

Assessment Report

Mapping the State of the Art of Climate Services Standardization from a Multi-Level Governance Perspective (MLG)

Deliverable 5.2

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Funded by the European Union

Climateurope2

Document Information

GRANT AGREEMENT	101056933
PROJECT TITLE	Supporting and standardizing climate services in Europe and beyond
PROJECT ACRONYM	Climateurope2
PROJECT START DATE	01/09/2022
RELATED WORK PACKAGE	WP5
RELATED TASK(S)	T 5.1
LEAD ORGANIZATION	Ecologic Institute (ECO)
AUTHORS	Martinez, G. (ECO), Cuevas Garcia, C. (TUM), Ferrant A. (REH), Giraud, L. (REH), de Goër de Herve, M. (RMC), Hobeika, M. (RMC), Krauß, W. (UBremen), Stocker, M. (RMC)
SUBMISSION DATE	28 March 2025
DISSEMINATION LEVEL	Public

History

DATE	SUBMITTED BY	REVIEWED BY	VISION (NOTES)
11 March	Grit Martinez (ECO)	Carmen Gonzalez Romero, Barcelona Supercomputing Center (BCS)	First draft reviewer

11 March	Carmen Gonzalez Romero		Review received
28 March	Grit Martinez (ECO)		Submitted

Please cite this report as: Martinez, G., Cuevas Garcia, C., Ferrant, A., Giraud, L., de Goër de Herve, M., Hobeika, M., Krauß, W., A., Stocker, M., (2025) Assessment Report on Mapping the State of the Art of CS Standardization from a Multi-Level Governance Perspective. Deliverable 5.2 of the Climateurope2 project.

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About Climateurope2

Timely delivery and effective use of climate information is fundamental for a green recovery and a resilient, climate neutral Europe, in response to climate change and variability. Climate services address this concern through the provision of climate information for use in decision-making to manage risks and realize opportunities.

The market and needs for climate information has seen impressive progress in recent years and is expected to grow in the foreseeable future. However, the communities involved in the development and provision of climate services are often unaware of each other and lack interdisciplinary and transdisciplinary knowledge. In addition, quality assurance, relevant standards, and other forms of assurance (such as guidelines, and good practices) for climate services are lagging behind. These are needed to ensure the saliency, credibility, legitimacy, and authoritativeness of climate services, and build two-way trust between supply and demand.

Climateurope2 aims to develop future equitable and quality-assured climate services to all sectors of society by:

- Developing standardization procedures for climate services
- Supporting an equitable European climate services community
- Enhancing the uptake of quality-assured climate services to support adaptation and mitigation to climate change and variability

The project will identify the support, and standardization needs of climate services, including criteria for certification and labelling, as well as the user-driven criteria needed to support climate action. This information will be used to propose a taxonomy of climate services, suggest community-based good practices and guidelines, and propose standards where possible. A large variety of activities to support the communities involved in European climate services will also be organized.

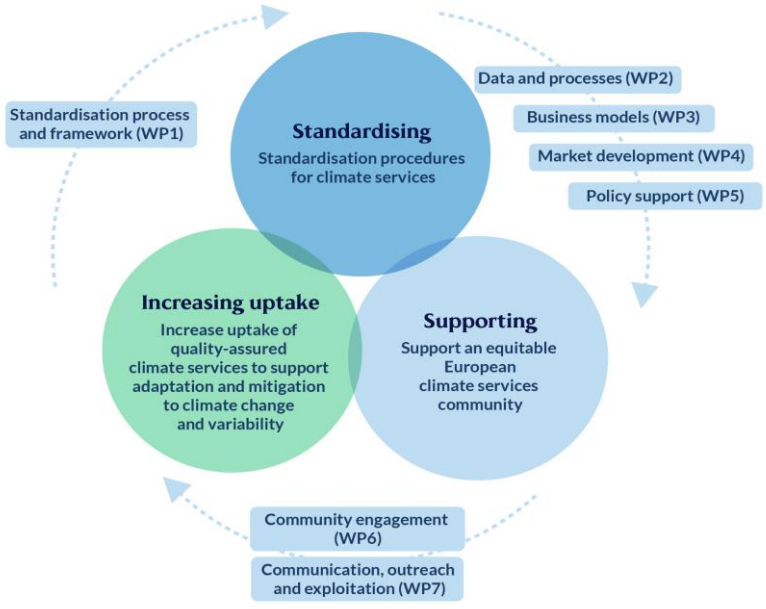


Figure 1 Structure of Climateurope2 project

Executive Summary

This deliverable aims to gain a deeper understanding of the needs related to climate services and their standardization from a governance perspective. We focused on stakeholders at the national, regional, and local levels across Europe, seeking to learn about their experiences and requirements for integrating climate-related information into their daily activities. Our audience provided valuable insights into the challenges and barriers they face when using climate information in governance and policy making and how standards would be helpful. The engagement with our primary target group was facilitated through three key intervention methods: (1) Interviews at national, regional, and local governance levels across Europe, (2) survey, and (3) a roundtable discussion at the Climateurope2 festival in Venice (March 2024), using the fishbowl method.

Keywords

Multi-level governance (MLP), adaptation, mitigation, climate services, standardization, EU, national, regional and local levels, decision context, ecosystem of actors, co-production processes, delivery mode, evaluation, knowledge systems, place-based needs, limits of standardization, Poland, Spain, Belgium, Germany, France.

1 Introduction

Grit Martinez

1.1 Significance of Multi-Level Governance systems for climate change decision making and for climate service standardization processes in Europe

Climate services are developed to support societal mitigation and adaptation efforts in response to both short- and long-term climate change impacts (IPCC, 2022). The European Roadmap for Climate Services and the Global Framework for Climate Services are key concepts with both European and global focuses. Launched in 2009, the Global Framework for Climate Services which later evolved into the National Framework for Climate Services is a global partnership of governments and organizations that produce and use climate information and services. Its goal is to build an infrastructure for climate services both within the EU and internationally, while also opening new markets and engaging multiple stakeholders at various levels. Together with the European Roadmap, it lays the foundation for shared solutions and pathways, facilitating the development of a climate services market that provides significant benefits to society.

The effort to understand the recognition and utilization of climate services as well as the knowledge and practices surrounding climate service standards from a multi-level governance (MLG) perspective, is relatively recent (Hewitt et al., 2020). In general, the term MLG refers to the distribution of policy-making power beyond the national level to regional and local levels, involving both governmental and non-governmental organizations. The EU is an example of a group of states transferring authority to supranational organizations. In the context of adapting to a changing climate and mitigating the impact of climate change, this engagement spans a wide range of, including policymakers at the national level, as well as regional and local governments, municipalities, communities, and city representatives. With the adaptation policy cycle the EU established a comprehensive framework designed to guide the process of adapting to climate change and its impacts across various sectors. The adaptation policy cycle is a dynamic, multi-stage process that emphasizes a collaborative and evidence-based approach to managing climate risks. The cyclical nature of this process ensures that policies remain flexible and responsive to new information and changing climate conditions.

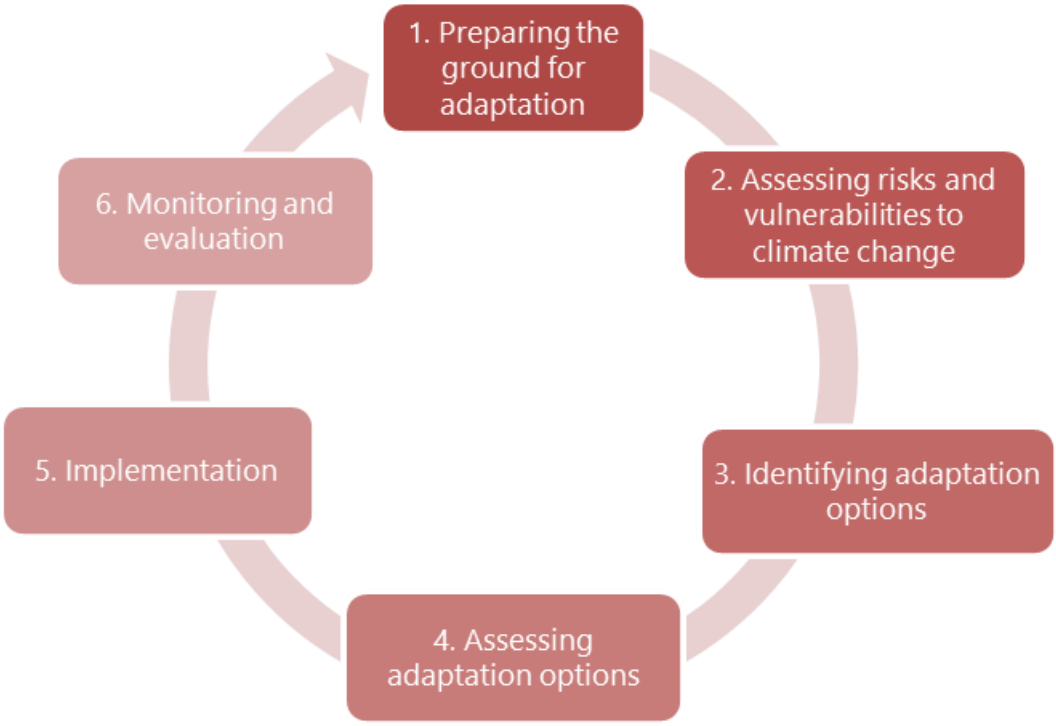


Figure 2 Adaptation policy cycle, based on the EEA Adaptation Support Tool. Source: Climate-ADAPT (https://climate-adapt.eea.europa.eu/en/knowledge/tools/adaptation-support-tool, accessed on 05/03/2025)

