulnerability analysis**	Public water management	Water allocation long term strategy	Drought
				Private tourism sector	Long term construction development	Sea level rise Coastal erosion
			Hindcasts	Public water management	Water allocation, analysis of climate impacts on water availability	Drought
			Designed short term forecast service for water quality and quantity on reservoir	Public water management	Water allocation	Drought Extreme precipitation
					Water quality	Drought Extreme precipitation

5.6. Georgia

The National Environmental Agency (NEA) of the Ministry of Environment Protection and Agriculture of Georgia (MEPA) is the main provider of CS in the country. Under the NEA, the Department of Hydrometeorology is mandated to provide meteorological and hydrological information and warning services, distributing these to governmental bodies at all levels and to the public. The LEPL State Military Scientific-Technical Center "DELTA" operates a weather radar in the region, which is used by other organisations for the purpose of forecasting and early warning.

The NEA also have a network of hydrometeorological stations recording observation data, although the mountainous regions in particular have a sparse, or in some places non-existing, observational network. In these regions, satellite data is used to complement the in situ observations.

Some of these CS are available only to certain sectors and stakeholders, such as government organisations, energy companies or agriculture, while others are openly available. At this stage in the project, it is not yet clear which stakeholders actively make use of each CS and how they are used in decision-making, and this task endeavours to further understand the use of these CS during the course of the project. Responses to the questionnaires indicate that decision-makers at one of the NGOs primarily use forecast information and local knowledge for decision-making related to weather and climate hazards. Additionally, activities such as establishing climate change preparedness and response teams, involve not only the direct use of climate and weather information, but also requires them to summarise such information for other stakeholders. Respondents generally trusted the CS information used, some comparing information from different sources to ascertain trust, and others because there is no other tool they can use.

Table 7 Overview of the use of Climate Services in the Georgian Living Lab

characteristics **CS** **usage**

CS uncertainty and reliability	CS time scale	CS variables	CS provider and format	Type of CS	Used by	To decide what	In relation to which hazard
		River flow Precipitation Temperature …	National Environmental Agency (NEA)	**Meteorological observation data**			
		Radar	LEPL State Military Scientific-Technical Center "DELTA"		NEA		Meteorological hazards
			Farmers Meetings, personal contacts, surveys	**Local knowledge**	NGO		drought

For e.g. Windy & Global Goals, uncertainty and skill information is not provided.	Daily 1 week - 10 days horizon	Various, including temperature, precipitation, river discharge	Department of Hydrometeorology, Windy, Global Goals Samsung app	**Meteorological and hydrological forecasts**	Various sectors, including public		Flood Drought thunder storms
			Department of Hydrometeorology, SMS, social media	**Extreme event warnings & advice**	Various, including public		Extreme events
Not currently operational due to lack of observations	10-day	Observation data (unspecified) and NDVI (normalised difference vegetation index)	FAO agriculture extension services	**Agrometeorological bulletins**	Farmers		Drought
Not operative at this moment	Not specified		Turkish State Meteorological Service	**Frost EWS**	Farmers		Frost
	Produced twice per year, for winter and summer seasons		Based on Outlook Forums (SEECOF, MEDCOF) and ECMWF monthly & seasonal forecasts	**Seasonal outlooks**	Various sectors		
Not model based	Prepared in Spring only	Runoff			Government, energy companies, water sector		
	2021-2011	Essential Climate Variables	NEA Regional climate model RegCM4	**Climate projections**	Various sectors, agriculture, water, energy	Preparation of climate change reports e.g. on impacts on agriculture, and climate change adaptation plans	

5.7. Namibia

Stakeholders in the LL in Nambia make use of early warning services (including seasonal and sub-seasonal forecasts), agricultural CS, and regional meteorological and hydrological forecasts. At this time, detailed information regarding the CS currently used is unavailable but ongoing work will continue to co-explore the CS currently available and used, and the associated challenges.

The LL characterisation report (D1.1 Namibia, 2022) mentions different global/regional CS that can be used to further develop and design tailored CS and local solutions. These include the Copernicus Emergency Management Service (CEMS, including the Global Flood Awareness System, GloFAS), the S2S (sub-seasonal to seasonal) prediction project, TAMSAT and CHIRPS (which provide rainfall information from satellite and rain gauge data), and Global Historical Yield (GDHYv1.2+v1.3). Existing services available in the region will also be assessed, including the Rangeland Early Warning System for Namibia, which aims to inform livestock/wildlife land users and managers about developing drought conditions, and the African Flood and Drought Monitor, which provides 7-day flood risk forecasts and 6-month drought forecasts.

It was not possible to receive any responses to the questionnaires at the time of writing, and further information will be communicated to I-CISK project partners as it becomes available throughout this ongoing task.