The key EU legislative documents on adaptation include the Communication on Managing Climate Risks in Europe (2024), the European Climate Law (2021), the EU Adaptation Strategy (2021), and the Mission on Adaptation to Climate Change (2023). EU Member States and EEA countries are actively adapting to climate change and natural variability by implementing their National Adaptation Strategies and National Adaptation Plans. Every two years, Member States report on national adaptation actions under the Regulation on the Governance of the Energy Union and Climate Action (EU, 2018/1999) (PE/55/2018/REV/1). National Adaptation Strategies (NASs) are overarching national frameworks for climate adaptation, identifying key climate risks and outlining strategies to address them across various sectors. National Adaptation Plans (NAPs), on the other hand, translate these strategies into actionable adaptation and mitigation measures at regional and local levels. At present, 26 of the 27 EU Member States have developed a National Adaptation Strategy (NAS), while 16 have established a National Adaptation Plan (NAP). Among these, 12 NASs are based on climate risk assessments, and 15 Member States have established both a NAS and a NAP. (ETCCA, 2023).

Europe continues to make significant progress in integrating adaptation to climate change and natural variability at various policy levels. For instance, countries such as Belgium, Denmark, Estonia, Malta, Poland, Portugal, Romania, and Slovakia are increasingly incorporating climate change impacts into

their national Disaster Risk Management (DRM) frameworks and sectoral policies (Leitner et al., 2023; EEA, 2022). Additionally, the updated EU Adaptation Strategy (COM/2021/82 final) from 2021 emphasizes the importance of regional and local levels in adaptation efforts, recognizing the critical role of municipal and regional authorities. However, according to the EEA, only nine EU Member States (Denmark, Estonia, France, Germany, Lithuania, Portugal, Romania, Spain and Sweden) had budgets explicitly earmarked for and readily available to strengthen climate adaptation actions (e.g. national climate projections, **climate scenarios and climate services**, capacity-building and websites) in 2021 (EEA, 2022).

While adaptation planning across all policy levels is increasingly becoming a norm, it is so particularly at the municipal level. Approximately 51% of European cities (Reckien et al., 2024) have now established specific adaptation plans, a considerable rise from the 26% reported in 2018 (EEA, 2024). National adaptation reporting also provides valuable insights into the impacts of climate change and adaptation strategies at both the subnational and urban levels. In 2023, ten EEA countries specifically highlighted the urban sector as being significantly affected by climate change and assessed the risk of future impacts as medium to high (EEA, 2024). This suggests an increase in risk for urban areas due to climate change. Additionally, nine EU Member States focused specifically on urban areas in their national strategy summaries. Moreover, European, international, and national policies play crucial roles in providing guidance, funding, knowledge, and capacity building in setting the adaptation and resilience framework for cities and regions to act. Established through the Pact of Amsterdam in 2016 and updated through the Ljubljana Agreement in 2021, the Urban Agenda for the EU (UAEU) is a coordinated approach addressing the urban dimension of EU policies, emphasizing subsidiarity and proportionality. It focuses on better regulation, funding, and knowledge across EU policymaking.

The example of the EU's 'Water Sensitive City' concept provides good proof of concept from a multi-level governance perspective. For example, in the water resource sector in Germany specific urban challenges such as 'Water Sensitive City' (WSC) for which the so-called „sponge-city „approach has been established, are addressed. A "sponge city" buffers rainwater at its place of origin. "Green elements" just as swales, tree-drains, green roofs and facades help to evaporate, store and infiltrate the rainwater, which strongly reduces the outflow. Since many European regions need to cope with excessive water intake this situation underpins the need for a multi-level governance approach for implementing water sensitive city concepts on a large scale in Europe. Given the wide-ranging variability of local conditions, a tailored, place-based approach and the utilization of customized climate services becomes imperative. Concurrently, higher-level authorities establish the overarching framework and gauge its level of supportiveness. Promising examples are e.g. the Emscher Landscape Park (ELP) in Germany or the Dutch Delta Program (Georgi, 2024).

Example of multi-level governance approach from the water sector in Germany

In 2023, the National Water Strategy in Germany was adopted, which lays the foundation for sustainable management of water resources and the protection of water bodies. The action 13 "Near-natural rainwater management" and 19 "Further develop and implement the vision of a water-sensitive city" are two pillars in the National Water Strategy. Together with "Natural climate protection action program's" # 7 "Field of action Natural climate protection on settlement and traffic areas" the concept of the so called "sponge city" has been anchored in national, regional and local level throughout various regions in Germany.

In light of the steady increase of high impact events such as flash flood and heavy rain, Germany's government started to implement a policy mix at national level, which creates supportive framework conditions for the implementation and perpetuation of "sponge city" principles so that innovative approaches are increasingly implemented at municipal level. These include the amendment of the Federal Water Act by prioritizing decentralized management of precipitation water and avoidance of wastewater; the amendment of the German Building Code by expanding the list of stipulations; the strengthening of nationwide financial support for local construction and research projects on the "sponge city" with a focus on evaluating measures; the integration of sustainable outdoor facilities and the greening of buildings in programs for climate-friendly new construction; the recommendations by the federal government for the definition of orientation and characteristic values for the quantitative and qualitative green and open space provision at municipal level; the development of municipal political and planning strategies for the implementation of the sponge city; improving the data and information basis for the implementation of the" sponge city" and further education and training on water-sensitive cities; blue-green infrastructure and adaptation to adaptation to climate change in urban areas. This policy mix for climate-resilient "sponge cities" combines key policy instruments at federal level which provide a framework for the faster and nationwide implementation of the "sponge city" principle.

At regional and local level, the conversion of cities into a climate-resilient "sponge city" involves different urban spaces, actors and institutions. In particular, such a vision requires greater cooperation between different departments in the municipal administration. At the same time, the potential benefits of climate-resilient "sponge cities" are broadly diversified in different municipal fields of action. At regional and local level in Germany common policy instruments for a "sponge city" include municipal design statutes, textual specifications in development plans and urban development contracts, funding programs for greening and unsealing, as well as split wastewater charges, including reductions in charges in the case of near-natural, runoff-reducing measures. In Germany pioneering cities such as Emscher region/Ruhr area or the city of Hamburg are increasingly adopting strategies and political decisions, funding instruments and measures to improve the information base and spatial planning instruments framed by Germany's national level policies. To support the various initiatives aimed at adapting to and mitigating the effects of climate change, climate services are needed at all governance levels and throughout the different phases of the policy adaptation cycle. Ideally, climate services align with the stages of the adaptation management cycle – planning, policy development, implementation, monitoring, and evaluation (see illustration below). In practice, however, climate services often face complex challenges at the municipal level, such as already

established sectoral adaptation measures, local networks and policy routines prioritizing other issues, or conflicting interests between departments or measures.

Figure 3 Example of multi-level governance approach from the water sector in Germany

1.2 Objectives of the report

This report presents an analysis of the role of Multi-Level Governance (MLG) systems in climate change decision-making and the standardization of climate services in Europe. In the context of climate adaptation, governance structures at local, national, and EU levels play a crucial role in shaping policies and the effectiveness of climate services. These services are essential tools for mitigating and adapting to climate change, and their integration into climate policies at various governance levels is paramount to achieving long-term resilience.

The significance of MLG systems in addressing climate change lies in their ability to connect different layers of decision-making, enabling more coordinated and effective responses. Climate service standardization processes ensure consistency, quality, and comparability across different regions, which is vital for enhancing cross-border cooperation and ensuring equitable climate adaptation strategies. This report delves into these dimensions, particularly focusing on the adaptation policies of the EU, the adoption of climate services at different governance levels, and asks if standardization processes are involved.

The purpose of this report is to assess how climate services are integrated into governance structures and how their standardization could enhance climate adaptation and policymaking across multiple levels. As climate risks become increasingly complex, the need for reliable and standardized climate services has grown. Effective multi-level governance (MLG) frameworks are crucial for bridging the gap between climate science and decision-making processes, ensuring that climate-related information is accessible and actionable for policymakers at different levels while beneficial to other key stakeholders such as civil society organizations or the private sector too.