6. Barriers to use and limitations of existing climate services

In this section we describe some of the key challenges that stakeholders in each of the LLs have identified in the use of existing CS for decision-making. Some challenges are broad and relate to accessibility of information or insufficient resolution, and some are sector- or decision-specific such as challenges interpreting the available information, or lack of useful variables for a specific use case. Key challenges are highlighted in bold, with additional details or experiences provided by stakeholders or discussed in the LL characterisation reports (D1.1, 2022) provided where available. The key challenges, alongside the types of CS currently used and CS needs for each LL, are also summarised in table 8.

6.1. The Netherlands

Stakeholder engagement

The CS available is produced for the water board of Rijnland, a key stakeholder of the LL. Water sectors representatives were not necessarily aware of the various CS and climate information available from Rijkswaterstaat.

Limited lead times

Current CS are available at 15-day lead times, resulting in challenges for decision0making that relies on information on longer timescales beyond 2 weeks ahead.

6.2. Spain

Dissemination, communication & tailored information

During initial interviews conducted during the establishing of the LL, REDIAM, who integrate and disseminate environmental information from various providers, highlighted concerns that their CS are not reaching the target audiences as desired – potentially due to a combination of lack of effective dissemination and communication, and lack of tailored information for the needs of local users. Stakeholders in the agriculture sector noted in the questionnaire responses that a lack of specialised information, and slow communication of information on drought cause challenges for decision-making. Another limitation is the inaccessibility of information from other sources, such as river basin authorities or drought reports.

Forecast uncertainty

The uncertainty of forecasts is noted as a challenge in all questionnaire/interview responses, from the forestry, agriculture and rural development sectors; some forecasts/CS are too uncertain to support decision-making processes.

Insufficient spatio-temporal resolution

While the 2-week forecasts from AEMET and elTiempo.es, for example, are considered to be generally reliable with sufficient resolution, other CS, particularly longer-range predictions, do not have spatial or temporal resolutions adequate to support decision-making.

6.3. Italy

Insufficient temporal resolution

Users of the IColt CS, designed for irrigation water demands in the Burana area, highlighted that currently, rainfall forecasts are provided as weekly precipitation totals. However, a higher temporal resolution, ideally with 3-day totals, would be more useful for decision-making and ascertaining if a rainfall event will be a positive or negative event for crops. A single intense precipitation event could be damaging for crops, whereas rainfall that is more evenly distributed throughout the week could be beneficial. A forecast of total weekly precipitation makes it challenging for the decision-maker to know how the precipitation may be distributed during the week.

Data accessibility

Some stakeholders highlighted that it can be challenging to download historical data from the ARPAE website. Others noted that ftp and CS interfaces are convenient, highlighting that ease of access to CS and data varies between stakeholders, and varies depending on the CS and data required.

Unclear information on forecast uncertainty and skill

Some stakeholders noted that uncertainty information, where provided, can be challenging to use and is not very ‘user-friendly’, and in cases where uncertainty and/or skill information is not provided, it is challenging to understand whether forecast information is reliable and this impacts decision-making.

6.4. Hungary

Insufficient variables

It was noted in the LL characterisation report (D1.1 Hungary, 2022) that while the existing CS used by stakeholders in the LL are important for detecting heatwaves, a key limitation is that the information available doesn’t consider other important factors related to heatwaves, such as wind, direct sunshine, building density, health impacts etc.

6.5. Greece

Intersectionality

Climate change vulnerability assessments are available at LL level; however, they focus on single sectors and lack information on cross-sectoral-links. Studies were mostly designed for governmental and administrative level.

Lack of tailored information

While the CC vulnerability assessments mentioned previously are available for specific sectors, in general there is a lack of CS information on different timescales that is tailored to support the needs of different sectors, for example with the most useful variables and indicators, and including a lack of information on the severity of predicted hazards or compound impacts of multiple hazards.

Accessibility to non-expert users

CS that use climate projections, seasonal and sub-seasonal information would be of great use in this LL to inform local administration, local authorities and local businesses to better plan development and management activities. At the moment, this information is accessible only by researchers and consultancies and therefore does not reach a wider audience of potential users and stakeholders. The main barrier is the lack of expertise/resources needed to extract and convert this data into useful information for the LL. Also related to accessibility and usability of CS by non-expert decision-makers, a lack of information/clarity regarding the reliability and uncertainty of CS was noted.

6.6. Georgia

Service discontinuity

One of the challenges highlighted is the lack of long-term national strategy for user-driven CS. CS are produced on demand but are not available on a continuous basis. CS were noted as being so scarce that it is difficult to discuss solutions and take decisions.

Fragmented information

Stakeholder responses indicated that one challenge with the use of CS is that existing information is fragmented – there exists no single complete dataset where a wide range of information is accessible.

Language barriers

One stakeholder noted that while the language of CS was not an issue for them personally, it can be a serious problem for end users they work with (such as local farmers).

6.7. Namibia

Insufficient resolution

It was highlighted that in general, the current CS used by stakeholders lack sufficient spatial and temporal resolution. More information is needed to better understand the specific CS used and the spatio-temporal resolutions currently available, and the spatio-temporal resolutions that would be more useful for decision-making.

Lack of tailored information

Stakeholders currently use Early warning services, agricultural CS and regional weather and hydrological forecasts that are not tailored to the region, which can be challenging to use for decision-making purposes.

7. Climate service needs

This subsection describes the needs expressed by each LL regarding the next generation of CS. Needs range from tailored CS to be developed during the project that meet the needs of specific sectors or stakeholders, to better integration of, or improvements to, existing CS. These are also briefly summarised, alongside the CS currently used/available, and challenges in using these, in table 8.

7.1. The Netherlands

Seasonal, sub-seasonal and climate change information

The current CS offer 15-day forecasts, but, particularly in the water recreation sector, there is a need for longer lead times including seasonal, subseasonal and climate projection information for the water system. These longer lead times would allow stakeholders to prepare better for upcoming drought events and, by incorporating climate change information, develop climate adaption plans that account for the frequency and severity of droughts anticipated in the future.

Stakeholder engagement for co-creating tailored CS

Within the I-CISK project, the water board of Rijnland aims to strengthen communication and engagement with other sectors and stakeholders such as those from the agriculture and water tourism/recreation sectors, in order to co-create tailored CS that are informative for their decision-making processes.

7.2. Spain

Sector-tailored information

The climate information currently available are not tailored to stakeholders needs and do not take into consideration the impact of forecasts and projections (e.g. expected acorn production in the coming year, or pasture productivity at various timescales). These tailored CS would help farmers to adjust their plans and estimate productivity, manage water availability and plan management of activities such as those related to wildfire risks. Key variables of interest include rainfall patterns (seasonal distribution, yearly accumulations), and the start and duration of summer and winter seasons.

Improved spatio-temporal resolution

Existing forecasts are available up to 7-14 days; however, stakeholders noted that the addition of CS covering longer timescales (sub-seasonal, seasonal, annual) would be useful to make informed decisions. For example, longer-range forecasts would allow farmers to adapt (reducing numbers of livestock, when to harvest etc), and would assist in planning tourist activities and forest management activities. In addition, the spatial resolution of existing information from e.g. climate projections is seen as too coarse (e.g. only international information is available) to be informative at the scale of the LL, and would benefit from being downscaled to more local levels / regions.

Historical data and climatology

Easy access to historical data (such as precipitation, temperature, runoff generation, vegetation phenology etc.) would allow stakeholders to identify trends / confirm observations of trends and help them to make decision with or without forecast information. Alongside this, information on climate and hydrological characteristics based on historical data would be useful.

Uncertainty and skill information

Questionnaire/interview responses from the forestry and agriculture sectors highlighted a need for reducing the uncertainty in the forecast information, and the response from the rural development sector indicated an interest in improved availability of uncertainty and skill information for available CS.

7.3. Italy

Higher spatio-temporal resolution

The LL would like to use existing climate projections, seasonal and short-term forecasts provided by the Copernicus Climate Data Store (CDS). However, the variables of interest (precipitation, temperature, snow cover and river discharge) are currently available at 1° to 0.1° resolution. Stakeholders highlighted that they would need those variables to be downscaled to catchment (or even station) resolution in order to be useful for decision-making. Temporal resolution was also mentioned as a barrier to use of existing CS, implying that availability of CS at different temporal aggregations (e.g. 3 days compared to the currently availably weekly aggregated variables) would be beneficial and useful.

Local data integration

The new CS will need to integrate water withdrawals from water users, as the lack of this information is seen by most Stakeholders as a threat for a sustainable water management.

River discharge forecasts

A crucial missing variable is the river discharge forecast for Secchia river, from which all stakeholders withdraw water for the various sectors. Requirements are for river discharge forecasts at daily, sub-seasonal and seasonal timescales, for the catchment and at station level. Other stakeholders noted that river discharge predictions would be useful at all times, rather than only during dry periods as is currently available to them.

Uncertainty information

Questionnaire/interview responses indicated an interest in better provision of uncertainty information that is explained in a way that is effective for local decision-makers.

7.4. Hungary

CS for adaptation planning

The Hungarian LL identified the need for tailored CS to assist the Budapest municipality in the planning of adaptation strategies considering the increase in frequency and severity of heatwaves. The tool should serve four purposes:

- promote the increase of green spaces, and green infrastructure in the city

- heatwaves warnings
- mapping of urban and micro heat island spots and buildings
- health impacts and mitigation measures in relation to heatwaves and air pollution

7.5. Greece

Sector- tailored information

While it was noted that climate change vulnerability assessments are available that focus on individual sectors, there is currently a lack of information on other timescales that is tailored to support sector needs. It was highlighted that new sector-specific indicators and variables should be developed for sector-tailored CS. In the case of climate change assessments, it would be useful to identify links between sectors, with information available to support decision-makers outside of the government and administrative level and increase accessibility for non-expert users.

Improved spatio-temporal resolution

The stakeholders have expressed the desire to have CS of least 10 km spatial resolution covering the Island of Crete, and access to information on monthly, subseasonal and seasonal timescales.

Climate Hazard severity

The severity of forecasted events is currently not available, resulting in lack of actions that should be taken according to hazard severity.