The report is organized as follows to facilitate an in-depth exploration of the topic:

- Section 1: Introduction
  This section outlines the significance of Multi-Level Governance systems in climate change adaptation and the standardization of climate services in Europe. It also defines the objectives of the report.
- Section 2: Methodology
  This section describes the methodological approach used to conduct the research, including a literature review, case study selection, interviews, surveys, and fieldwork. It details how data was collected from various stakeholders, such as policymakers and local actors.

- Section 3: Results
  The results section presents the findings from the research, broken down into several subsections:
  - 3.1 EU Climate Change Adaptation Policy Dissemination: Analyzes the implementation of EU adaptation policies at the national and subnational levels.
  - 3.2 Uptake and Standardization of Climate Services: Explores how climate services are standardized and incorporated into EU member states' climate policies.
  - 3.3 Uptake of Climate Services in Climate Policies: Provides insights from case studies of specific countries (Belgium, France, Spain, Poland) and local-level case studies.
  - 3.4 Results from Discussions with Local and Regional Policy-Makers: Summarizes the outcomes of discussions with stakeholders at various levels of governance.
  - 3.5 Results from the Survey: Presents the key findings from the survey conducted with policymakers and other stakeholders.
- Section 4: Conclusion
  This section summarizes the key findings of the research and provides recommendations for enhancing the integration and standardization of climate services in EU member states' climate policies.
- Section 5: Annexes
  This section includes supplementary materials, such as references, case study selection criteria, interview guides, and survey questions.

This structure is designed to offer a logical flow from the background of the issue to the analysis and conclusions, providing a thorough understanding of how Multi-Level Governance and climate service standardization processes are evolving in Europe.

2 Methodology

Grit Martinez and Laeticia Giraud

2.1 Methodology outline

This report examines the role of climate services for adaptation policy, with a focus on their potential standardization and integration into decision-making and planning. The methodology adopted for this analysis is guided by four key research question developed by the team of Work Package 5:

1. *Are climate services used in the climate adaptation policy cycle?*
2. *Are standards known and/ or used in climate adaptation policy formulation and in decision-making and planning? If yes, which?*
3. *What are the requirements on standards for climate service to be helpful for adaptation policy formulation, decision making and planning?*
4. *At which stages of the design of adaptation policies, decision making and planning, could climate service standards be helpful?*

To address these questions, the research employed a multi-method approach:

- **Performing a literature review on EU policy landscape on adaptation and climate services at various governance levels** (academic and grey literature, mainly policy documents): A comprehensive literature review was conducted to understand EU legislation on climate adaptation at national and subnational levels, focusing on implementation of climate services.
- **Mapping of the existence of climate services** in European, national and regional policy documents and in the climate adaptation policy cycle: the mapping process involved selecting a diverse sample of EU countries and regions to analyze the integration of climate services into adaptation policy. Data collection included desk-based research on policy documents and semi-structured interviews with key stakeholders at different governance levels.
- **Undertaking a survey across EU member states:** A targeted survey was conducted across EU member states to assess policymakers' and authorities primarily but also allow other stakeholders such as private, non-governmental actors and research institutions familiarity with climate services and standards. The questionnaire covered institutional backgrounds, perceptions of climate services, and knowledge of standardization. Responses provided valuable insights into the role and recognition of climate service standards in adaptation planning.
- **Carrying out semi-structured interviews and a discussion using fishbowl method** at various levels in selected EU case studies: Semi-structured interviews were conducted with policymakers, climate service providers, and knowledge-brokers to deepen the understanding of engagement between users and providers. A fishbowl discussion was also organized to facilitate an inclusive dialogue on the practical challenges and opportunities of standardizing climate services in adaptation policy.

2.2 Literature review on the EU policy landscape on adaptation to climate change and climate services at various governance levels

To understand the EU legislation on adaptation at national and subnational level, and current status of implementation in EU Member States, a literature review was performed based on scientific and grey literature. Section 3.1 provides an overview of the findings.

In a second step, a literature review was undertaken specifically on standardization of climate services in adaptation and mitigation in EU policies at national, regional and local levels. The results are presented in Section 3.2.

2.3 Mapping of the manifestation of climate services

The mapping was organized around a series of steps:

1. **Selection of a sample of countries and regions within the EU for suitable case studies** (see tables 1 and 2)**.**
2. **Definition of the analytical framework for the case studies.** A framework for the mapping and analysis of the cases was defined to organize the data collection. It is displayed in Annex 2. This framework is also identified as "canvas" in the following.
3. **Collection of data through desk-based research, mainly policy document analysis.** Building on the framework, information and data was collected based on literature review in the first instance. The information is organized on the canvas.
4. **Collection of data through interviews.** After the preliminary phase of desk-based research, a series of interviews was organized with focal points identified at different levels of governance: national, regional level and local.



Figure 4 Schematic representation of the methodology supporting the mapping exercise. Source: Ramboll

2.3.1 Case study selection and methodological approach.

Case Study Selection and Methodological Approach

The selection of case studies reflects a strategic approach to examining multi-level governance in climate adaptation. Rather than focusing on a single governance tier, we include national (Poland, Spain, France, Belgium), regional (Catalonia, Brittany, Flanders), urban (Warsaw, Barcelona), and local (Ammerland) cases. This diversity enables an exploration of climate services across different governance structures, highlighting how adaptation policies and decision-making processes unfold at various scales. Additionally, the inclusion of these cases is grounded in practical accessibility and alignment with the broader objectives of the deliverable, ensuring a balance between contextual depth and comparative breadth. The selected cases illustrate distinct socio-political, economic, and climatic conditions, allowing for a nuanced understanding of how climate services operate under different institutional arrangements.

Methodologically, this deliverable embraces a pluralistic research design to capture the complexity of climate adaptation governance. The case studies employ a range of methods, including surveys, desktop research, expert interviews, and long-term ethnographic fieldwork. This methodological diversity is intentional, reflecting the need for flexibility when examining climate services in varying policy and governance settings. Surveys are utilized for broad national-level assessments, while interviews provide in-depth insights into stakeholder interactions. Desktop research ensures a systematic review of policy frameworks, and ethnographic studies and surveys allow for a deeper understanding of long-term adaptation processes at the local level. This mixed-methods approach enables triangulation, strengthening the reliability of findings and ensuring that both quantitative trends and qualitative narratives are accounted for. By integrating multiple perspectives, the deliverable provides a comprehensive and context-sensitive analysis of climate services across different governance levels.

Each case is made of a country and a sub-national entity, i.e. a region, province or city or represents in-depth ethnographic research within a country such as in the northern region of Germany. The rationale to study these levels was to understand better how climate services are produced, delivered and used at the different levels of governance to inform climate policymaking and whether standardization could help streamline the uptake of climate services.

Special attention was paid to select a diversity of member states that represent the variety of climate hazards that EU countries can face. The selection also consisted of countries/ regions that are at different stages and progress regarding adaptation planning and implementation as well as climate services production and usage.

In the following table, we categorize the case studies along the deployment of National Adaptation Strategies (NAS), National Adaptation Plans (NAP), National Climate Risk Assessment (CRA) and locate them in Europe.

The following cases were selected:

Table 1 Selected countries and/or associated region or city for the case studies

Member State	National Adaptation Strategy (NAS)	National Adaptation Plan (NAP)	National Climate Risk Assessment (CRA)	European transnational regions	Region/ City
Belgium	Adopted	Superseded	In progress	North Sea Northwest Europe	Flanders
France	Adopted	Adopted	N/A	Alpine Space Atlantic area Mediterranean Sea North Sea Northwest Europe Southwest Europe	Bretagne
Spain	Adopted	Adopted	Completed	Mediterranean Sea Southwest Europe	Catalonia / Barcelona
Poland	Adopted	N/A	In progress	Baltic Sea Central Europe	Warsaw
Germany	Adopted	Adopted	Adopted	North Sea Lower Saxony	Ammerland District

In the following, we situate the case studies and the respective methodology in the analytical framework of Climateurope2.