Reliability and Uncertainty

Both responses highlighted that there is a lack of information or clarity regarding reliability and uncertainty information related to the CS they currently use, and such information would be useful for decision-making.

Multi-hazard CS

According to the LL report (D1.1 Greece, 2022), there is a need for CS that "*help to assess synergistic effect of multiple climatic threats, water and energy needs (availability of resources) and infrastructure (e.g. resorts, ports, marinas, roads, etc.) physical security due to extreme events (flooding, surging, snow fall, icing etc.). The service should also be able to target a diversity of seasonal and spatial coverage (summer costal activities / winter mountainous activities)*."

7.6. Georgia

Multi-hazard early warning system

The LL expressed the need for an early warning system for floods, landslides, debris flow/mudflow, snow avalanches, drought, hailstorm and windstorm. It is understood that such a system is currently under development for the region.

Impact based forecasts

In the water resources management and agriculture sectors, there is a need for impact-based forecasts to better inform and alert the public on climate hazards and inform decision-making.

Observation network maintenance

The LL has identified that data from the observing networks are crucial for strengthening CS for the purposes of climate adaptation strategies, and with this, the critical need for regular maintenance of the network of automatic weather stations. This also includes the integration of the data from this network into operational data flows and international data exchange.

Sector-tailored information

Survey responses indicated a lack of CS in the region, and the clear need for CS that can consistently provide local farmers with information about potential climate hazards and allow agricultural planning. It would be useful to provide information in a relevant language for local decision-makers.

7.7. Namibia

Capacity building

One of the main needs identified by the Namibia LL concerns the technical capabilities of stakeholders at different levels to analyse hydro-meteorological data and water resources threats. Technical capacity building would allow stakeholders, decision-makers and institutions to improve their short- and long-term management strategies and plans to consider climate hazard impacts, and warnings dissemination to the local population.

Awareness

In relation to the need for technical capacity building there is a lack of awareness on climate change impacts, adaptation and mitigation strategies from national to local levels. During the I-CISK project the LL aims to build the capacity of media, theatre groups, entertainment, and advertising industries" *to mobilize their experience in shaping public awareness and increase the active public participation in the climate change adaptation and mitigation debate*" (D1.1 Namibia, 2022).

Impact-based CS

I-CISK partners working with the Namibia LL identified the need for impact-based forecasts and climate projections to better quantify the effects of climate hazards on relevant socio-economic sectors of the LL and Namibia.

Improved spatio-temporal resolution

While further information is needed to better understand the specific CS used by stakeholders in the Namibia LL and their spatio-temporal resolution, it was identified that this is something that needs to be improved in order to better support decision-making.

8. Concise summary of CS use, barriers and needs

Table 8 indicates the types of CS currently available and/or used in each LL (in many cases, we are aware that these CS are available, but at this stage have been unable to ask all stakeholders and user groups whether and how they use these CS in their decision-making), the key challenges or barriers to effective use of these CS, and the associated or highlighted CS needs, in order to provide a concise summary of the information discussed in sections 5, 6 and 7.

Table 8 Overview of the types of CS currently available / used in each LL, barriers to their use, and CS needs.

Living Lab	CS currently in use	Barriers to effective use	CS needs
The Netherlands	Drought monitoring system (including medium-range forecasts), streamflow predictions	Stakeholder engagement with CS and lack of tailored information, limited lead times	Longer timescales, including subseasonal, seasonal and climate projections, strengthen stakeholder engagement and communication
Spain	Climatological data, reservoir management support, seasonal forecasts, climate projections, forest fire risk management plans, climate scenarios viewer, drought monitoring, meteorological forecasts, river basin monitoring	Effective dissemination to target audiences, lack of tailored information, forecast uncertainty, insufficient spatio-temporal resolution, lack of access to historical data	Sector-tailored information (e.g. forecasts of rainfall patterns, seasonal distribution, start of summer and winter seasons), impact-based forecasts, improved spatio-temporal resolution, longer-range forecasts (sub-seasonal, seasonal and >6 months), historical data access
Italy	Regional climate projections, historical and current hydro-meteorological observations, agriculture water demand forecasts	Forecasts aggregated at weekly timescales causes challenges for decision-making, data accessibility, lack of information on uncertainty and skill	Improved spatio-temporal resolution, integration of local data, river discharge forecasts, effectively communicated uncertainty information
Hungary	CLMS Urban Atlas, green areas monitoring, biodiversity monitoring, historical global land surface temperature, meteorological data, air quality monitoring and information module	Lack of useful variables, limited information on potential of green infrastructure	Tailored CS and wider range of variables related to heatwaves, including health impacts
Greece	Weather forecasts, climate change impact assessments and vulnerability analysis, hindcasts, short-term forecast service for reservoir water quality and quantity	Current CC-scale CS focus on single sectors and lack cross-sectoral links, other CS are not tailored for sectoral use, accessibility for non-exert users	Sector-tailored information and sector-specific indicators, improved spatio-temporal resolution, hazard severity indicators, uncertainty and reliability information, compound hazard CS
Georgia	Meteorological observations, local knowledge, meteorological and hydrological forecasts, extreme event warnings & advice, agrometeorological bulletins, frost early warning service, seasonal outlooks, climate projections	Service discontinuity (CS produced on-demand rather than continuously) and lack of long-term national strategy for user-driven CS, language barriers for local decision-makers and end users	Multi-hazard early warning system, impact-based forecasts, maintenance and integration of observation network and data, sector-tailored information
Namibia	Early warning services, seasonal and subseasonal forecasts, agricultural CS, regional meteorological & hydrological forecasts	Insufficient spatial and temporal resolution for local-scale decision-making	Impact-based forecasts, capacity building, increased awareness, improved spatio-temporal resolution

9. Preliminary conclusions and future work

This report provides a preliminary overview of the current availability, use and gaps related to existing climate services in each of the seven Living Lab regions participating in I-CISK. The information summarised here is based on project scoping, initial meetings, establishing of the LLs (including LL characterisation reports prepared through WP1 for D1.1, which provide more detailed information regarding the climate of each LL, the stakeholders involved and a variety of other information) and targeted questionnaires and interviews, regarding barriers to use of existing CS, and needs for improved and tailored CS.

At this stage in the project, while the LLs were in the process of being established, with stakeholder relationships being built and expectations for the project clarified, alongside ongoing travel restrictions, the use of questionnaires to be distributed online to stakeholders within the LL was a useful and effective option to begin collecting information and building an understanding of the experiences of a range of stakeholders regarding their use of CS, and the associated challenges and needs. This tool was also easy to modify and provide as a simple word document, to allow project partners leading each LL to conduct interviews with stakeholders during the ongoing process of establishing the LLs, if this was preferable and easier to undertake. The provision of multiple formats also allowed translation of the questions where useful, and responses were received in multiple languages indicating that this provided a more accessible option for some stakeholders. The authors of this report translated responses to English where necessary to include all responses in this report. While the questions were designed to be relatively open-ended, in order to provide space for stakeholders to write about their experiences without being too restricted by very specific questions, in some cases it was apparent that the expectations from certain questions were not clear. It will be important to further improve the wording of such questions for future iterations to ensure that the questions are clear and understood across all LLs, sectors and roles, and also to discuss these aspects further during follow-on discussions and activities in each LL. These interviews/questionnaires formed the first step of Task 2.1, which focusses on "co-exploring climate information and adaptation information needs and obligations of the stakeholders in the living labs". T2.1 takes place as an iterative process throughout the 4-year project (see Figure 1, which indicates the planned timeline and concept), using a participatory approach to ensure the centrality of user needs to the development of CS within I-CISK. As such, lessons learnt from these initial activities will be carried forward into future activities with T2.1 and the wider project (see Figures 1 and 2), and will also allow us to reflect and understand changes in perceptions of CS needs and gaps as the project and collaborations evolve.

While we were able to hear from 21 individual participants across 12 [14] responses for questionnaire 1 [2], a caveat of conducting this activity at an early stage while the LLs were being established, is that we have not yet heard directly from stakeholders in 3 of the LLs: The Netherlands, Hungary and Namibia. This is due to the differing stages of progress in establishing the LLs, and differences in timing of convening the multi-actor platforms. As Task 2.1 is an iterative task, we will continue to collect responses to the questionnaires and provide project partners in all WPs with updates to the information summarised in this document. Further activities will also be conducted throughout the course of the project, in order to continue co-exploring the climate and adaptation information needs of stakeholders in the LLs. Methods, tools and techniques may include participatory documents and surveys/interviews, user stories, collaborative workshops, sector-themed discussion groups to co-explore sector-specific needs or to discuss conflicting terminology across sectors and fields, use case modelling and serious games.

It is clear from this report that there is a wide range of sectors and stakeholders involved (see Table 1), and therefore a wide range of decision-making contexts and specific decisions that are, or have the potential to be, made based on CS. This ranges from agricultural decision-making in The Netherlands, Spain, Georgia and Namibia, to tourism through water recreation (The Netherlands), tourism enterprises (Greece) and tourists themselves, alongside sectors such as utilities, transport, forestry, environmental protection and humanitarian aid. Stakeholders in many of the living labs are involved in disaster risk reduction and climate adaptation strategies related to their region and sector, and sometimes more broadly, for example at the government and policy-making level.

The majority of stakeholders across the LLs are concerned with drought, with 50% of responses indicating that drought was a hazard of concern for their organisation/sector/decision-making context. In addition, there are stakeholders across the LLs who are also concerned with multiple hazards, including forest fire, water availability, flooding, heatwaves and other weather events such as hail and thunderstorms. Motivations for improving CS and their use include the importance of influencing preparedness and adaptation strategies, the increased risk of hazards and extreme events due to climate change, avoidance of conflict due to water demand, impacts of extreme events on many (if not all) sectors, easier exploitation of available information, policy support, and a drive for actors to see directly how CS can help them to move from reactive to proactive decisions and actions.