2.3.2 Definition of the analytical framework

The analytical framework used to study the five national-subnational levels cases was developed based on the Climateurope2 project theoretical basis. More specifically, the scope of the framework covers the four dimensions of climate services identified in Climateurope2, summarized in the figure below:

- Decision context
- Ecosystem of actors and co-production processes
- Delivery mode and evaluation
- Knowledge systems

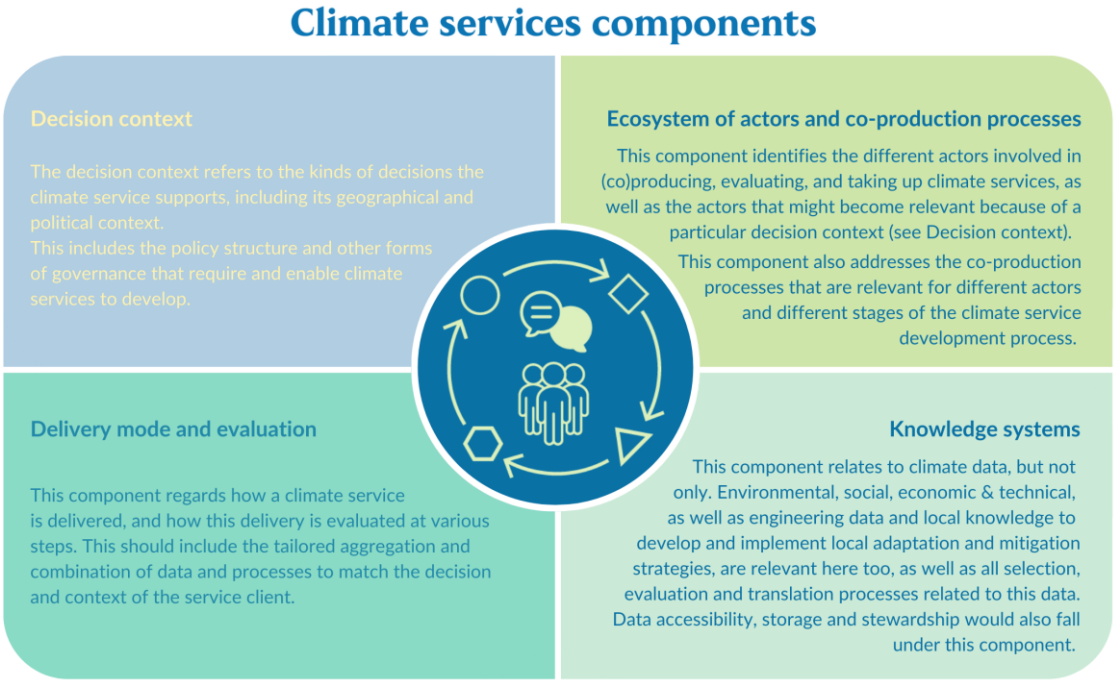


Figure 5 Climate services components as described in Climateurope2 project

The table in **Annex 2** presents the framework used to develop the use cases. It forms the basis of the interview guide used to conduct interviews and collect information.

2.3.3 Collection of data through desk-based research

Most data used to analyze the manifestation of climate services in the case studies and answer the research questions was collected through desk-based research, which consisted in a thorough review of policy, regulatory and framing documents published at different levels by authorities (e.g. NAP, NAS, CRA, etc.).

In some cases, useful background information was also retrieved from websites of ministries, regional authorities or environmental agencies.

2.3.4 Collection of data through interviews

Following the desk-based research, from which a preliminary assessment was made, and potential gaps identified, a process of stakeholder consultation targeting authorities at European, national and regional levels, as well as climate data and climate services providers like C3S, European National Meteorological Agencies and/or national research institutes, served to collect additional information.

The stakeholder consultation was mainly based on semi-structured interviews. This was complemented by a survey and a fishbowl discussion.

This consultation focused on improving our understanding of the different processes of engagement between the climate services users (European, national and/or regional authorities) with climate services providers or data providers.

For this, the consultation was conducted:

- Within the above-mentioned use cases, with authorities at European (e.g., the EEA), national and regional levels.
- With data providers or intermediaries, at national and regional levels.

The interview guide used to conduct the interviews can be found in **Annex 3.** The guide was adapted to the interviewees role and gaps identified in the document review.

2.3.5 Collection of data through anthropological fieldwork

In Northern Germany (Ammerland), data collection is based on long-term ethnographic fieldwork, incorporating participant observation and co-production of knowledge activities within the framework of the ERA4CS project CoCliServ (Krauß 2020). This approach allows for an in-depth exploration of how climate services are understood, negotiated, and implemented at the local level. Through immersive engagement with stakeholders—including local authorities, farmers, environmental groups, and residents—the research captures lived experiences, decision-making processes, and informal adaptation strategies that may not be visible through conventional policy analysis. Participant observation provides insights into everyday practices and interactions, while co-production activities foster dialogue between researchers and local actors, facilitating a mutual exchange of knowledge. This method not only documents adaptation efforts but also contributes to the iterative development of climate services, ensuring their relevance and applicability in local governance settings.

2.3.6 Interview data from a survey of the German Competence Centre for Climate Impacts and Adaptation (KomPass)

Our research found that, in parallel with the interviews conducted for this report, the German Competence Centre for Climate Impacts and Adaptation (KomPass) had carried out a series of semi-structured interviews with regional and local decision-makers. These interviews focused on the utilization of climate services in communities and the need for potential standards on which these services are based. An overview of the survey results is thus included in this report.

2.4 Survey with policy makers and further stakeholder groups at various levels

2.4.1 Overview

Exploring existing knowledge on climate service standardization is a key foundation for further standardization efforts in Europe. Through the survey, we aimed to determine whether climate services and potentially climate service standards are known, understood, and used within the policy arena at the various levels.

The survey gathered information on how different stakeholders perceive climate services. Specifically, it sought to understand whether they are familiar with climate service standards, and if so, whether these standards are accepted, considered necessary, or applied in climate change impact-related policymaking. Additionally, the survey questions were designed to complement the work of all WPs in Climateurope2 while obtaining firsthand insights directly.

We gathered information on knowledge about climate services and standards across three key dimensions:

- Institutional background
- Perception and utilization of climate services
- Knowledge about and advice on standards for climate services

This three-tiered structure was designed to view interviewees as integral partners in the creation of climate services and subsequent standards. Our goal was to capture content relevant to standardization, rather than focusing solely on the content of climate services. However, we recognized that it was important to communicate in a practical way, addressing the interviewee's work environment before moving on to more intangible and complex topics like standardization.

The survey questions were developed by Ecologic Institute, reviewed and approved by Climateurope2 partners across all work packages, and ultimately published in the Milestone Report titled "Policy Maker Survey."

The questionnaire consisted of 22 questions, primarily multiple-choice, with additional open-ended response options for some questions. The estimated time to complete the questionnaire was around 10 minutes. When designing the questions, we considered the perspectives of decision-makers at national, regional or local levels, especially when addressing issues such as the political adaptation cycle and related ISO standards. Participants had the option to skip questions that were not relevant to them, which we hoped would prevent individuals with limited knowledge of climate services or standards from being discouraged by irrelevant questions.

The survey reached its target audience through well-known and widely distributed newsletters, partner organizations via social media posts, and targeted messages to EU-wide climate projects (see illustration below on detailed survey dissemination).

2.4.2 Survey dissemination

For the dissemination we collaborated at EU, national and regional levels with the following organizations:

At the EU level

The EEA's two important platforms (1) Mission Implementation Platform (MIP4Adapt) and (2) CLIMATE ADAPT (including the Climate Resilience Post a joint activity from 4 Horizon 2020 projects supporting the EU Mission) which support European regional and local authorities to prepare and plan their adaptation pathways to climate resilience. Between September and December 2024, the survey was channeled through the three newsletters of both platforms.

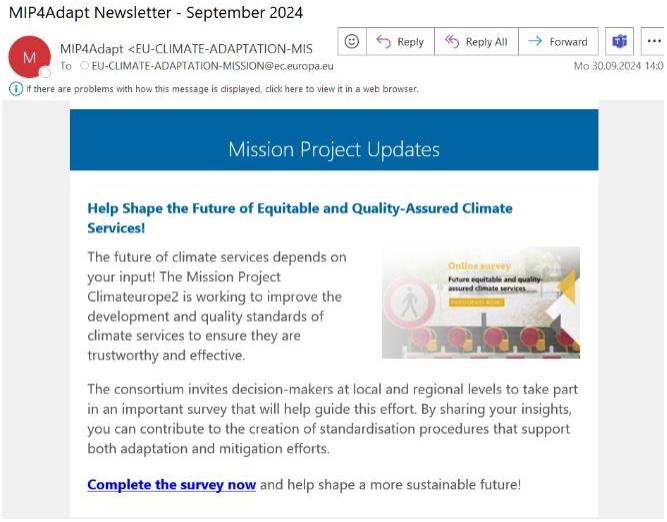


Figure 6 Example of distribution at EU level via the MIP4 Adapt Newsletter September 2024



Figure 7 Example of distribution at EU level via Climate-ADAPT October 2024

National and regional levels

The (1) Brussels-based platform European Regions Research & Innovation Network (ERRIN) with 120 regional organizations from more than 20 European countries (in total 500 contacts), (2) European Federation of Agencies and Regions for Energy and the Environment (FEDARENE) who's members are local authorities from 80 regions in 24 EU countries, (3) the newsletter of the EU wide acting academic think tank for environmental research and policy analysis, Ecologic Institute and additional social media posts at X and Linked In, (4) political decision makers in various EU projects supporting European regions to become climate-resilient e.g. VALORADA (Validated Local Risk Actionable Data for Adaptation) https://valorada-project.eu/ and REACH-OUT (Shaping Climate Resilient Cities) https://reachout-cities.eu/ and (5) the newsletter of climateurope2 as well as the wider network of climateurope2 and other partners.

Link to the LinkedIn post, published on 24/09/2024:
https://www.linkedin.com/feed/update/urn:li:activity:7250060975964393474

Link to the post on X, published on 24/09/2024:
https://x.com/climateurope2/status/1844295725804552280

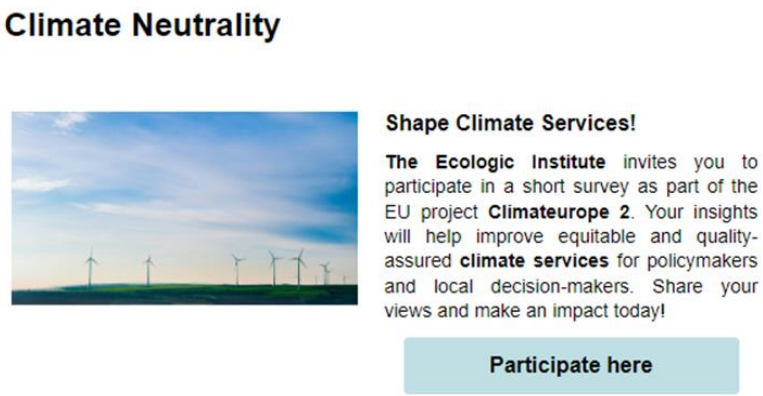
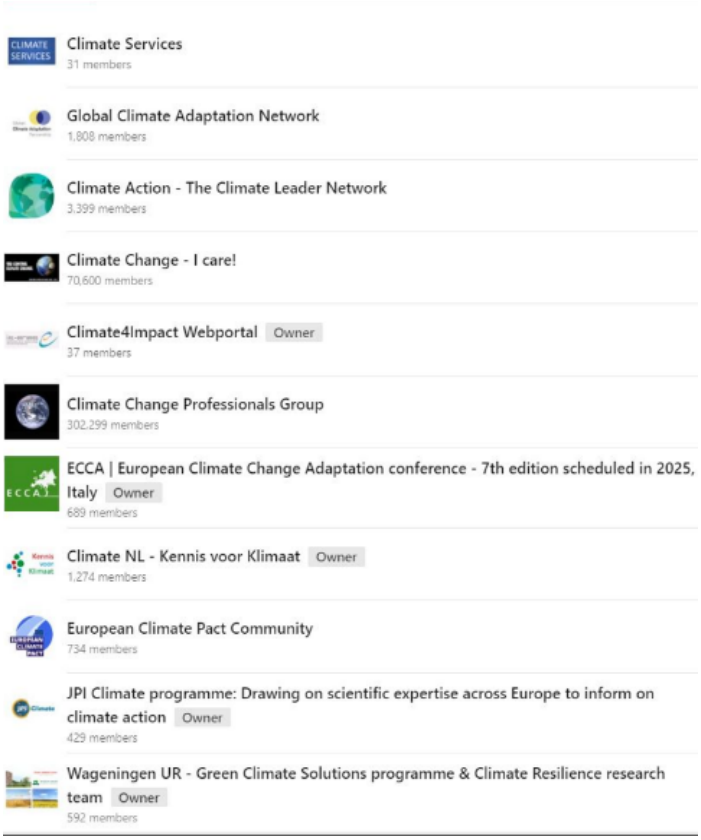


Figure 8 Example of distribution at regional level via the FEDERANE Newsletter September 2024 https://fedarene.org/

In addition, an invitation to the survey was sent to important climate change action groups via LinkedIn between September and October 2024.



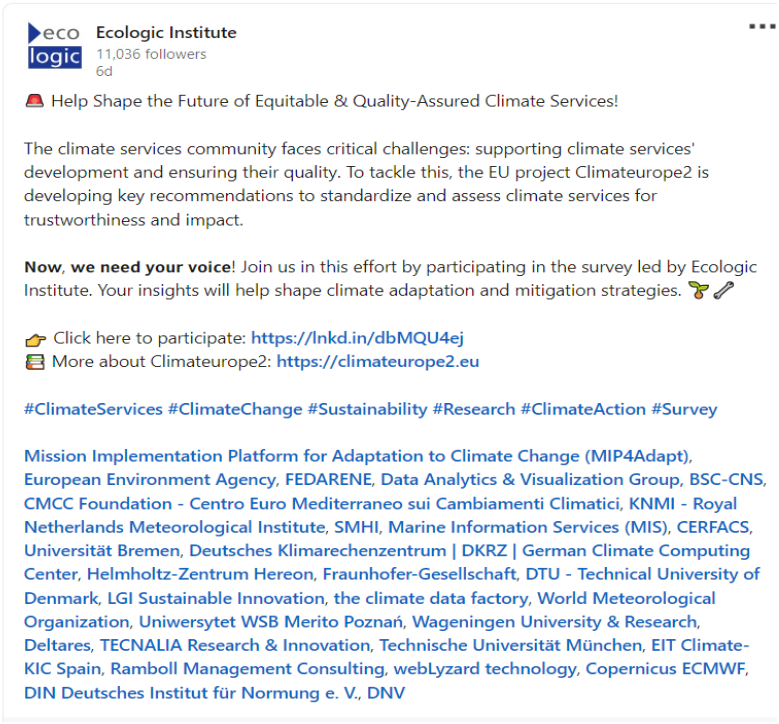


Figure 9 Example of social media posts at X and Linked In via Ecologic Institute www.ecologic.eu

Also, at the occasion of various meetings such as Climateurope2 festivals, webstivals and related conferences e.g. "Climate services for climate-resilient cities and regions" in Hamburg in October 2024 or the Smart City Expo in Barcelona in November 2024 participation in the survey was promoted through respective partners of the Climateurope2 consortia.

2.5 Interviews and stakeholder discussion

The study engaged stakeholders through three categories of interventions: (1) Semi-structured interviews, (2) surveys and (3) fishbowl discussion. The fishbowl discussion is a well-known method to manage group discussions. Rather than having an open discussion with a large group that might only benefit the participation of a small active subgroup, the method creates a safe, welcoming environment in which to intentionally connect multiple ideas and perspectives on a topic ensuring that every voice is heart. Steps (1) - (3) were accompanied by the analysis of policy documents.

2.6 Conclusion

This multi-method approach provides a comprehensive overview of the role and perception of climate services in adaptation planning across various governance levels in the EU. By combining different methods, the study offers a nuanced analysis of if and how climate services are integrated into policy and where standardization might enhance their effectiveness.

3 Results

The following review (section 3.1.) has been built using around 20 scientific articles and grey literature. It provides an overview of the EU legislation on adaptation at national and subnational level, and status of implementation in EU Member States.

Section 3.2 then dives deeper into additional literature on the uptake and standardization of climate services in adaptation and mitigation in EU policies at national, regional and local levels.

3.1 EU climate change adaptation policy dissemination within Member States

May Hobeika

This section reviews the current EU legislation on adaptation and mitigation at the national and subnational (municipal and regional) level and their current status of implementation in Member States, with a focus on the acknowledgement of climate services and on standardization of climate services.

3.1.1 EU legislation on adaptation at the national level and current status in Member States

EU legislation on adaptation at national level

The key EU legislative documents about climate change adaptation are:

- Communication on managing climate risks in Europe (2024),
- Mission on Adaptation to Climate Change (2023),
- European Climate Law (2021),
- EU Adaptation Strategy (2021).

In March 2024 the European Commission adopted and published a Communication on managing climate risks in Europe (COM/2024/91 final), in response to the first-ever European Climate Risk Assessment (EUCRA) (EEA, 2024b). The report pinpointed 36 significant climate risks across Europe, categorized into five main groups: ecosystems, food security, public health, infrastructure, and the economy. Together, the two documents are a call to action for all levels of government, as well as the private sector and civil society. They set out how all major sectors and policy areas are exposed to

climate-related risks, how severe and urgent the risks are, and how important it is to have clarity on who has the responsibility to address the risks.

The Communication outlines four key areas for action:

- **Improved Governance:** Enhance understanding and responsibility for climate risks, with closer cooperation between national, regional, and local levels.
- **Empowering Risk Owners**: Provide better tools and data access, including the Galileo Emergency Warning Satellite Service (EWSS) by 2025, and address data gaps through proposed legislation.
- **Harnessing Structural Policies:** Use Member States' structural policies to manage climate risks, integrating them into disaster risk management and future-proofing civil protection systems and assets.
- **Preconditions for Financing Climate Resilience:** Mobilize finance for climate resilience, support Member States in integrating climate-risk budgeting, and convene a Reflection Group on Climate Resilience Financing.

The **European Green Deal (2020)** prioritizes addressing climate and environmental challenges (EC, 2019). Key to this initiative is the **European Climate Law** adopted in 2021, providing a legal framework for EU policies on climate change adaptation (EC, 2021). Article 5 of the law mandates continuous progress in enhancing adaptive capacity, resilience, and reducing vulnerability to climate change. Moreover, the European Climate Law requires the Commission to develop a Union strategy on adaptation in line with the Paris Agreement and for Member States to adopt and implement national strategies.