While there remains gaps in our knowledge and understanding of exactly how the various CS are used by different stakeholders in each LL, section 5 of this report starts to summarise our current understanding, such that this can be built upon in the next stages of the I-CISK project. Some examples were provided by stakeholders through responses to the questionnaires / interviews, such as the use of hydro-meteorological data from monitoring networks to make decisions on water allocation for industries and agriculture or limitations to water withdrawals. Other examples include the use of forecasts to issue warnings for extreme events, to influence urban planning, and to plan activities such as construction or tourist activities. Tables 2 to 7 provided information on the CS that are available and / or used by each of the seven LLs. In some cases, it is not yet known whether all of the available CS are utilised by the stakeholders in the LLs. These have been included to provide as complete a picture as possible of the CS that the LLs are aware of with availability in their region, and future activities will aim to further understand whether some of the available CS are not actively used in decision-making, and the reasons for this, which will help to shape the tailored CS co-created through I-CISK.

Some of the main challenges that stakeholders are faced with when using CS to make decisions were summarised in section 6, with a summary provided in Table 8. Key barriers to the use of CS for decision-making include insufficient resolution (temporal and/or spatial), such as rainfall forecasts aggregated over the period of a week when the application requires knowledge of how the rainfall may be distributed over the week, or information that may be aggregated over a large region and not provide enough spatial information to be used at the local scale. Accessibility of CS was also noted as a concern in more than one LL, such as the potential for the information to each the target audience, or difficulty of stakeholders to download the required data, or information that is only accessible to some sectors. In some cases, the variables provided by the CS were not sufficient for the decisions required. For example, in Hungary CS are important for detecting and predicting heatwaves, but key variables such as wind, sunshine, health impacts etc. are not available in addition to temperature, and these are key in understanding and communicating the potential impacts of heatwaves.

The needs of each LL in improving CS and developing the next generation of CS (see section 7 and Table 8) range from the development of CS at additional timescales (e.g. seasonal forecasts for regions where currently only 15-day forecasts are available) and spatial resolutions that are relevant to decision-makers, to CS that are tailored to specific sectors and provide impact-based and/or action-based forecasts (for example, expected crop production in addition to rainfall patterns). For many, additional variables (such as those mentioned previously for heatwaves, or provision of river flow forecasts) are required for effective decision-making, and forecasts of compound events and their impacts could be useful to a range of stakeholders. There is also a need to incorporate local knowledge and information into the co-development of improved CS. One example provided is the potential to integrate information on water withdrawals from water users, as the lack of information on water withdrawals is a threat for sustainable water management and integration would be beneficial for a variety of decision-makers.

Overall, this report has summarised the current state of knowledge of the I-CISK project in relation to the availability and use of existing CS and needs for improved CS for a range of stakeholders across seven diverse LLs with different motivations and aims. This information is designed to be used by other WPs and project partners in the I-CISK project to further co-develop their research and development priorities based on an increased understanding of stakeholders' experiences, challenges and needs. It may also provide a useful insight for other audiences, such as CS providers, into the reflections of stakeholders on needs and gaps of existing CS. Several gaps remain following this report, such as more specific information on the types of decisions that are made, a better understanding of the process of decision-making and the trust in the available CS information. Future activities, in collaboration with other WPs in the I-CISK project, will continue to co-explore the challenges and needs of stakeholders participating in each LL, making use of research and outputs from all WPs during the course of the project, to receive feedback on the process of the research and co-creation of tailored CS through an iterative process that seeks to incorporate feedback regularly in order to provide the most potentially useful research outcomes and CS. This report therefore provides a starting point for co-exploring the challenges and needs of stakeholders participating in the I-CISK project, and how we can begin to address the challenges faced and the needs for improved CS in the seven LLs.

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Appendix 1: Glossary

Acronym	Definition
AEMET	State Meteorological Agency of the Spanish Government
ARPAE	Regional Agency for Prevention, Environment and Energy of Emilia-Romagna, Italy
C3S	Copernicus Climate Change Service
CC	Climate Change
CDS	Copernicus Climate Data Store
CEMS	Copernicus Emergency Management Service
CHIRPS	Climate Hazards Group InfraRed Precipitation with Station data quasi-global dataset
CLMS	Copernicus Land Monitoring Service
CS	Climate Service
CSIC	Spanish National Research Council
DELTA	LEPL State Military Scientific-Technical Centre, Georgia
DRR	Disaster Risk Reduction
DX.X	I-CISK deliverable (X.X refers to deliverable number)
ECMWF	European Centre for Medium-range Weather Forecasts
EO	Earth Observation
EWS	Early Warning System
FAO	United Nations Food and Agriculture Organisation
FTP	File Transfer Protocol
GDHY	Global Dataset of Historical Yields
GEOSS	Global Earth Observation System of Systems
GloFAS	CEMS Global Flood Awareness System
HERA	Holding Energia Rosorse Ambienta, public utility company in Bologna, Italy
KNMI	Royal Netherlands Meteorological Institute
KRDF	Kakheti Regional Development Foundation, Georgia
LEPL	Ministry of Internal Affairs, Georgia
LL	Living Lab
MAWLR	Ministry of Agriculture, Water and Land Reform, Namibia
MEDCOF	Mediterranean Climate Outlook Forum
MEFT	Ministry of Environment, Forestry and Tourism, Namibia
MEPA	Ministry of Environmental Protection and Agriculture, Georgia
MSX	I-CISK Milestone (X refers to milestone number)
NDVI	Normalised Difference Vegetation Index
NEA	National Environment Agency of Georgia
NGO	Non-Governmental Organisation
NUST	Namibia University of Science and Technology
OAK	Hungarian National Institute of Public Health
OKIR	Hungarian National Environmental Information System
PET	Potential Evapotranspiration
PERT	Program Evaluation Review Technique (diagram/chart)
REDIAM	The Environmental Information Network of Andalusia, Spain
SASSCAL	Southern African Science Service Centre for Climate Change and Adaptive Land Management
S2S	Subseasonal to Seasonal
SEECOF	Southeastern Europe Climate Outlook Forum
TAMSAT	Tropical Applications of Meteorology using SATellite data and ground-based observations
TX.X	I-CISK Task (X.X refers to work package and task number)
UNESCO	United Nations Educational, Scientific and Cultural Organisation
WASH	Water, sanitation and hygiene
WPX	I-CISK Work Package (X refers to work package number)
WWF	World Wildlife Fund

Appendix 2: Questionnaires / Interview Questions

The following pages show the interview questions provided to the LLs to conduct interviews for this task and deliverable. The questions were provided as below, and the same questions were also provided as two google forms that could be submitted to us online, alongside the corresponding consent forms. Some LLs also translated the following into a more relevant language for the stakeholders in their LL.

I-CISK

HUMAN CENTRED CLIMATE SERVICES

Task 2.1

Living Lab Stakeholder / Participant Questionnaire: Information on Climate Service Needs & Gaps

February 2022

Context

As we make progress in establishing the I-CISK project and building partnerships within the 7 Living Labs, we seek to gain an understanding of the current use of climate services and information, barriers to use of existing climate services, and needs for improved climate services, in each of the Living Labs. Insight into what is good about existing climate services and what could be improved, alongside how the information is being used for decision-making, will provide key information for the progress and development of this research project, alongside increasing the understanding of decision-making and associated challenges across the I-CISK project partners.

In order to learn more about these important topics, we have put together a list of questions that we'd like to ask those who are involved in using climate or weather data / information / services for decision-making purposes. The responses to these questions will be summarised in a report that will be shared with partners of the I-CISK project to provide an overview of existing use of, barriers to use of, and need for improved climate services. The report will also potentially provide useful information to the producers of climate services to further improve their products. The report will be publicly accessible, but any responses included will be anonymised.

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 Rebecca Emerton (the contact person at ECMWF who will be collecting the responses).

Please send any completed questionnaires (if you are recording answers in this document instead of the google forms) to […] and […].

Thank you for your collaboration!

Informed Consent Form

I, undersigned ---

---(please write your name here), resident of ---

--(please write the place of residence and country)

am pleased to give my informed consent to voluntarily participate in the I-CISK Project (www.icisk.eu) funded through European Union's Horizon 2020 research and innovation programme under grant agreement No 101037293. I understand that the main objective of I-CISK is to develop a next generation of climate services that follow a social and behaviourally informed approach, co-producing these climate services with their users. The project aims to meet the climate information needs of citizens, decision makers and stakeholders at the spatial and temporal scale relevant to them. The project activities are focused in seven living labs across Europe (Georgia, Greece, Hungary, Italy, Netherlands, Spain) and Africa (Namibia). The living labs have a pivotal role in co-creating the human centred climate services to prepare current and future generation to address the impacts of climate variability and change, and multiple hazards (e.g., flood, droughts, water scarcity and heatwaves).

I am voluntarily participating in I-CISK's co-creating process as part of the I-CISK's living lab in

----

(please insert name of the living lab and country here).

There is no foreseeable risk to me and other participants of the project as a result of participating in this activity. The research is not expected to lead to risk of misuse, stigmatisation of certain societal groups, political or financial retaliation. The outcomes of the project and its application to the living labs and beyond are expected to contribute to empowering citizens, stakeholders and decision-makers to decide how to adapt to climate change and mitigate the impact of extreme events. The results of the project activities will be made available to me upon request.

I am aware that my participation in the in I-CISK activities is purely on voluntary basis. I have full right to decide to participate or not to participate in a specific project activity. Moreover, I can choose to withdraw my participation in the living lab activities at any point in time during the project implementation period. I need not to provide any reason behind my decision not to participate in a project activity or fully withdraw my participation from the project. However, the research data provided by me before stopping my participation can be used in the project results.

Moreover, I provide my consent on the following specific points outlined in the Table below.