This led the Commission to introduce in 2021 a more ambitious **EU Adaptation Strategy**, incorporating advancements in climate science, technology, and understanding of adaptation measures since it was introduced in 2013 (COM, 2021). It defines how the European Union can adapt to the impacts of climate change and build climate resilience by 2050. The Strategy proposes 48 actions to enhance adaptation planning and risk assessments as a key step for smarter, swifter and more systematic adaptation across Europe. It entails crucial components such as the advancement of nature-based solutions, efforts to address knowledge deficiencies, and the provision of funding for climate adaptation measures.

To accelerate adaptation efforts, the European Commission launched the **2023 Mission on Adaptation to Climate Change**, rallying actions across EU regions, cities, and local authorities (EEA, 2023). Moreover, the 2023 Mission on Adaptation benefits from the **Technical Support Instrument (TSI)** that provides technical assistance to EU Member States for climate change adaptation strategies and resilience improvement. For instance, it aids in managing rural wildfires, flood risks, and heatwaves.

As a result, EU Member States and EEA countries are actively adapting to climate change by implementing their National Adaptation Strategies and National Adaptation Plans. Every two years, Member States are reporting on national adaptation actions occurring under the **Regulation on the Governance of the Energy Union and Climate Action (EU, 2018/1999)** (PE/55/2018/REV/1).

In line with Article 19, concerning national adaptation actions, they reported national adaptation action for the first time in 2021. The European Environment Agency (EEA) compiles reports (EC, 2023b) offering valuable insights for assessing national measures and progress at EU level (EC, 2023c), as mandated by the European Climate Law (EC, 2023d). Additionally, beginning in 2023 and recurring every five years thereafter, the Commission will evaluate the combined progress made by Member States. However, there are no stipulations for Member States to establish adaptation targets that are binding or quantifiable for adaptation (EPRS, 2023).

In March 2023, EU Member States reported their national adaptation actions for the second time and included adaptation aspects in their national energy and climate plans' progress reports for the first time. The Technical Paper "Is Europe on track with climate resilience? – Status of reported national adaptation actions in 2023" written by **the European Topic Centre on Climate Change Adaptation and LULUCF** (ETCCA, 2023) presents the state of national adaptation efforts across Europe, focusing on recent advancements and insights gained since the 2021 EEA reporting period (EEA, 2021). The reported information by countries in accordance with Article 19 of **the Regulation on the Governance of the Energy Union and Climate Action (GovReg)** is accessible through the country profiles on *Climate-ADAPT*. Likewise, information provided by EU Member States under Article 17 of the GovReg can be accessed via the *Climate and Energy in the EU* portal. These country profiles offer the most recent information as provided and updated by each respective country.

Dissemination status in EU Member States

NAS, NAP and national climate risk assessments

Over the past two years, countries have made progress in enhancing various aspects of their adaptation planning. Yet, rapid and radical progress remains elusive because of the nature of the adaptation policy cycle, resource-intensive climate risk assessments, and the complexities of long-term strategic planning and implementation of adaptation measures, along with challenges in monitoring, reporting, and evaluation (MRE).

The 2023 national reports indicate continued advancements in evaluating climate-related hazards, vulnerabilities, and risks, underscoring the ongoing efforts in many Member States to enhance, broaden, and deepen their understanding of climate risks. Between the two reporting periods 2021 and 2023, approximately half of EU Member States[1] reported significant progress in **updating or conducting new assessments of climate-related hazards, vulnerabilities, and risks** (ETCCA, 2023). Additionally, notable efforts were made in related areas, such as the development of assessment methodologies and the enhancement of content in web-based databases at the national level.

The number of Member States with legal mandates for conducting climate risk assessments has increased. In many of the Member States where climate legislation has been recently introduced or revised, the requirement for preparing and regularly updating Climate Risk Assessments (CRAs) has been enshrined in national law, e.g. in France, Spain and Italy (EEA, 2024b). It is often linked to the revision cycles of national adaptation strategies (NAS), national adaptation plans (NAP), sectoral

[1] Including Austria, Belgium, Croatia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Poland, and Sweden.

adaptation plans (SAPs), and/or regional adaptation plans (RAPs). Nonetheless, countries with such legal obligations remain in the minority.

The 2023 ETCCA Technical Paper indicates that **since 2019, all 27 EU Member States have a dedicated adaptation policy in place**. At present, 26 EU Member States have developed a National Adaptation Strategy (NAS), while 16 have established a National Adaptation Plan (NAP), and 15 have implemented both. Additionally, several countries have started to enforce legal mandates aimed at addressing climate change, with several incorporating distinct requirements for adaptation measures. In 2023, eight[2] EU Member States reported having adopted a national climate law including adaptation aspects. Since 2015, a total of 14 EU Member States adopted a revised or new National Adaptation Strategy (NAS). Among them, nine have implemented both a NAS and a NAP (ETCCA, 2023).

3.1.2 EU legislation and initiatives on adaptation at the subnational level and current status in Member States

EU legislation and initiatives related to adaptation at the subnational level

Recognizing the role of municipal and regional authorities, the European Commission issued in October 2023 the Communication on Enhancing the European Administrative Space to enhance the capacity of public administrations in EU Member States.

The updated **EU Adaptation Strategy** (COM/2021/82 final) from 2021 emphasizes the importance of the regional and local level in adaptation efforts. Consequently, scaling up regional and local adaptation measures and ensuring seamless coordination of adaptation policies across all administrative levels are crucial requirements for effective adaptation. The Committee of the Regions estimates local and regional authorities to be responsible for 90% of climate change adaptation policies across Europe (CoR, 2020).

Recognizing the role of municipal and regional authorities, in October 2023 the European Commission issued the **Communication on Enhancing the European Administrative Space** (EC, 2023). It aims to bolster the capacity of public administrations in EU Member States, particularly focusing on their role in leading the green transition and enhancing resilience.

National adaptation reporting also offers insights into the impacts of climate change and adaptation strategies at both the subnational and urban levels. In 2023, ten EEA countries[3] specifically highlighted the urban sector as significantly affected by climate change and assessed the risk of future impacts as medium to high (EEA, 2024). This suggests an expected increase in risk for the urban sector due to climate change. Nine EU Member States[4] specifically focused on urban areas within their national strategy summaries. Deliverable 5.1 provides an additional assessment of how additional European measures and directives are supporting climate adaptation measures at the local level.

[2] Croatia, Finland, Greece, Hungary, Iceland, Ireland, Luxembourg, Portugal and Spain.

[3] Austria, Bulgaria, Czechia, Hungary, Italy, Portugal, Romania, Slovakia, and Spain.

[4] Austria, Bulgaria, Hungary, Italy, Luxembourg, Poland, Portugal, Slovenia, and Spain

Implementation status of subnational adaptation strategies and plans in EU Member States

Adaptation planning is increasingly becoming part of the norm, also at the subnational level. Approximately 51% of European cities (Reckien et al., 2024) have now established specific adaptation plans, a considerable rise from the 26% reported in 2018 (EEA, 2024). Various factors affect the creation and advancement of local climate and energy strategies, including the size of the city (which impacts technical and resource capacity), national laws on climate planning, and engagement in urban networks or initiatives. For example, the degree of urbanism influences the existence of a local adaptation plan (European Court of Auditors, 2024): 74% of surveyed municipalities qualifying as cities either have one or are working on it, while only 52% of the municipalities qualified as towns and suburbs do, and this number drop to 21% for municipalities situated in rural areas. In 2020, around 123 million individuals in the 38 EEA-countries resided in local authorities committed to adaptation through the **Covenant of Mayors**[5]. This initiative continues to provide vital assistance to local authorities through capacity building, technical support, networking opportunities, and participation in European projects focused on the local level. The number of signatories of the Covenant of Mayors has since increased to 202.5 million.

However, the existence of adaptation plans does not equal flawless implementation of adaptation strategies. First, a study of the European Court of Auditors (2024) demonstrates that the **awareness** of stakeholders about EU and national adaptation strategies, plans, and tools, is relatively low. Second, **the prevalence of top-down regulatory frameworks and legal mandates for sub-national levels remains relatively low** (ETCCA, 2023). Requirements for regional and local governments to establish adaptation plans can significantly accelerate policy implementation. These obligations may stem from national climate legislation or other centralized laws, stimulating the development and enhancement of regional and local adaptation strategies. Nonetheless, **only seven Member States**[6] **reported adopting Regional Adaptation Plans (RAPs) between 2021 and 2023**. According to the European Environmental Agency (EEA), the expansion and progression of regional and local strategies and plans may naturally stem from national climate laws or other dedicated central legislation (EEA, 2024). However, currently, this is not the prevailing scenario, as regulatory frameworks and legal obligations imposed from the top-down on the sub-national level remain a minority approach.

In 2018, a study involving 885 cities across the EU and UK suggested that various factors, including the size of the city, national laws on local climate and energy planning, and involvement in city networks or initiatives (such as the Covenant of Mayors), positively influence the creation and progression of local climate and energy plans (Reckien et al., 2024). Significant advancements have been made since that time, with over half of European cities now equipped with specific adaptation plans (ibid).

While these plans might differ in specific aspects, they typically adhere to a common framework. Notable examples can be seen in the cities of Sofia (Bulgaria), and Galway and Dublin (Ireland). The

[5] Available at: Covenant of Mayors - Europe | Covenant of Mayors - Europe (europa.eu)

[6] These include BE, GR, HU, IE, PT, ES, SE.

adaptation plan of Galway[7] is particularly distinguished by its thorough risk analysis, detailed implementation steps, the incorporation of adaptation measures into planning processes, enhancements to infrastructure, initiatives to raise public awareness, and continuous monitoring. This strategy has been partially prompted by a mandate from the Irish government that requires cities to develop robust plans, including evaluations of climate risks. Moreover, Galway is poised to unveil a new combined Climate Action Plan in 2024, further demonstrating its dedication to enhancing climate resilience.

A recent analysis evaluated local climate action plans based on several criteria: assessing impacts and risks, setting adaptation objectives, pinpointing adaptation actions, detailing implementation methods, conducting monitoring and evaluations, and engaging the community**. Although the overall quality of these plans has improved over time, the average quality rating still only reaches about one-third of the potential maximum**. This underscores the necessity for improved public engagement, more precise alignment of risks with objectives, and a focus on the unique adaptation needs of vulnerable populations (Reckien et al., 2024).

In many EU Member States, sub-national adaptation remains primarily voluntary and non-binding, **relying heavily on bottom-up initiatives**. As mentioned earlier, a growing number of cities and municipalities are formulating their own adaptation strategies and plans as participants in the **Covenant of Mayors**[8] **initiative**. To comply with the Covenant, local authorities are required to create a **Sustainable Energy and Climate Action Plan (SECAP)**. Currently, there are more than 11,800 signatories, representing over 30% of the EU's total population. Among them, 8,076 SECAPs have been submitted, and 38% of signatories with SECAPs have already provided monitoring reports (EPRS, 2023). These SECAPs encompass 19,701 actions aimed at addressing climate change, with approximately 25% of these actions including adaptation plans, either separately or in conjunction with mitigation and/or efforts to alleviate energy poverty. Among the adaptation actions planned and reported by the Covenant of Mayors (CoM) signatories in 202, most actions were reported in sectors such as water (17%), buildings (13.6%), the environment (11.7%), land (10.8%), agriculture (9.3%), and health (7.6%) (EEA, 2024).

Moreover, several countries have reported the engagement of regional and local governments in the 2023 **EU Mission on Adaptation to Climate Change**[9]**.** Around 300 municipalities from 25 EU Member States[10] have signed the Mission Charter. A comprehensive list of all local and regional authorities that have endorsed the Mission Charter can be accessed via the Mission Portal[11]. By signing the charter,

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[7] Galway adaptation plan. Available at : https://www.galwaycity.ie/uploads/downloads/application_forms/environment/Galway%20City%20Council%20Adaptation%20Strategy%202019-2024.pdf

[8] Available at: Covenant of Mayors - Europe | Covenant of Mayors - Europe (europa.eu)

[9] EU Mission on Adaptation to Climate Change. Available at: https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/adaptation-climate-change_en

[10] These countries include Austria, Belgium, Bulgaria, Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden.

[11] Mission Portal: EU Mission on Adaptation to Climate Change. Available at: https://climate-adapt.eea.europa.eu/en/mission/the-mission/regions-and-local-authorities

municipalities commit to developing and implementing local adaptation plans, engaging with citizens and stakeholders, sharing knowledge and best practices, and monitoring and reporting progress.

The following section dives deeper into the uptake and standardization of climate services in adaptation and mitigation in EU policies at national, regional and local levels, based on findings from desk research.

3.2 Uptake and standardization of climate services in EU member states' climate policies at various governance levels

Mathilde de Goër de Herve & May Hobeika

Climate services are climate information tailored for decision-making (Boon et al., 2022). They take place at different levels of governance (Vaughan & Dessai, 2014). Their standardization would enable to better compare the quality and relevance of different climate services. Indeed, already in 2010, Biesbroek et al. (2010) noticed that even if topics, methods, and approaches are similar in the National Adaptation Strategies of Member States, many institutional challenges remain, notably in terms of multi-level governance and policy integration issues. Overcoming those difficulties can be eased by harmonized climate services. The ClimatEurope2 project has identified four components of climate services to be standardized (Doblas-Reyes et al., 2024): the decision context, the ecosystem of actors and co-production processes, the multiple knowledge systems involved, and the delivery and evaluation of those services. In this section, we reflect on the standardization of those four elements in light of scientific and grey literature.

3.2.1 Standardization of knowledge systems and uptake of climate services

The standardization of **knowledge systems** is supported by frameworks, concepts, and tools that can harmonize the production of climate knowledge. In 2010 already, the European Commission suggested guidelines related to risk assessment and mapping for disaster management (European Commission, 2010). Afterwards, it launched the **European Roadmap for Climate Services** in 2015 to advance the development and use of climate services in decision-making across various sectors (Street, 2016). Its main objectives were to foster the market for climate services, enhance the integration of climate data into planning and policies, and support innovation and investments in climate resilience. The roadmap aimed to bridge the gap between climate science and practical applications, ensuring that stakeholders (including businesses and policymakers) could effectively use climate-related information to mitigate risks and adapt to climate change.

For several years now, there has been an implicit agreement on the components of climate risks (Smith et al., 2022), which are most of the time defined following the IPCC's approach, as a combination of hazards, vulnerabilities, and exposure (IPCC, 2012). This characterization is sometimes challenged in the scientific communities (e.g. Fuchs et al., 2024) but overall, it remains the predominant approach nowadays. The publication of the first European Climate Risk Assessment (EUCRA) in 2024 (EEA, 2024a) can be expected to become a milestone for coordinating approaches to climate risk assessments in

Europe, for example based on the different exposed sectors such as ecosystems, water and food security, health, energy, critical infrastructure, supply chains, etc.

Since the European Commission's 2015 Roadmap for Climate Services, the continuous development of climate services in the EU has led to a complex landscape of products, services, and actors (Panenko et al., 2021). The broad definitions of climate services employed by the WMO and EU can contribute to possible discrepancies between user expectations and what producers provide, and to address this issue, alternative terms such as "climate adaptation products, services, and knowledge-action systems" have been suggested (Panenko et al., 2021). According to Panenko et al. (2021), knowledge-action systems for climate change adaptation were most developed in corporatist and/or decentralized nations such as Austria, Denmark, and Germany. In contrast, statist and centralized countries exhibited varying levels of integration, with some advancing adaptation services (e.g. France), while others lacked any such products or services (e.g. Greece). The authors argue that more precise terminology is essential for the field's development and the progress of climate services (Panenko et al., 2021).

Frameworks for standardizing climate services

A way to harmonize knowledge creation is to use standards such as **ISO standards, guidelines like the ones developed by WMO,** or **frameworks**. There is a growing trend towards standardizing Climate Risk Assessments (CRAs) to ensure they can be performed consistently and allow for comparisons over time at national and subnational levels. For example, the ISO 14091:2021 standard, focused on adaptation to climate change through guidelines on vulnerability, impacts, and risk assessment, is utilized by organizations globally, as it provides a systematic approach to understanding and managing climate risks. This standard has a broad international scope and is used in over 130 countries (Porst et al., 2022). It was developed jointly by international contributors and is aligned with other global sustainability efforts. Countries such as Germany and the Netherlands have specifically used the ISO 14091:2021 standard[12] for their national CRAs. This move towards standardization allows for the assessment of changes in risk, vulnerability, and preparedness in a consistent, clear, and comparable manner. A study by Smith et al. (2022) evaluated UK climate risk management approaches (UKCIP framework and implementations in CCRA2, TE2100, and Oasis LMF) against the 2021 ISO 14091 standard, revealing general alignment with some contextual variations across different frameworks. While the application of these standardized frameworks is still in its early stages, their potential importance suggests they warrant further attention and exploration in the future.