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 to participate in video/audio recordings (if necessary) during the project activities. The recorded video/audio can be used for I-CISK communication and dissemination activities.		
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		

Last but not least, 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) or chair of the I-CISK ethics committee (Dr. Ilyas Masih) or a principle researcher undertaking a specific project activity.

Interview Section 1 – Climate Services for Decision-Making in the Living Labs

Definition of "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" - European Commission, 2015

Introduce Yourself:

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.

6. How many years of experience do you have in this type of role?

7. Please briefly describe your educational and career background.

8. What is your gender?

9. Which Living Lab are you involved in? (circle)

   Spain Italy The Netherlands Greece Hungary Georgia Namibia

Decision-Making:

1. How are your day-to-day activities / the activities of your organisation affected by or linked to weather / climate?

2. What are the biggest challenges you / your organisation face?
These challenges may not be related to weather/climate at all, we are interested to hear about the key challenges you face in your activities in a wider context.

3. What role, if any, does the climate play in these challenges?

4. What are the types of decisions you have to make that are based on climate and weather data / information / services?

5. What is(are) the timescale(s) of this decision-making?

   emergency management, monitoring, short-term planning, climate adaptation, …

   and / or

   1 day, 1 week, 1 month, 1 season, 6 months, years, …

6. How are the climate and weather data / information / services used in making decisions?

7. What makes these decisions difficult to make?

8. Do you undertake any regular or post-event evaluation or reflection of the climate and weather data / information / services and the decisions made?
If yes, what does this process involve?

9. Are you or your organisation involved in / carrying out any climate adaptation or disaster risk reduction strategies?
If yes, please briefly describe these strategies.

10. Does your role involve summarising or providing climate or weather data / information / services for other people?
If yes, please briefly describe this process, including who you are providing this to, and any challenges specific to passing on this information to others.

Climate Service Use and Needs:

1. Please list the climate and weather data / information / services that you currently use in your decision-making.

2. Please list other climate and weather data / information / services that you have considered using, but have chosen not to, and why.

3. How would you describe the accessibility of existing climate and weather data / information / services?

4. How would you describe the performance (think of *usefulness, credibility, comprehensiveness, applicability, accuracy)* of existing climate and weather data / information / services?

5. Think about a recent extreme weather / climate event that you were involved in decision-making for. During this event:
   How were climate services and information used?
   Were they sufficient to avoid big impacts?
   What information was missing to make effective decisions?

6. Now considering decision-making more generally:

What are the main difficulties / challenges you face when using these weather and climate data / information / services?

7. What additional information would you find useful for the types of decisions you need to make?
   Please be as specific as possible (*for example, tell us about the type of hazard / climate risk / variable, region / spatial scale, temporal resolution, spatial resolution, format, supporting information, and any other comments you would like us to know).*

8. If you are involved in / carrying out climate adaptation or disaster risk reduction strategies, is there any particular climate service / information / data, or other type of information, that you are currently lacking to implement or develop these strategies? If yes, please explain.

9. Any other general comments regarding weather and climate data / information / services, challenges using them, and needs for improved climate services?

Interview Section 2 – Climate Service Details

Definition of "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" - European Commission, 2015

For each weather or climate data / information / service you are currently using for decision-making (listed previously in interview section 1), please tell us the following:

[Please note that you may wish to create a copy of these questions for each data / information / service used to keep the answers separate, or you may prefer to submit the answers using the google form 'Climate Service Details', which can be filled in any number of times]

1. Which weather or climate service / information / data are you answering these questions about?

2. Do you or your organisation produce this data / information / service?
   a. If yes, please tell us about the models and/or input data used, or how it is produced.

   b. If yes, do you have a process in place to evaluate its use?

   c. If no, please tell us where, or who, you get the data / information / service from, and how you receive it (*internet, radio, mobile phone, …)*

3. If multiple different products or types of information are provided, please specify which you are using.

4. What is the format of the information you use? (*raw data, maps, charts, text, …*)

5. What type of weather / climate hazard / risk does the data / information / service apply to?

6. What variable(s) do you use?
   For example, are you using data / information on rainfall, temperature, river flow, soil moisture, other, ...

7. What is the available forecast horizon / timescale of the data / information? What forecast horizon / timescale do you use?
   For example, you may use a forecast that provides information for days 1 – 30, but you may only use days 1-10.

8. Are there aspects of the data / information / service that make it challenging / difficult to use? (*product visualisation, user interface, language, units, documentation / descriptions, variables available, …)*

9. Is information provided on the uncertainty in the climate or weather data / information / service?
    a. If yes, do you find the uncertainty information useful? Why / why not?

10. Is information provided on the accuracy / skill / performance of the climate or weather data / information / service?
    a. If yes, what kind of accuracy / skill / performance information is provided?

    b. If yes, is it useful, and why / why not?

    c. If no, would you be interested in receiving this type of information? What type of information would be useful to you in your decision-making?

11. Do you trust the climate or weather data / information / service, and why / why not?

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

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 10103729