Establishing CRAs is a way to provide the information needed to address climate risks. Available frameworks for standardizing CRAs are plethora in the scientific literature, addressing the different components of risks (hazard-vulnerability-exposure) and their interrelations. For instance, complexity resulting from compound, triggering, and consecutive hazards can be elucidated through multi-hazard assessments in Europe (Šakić Trogrlić et al., 2024). Concerning vulnerability, an example of a recognized framework is the vulnerability sourcebook, which has been updated to fit the IPCC

[12] ISO 14091:2021 Adaptation to climate change — Guidelines on vulnerability, impacts and risk assessment Available at: ISO 14091:2021 - Adaptation to climate change — Guidelines on vulnerability, impacts and risk assessment

philosophy and has been applied in more than 20 countries worldwide (Zebisch et al., 2021). More recently, the GIZ also proposed a climate risk assessment sourcebook (Zebisch et al., 2023), which could be used as a standardization base. Standardized approaches to CRA enable comparisons between geographical areas, and also over time (Dekens, 2023). However, frameworks that are developed for European regions need to be feasible, applicable, and at the same time pursue adaptive flexibility (Bachmann et al., 2025).

Yet, climate services are not limited to the information feeding CRA only. Other policy areas affected by climate change are also covered, such as water management, infrastructure design, agricultural and urban planning, etc. Plenty of frameworks and tools also exist in those areas to standardize information, sometimes also related to risk management (e.g. tackling water resilience, urban heat, etc.). Some examples are the soil and water assessment tool (SWAT)[13] and the agricultural conservation planning framework (ACPF) that can be coupled together (Rohith et al, 2024); the ecosystem assessment tool (Reid et al, 2005); a framework for urban pluvial flood resilient spatial planning through blue-green infrastructure (Ambily et al, 2024); etc. The diversity of frameworks ranges from high-level ones to very specific ones (such as the latter example).

Climate mitigation and the assessment of footprint are also an essential part of climate services and are necessary for policymakers, companies, and citizens to be able to act and reduce emissions and pressure on natural resources that provide ecosystem services. Gibin et al (2022) for instance have created a framework to assess the footprints of food consumption. The complexity of the interactions between different elements requires a multi-dimensional approach, and the authors claim that system-based standardized assessment tools and data harmonized across European countries are crucial to support a transition towards sustainable food systems.

Challenges related to harmonized knowledge creation

Several **challenges** need to be overcome to ensure harmonized knowledge creation. The main ones are listed here, illustrated with examples related to CRAs.

First of all, some components can or should be standardized, while others not (Doblas-Reyes et al., 2024), notably because the information provided has to be adapted to the local context and the way the message is conveyed must be tailored to the decision-maker needs (Vaughan & Dessai, 2014). For instance, which approach to use for CRAs depends on the objectives of the organization that will be using it (Smith et al., 2022). Sometimes, it can be possible to harmonize some parts of the process and not others, for instance using different methodologies to collect the data but using a standardized analytical framework to process them.

Where and when a standardization can take place, it needs to be flexible and develop over time, for example to adapt to and highlight new salient concepts of risks and prominent topics (Smith et al., 2022). Indeed, "the objectives and approaches of national CRAs are often – substantially – updated each time they are undertaken, making standardization challenging or unlikely" (Dekens, 2023, p.14). This can be explained by several drivers, such as the fact that new discoveries can reveal new research areas to explore, new governments can require different priorities than previously established, and

[13] https://swat.tamu.edu/

evaluation of previous methods and frameworks can call for adapting them to better capture the needs. As a result, it is often easier to replicate the use of a framework across geographies at a specific moment in time rather than across different time scales (Dekens, 2023).

In addition, building a common risk assessment methodology requires tackling challenges such as the lack of a common language (terminology) and the lack of appropriate data (of the required quantity, quality, scale, format, and accessibility) (Papathoma-Köhle et al., 2016). To give just one example, the concept of vulnerability comes from various theoretical backgrounds, each of them promoting a different emphasis (Adger, 2006), which is a challenge for standardizing information related to it and can explain the various frameworks and methods that exist to analyze and assess vulnerability.

The fact that indicators need to be tailored to the context also requires flexibility when standardizing knowledge production. Continuing with the example of vulnerability, the SoVI [Social Vulnerability Index] (Cutter et al., 2003) is often cited as a reference to assess social vulnerability, however it was built in the US context and therefore must be adapted when applied elsewhere (Cutter, 2024). Notably, the list of variables to be included in the indicator can vary from one country to another, depending on the socio-economic context that affects the vulnerability of individuals differently. For Europe, it has for instance been adapted to the Nordic context by Turesson et al. (2024).

Vulnerability assessments also need to be tailored to the spatial context within each country. To give one example, Caleca et al. (2025) point out cross-national differences in landslide mapping, and show how vulnerability assessment for landslide risks in European mountain ranges can be dependent on very localized aspects such as the exposure face of the slope (i.e. if the part of the mountain that is analyzed is situated toward the north or the south). Given the importance of this level of details, EU, national, regional, and local authorities might assess vulnerability in different ways. According to Caleca et al. (2025), the availability of data and the content is very heterogeneous from one place to the other since there is no standard on what information a landslide inventory should present.

Finally, an important obstacle to the standardization of knowledge systems is the limited dedicated national budgets for creating a structured knowledge base. According to the EEA (2017), only nine European Member States had budgets explicitly reserved for and readily available to strengthen climate adaptation actions. In general, the lack of resources is still one of the main obstacles to conducting repeated CRAs at the national level over time (Dekens, 2023), which is essential in the standardization process.

Those challenges do not mean that standardization of knowledge is impossible, but they are elements that need to be considered, discussed, and addressed when attempting to harmonize and standardize knowledge creation for climate services.

3.2.2 Standardization of ecosystems of actors and co-production processes

Multilevel governance involves a complex ecosystem of actors with the need for both a vertical integration (different administrative levels) and a horizontal one (different sectors). In multi-level governance systems such as the EU, collaboration between different layers of governance is an essential process to facilitate an efficient ecosystem of actors. However, power imbalances can be a major barrier to communication and collaboration between levels (Di Gregorio et al., 2019). In Europe,

the experience of the NECPlatform project (LIFE project) showed difficulties in involving the national levels in the six participating Member States (Bulgaria, Croatia, France, Italy, Portugal, and Romania) to take part in climate and energy dialogues (Pizzini et al., 2023). In the context of climate actions, the national actors can be more involved in mitigation policies while local actors are often more active in the adaptation domain (Di Gregorio et al., 2019), suggesting that specialization can happen between the different levels of governance, and questioning the idea of a hierarchical approach in multilevel governance. Yet, given the systemic feature of climate change challenges, multilevel governance "emphasizes the need for inclusive and participatory decision-making processes that involve multiple actors at different levels" (Pangalos, 2023).

The standardization of the **ecosystem of actors and co-production processes** can be justified by the fact that climate networks are a very effective support mechanism for adaptation and mitigation planning at the city level in Europe (Reckien et al., 2015). Participatory methods and approaches play an important role in local adaptation and mitigation implementation (Campos et al., 2018), or economic investment (Aziz & Shah, 2020). They must be flexible and iterative to promote joint learning, reassessment of stakeholders' needs and capacities, and co-produced, actionable climate services with the potential to catalyze climate action (André et al., 2023). They are not an end-goal in itself but "a mechanism to enhance the uptake of scientific knowledge information adaptation planning and decision-making" (André et al., 2023, p.13).

For instance, in agriculture, these methods enhance research and extension services by integrating farmers' expertise and developing locally appropriate solutions (Kumar et al., 2024; FAO, n.d.). Similarly, participatory budgeting in urban settings allows democratic decision-making for public project funding (Aziz & Shah, 2020). In forest management, participatory methods involve diverse stakeholders, including NGOs, landowners, and local governments, leading to social benefits that often outweigh economic and environmental outcomes (Fernandes et al., 2024).

Some principles for co-production have been established for climate services: inclusive, collaborative, flexible, decision-driven, process-based, and time-managed (Vincent et al., 2018) and can serve as a base for standardization. An example of a framework is the one offered by Daniels et al. (2020) for the co-production of relevant knowledge for impactful climate services.

Participatory methods and co-production of knowledge require resources, such as time and monetary finances. In Europe, there exists a variety of funding for climate adaptation that can result in unequal opportunities for the facilitation and implementation of such systems. For instance, large municipalities tend to finance adaptation locally, while in less urban or densely populated territories, international and national funding are more essential to implement adaptation (Aguiar et al., 2018). The ecosystem of financial actors can therefore be different nowadays between more urban or rural contexts, and that can affect the opportunities to involve various stakeholders.

3.2.3 Standardization of decision contexts

Decision contexts are not much standardized for various reasons. Adaptation policies adoption and diffusion are driven by both internal and external factors in all member states (Massey et al., 2014), affecting the demand for climate services. Among those factors, it is interesting to note that the shaping of policies and practices in a country is influenced by actions taken in other countries (Massey

et al., 2014). This suggests that more standardization would help the different countries to be able to access relevant information from one another. Yet, various boundary organizations[14] lead to various governance of climate change in EU Member States and can explain national differences in expert advice on climate change policy (Hoppe & Wesselink, 2014).

Moreover, insufficient resources are one of the main barriers to climate adaptation at the local level (Aguiar et al., 2018; Reckien et al., 2015), which means that it can be complicated to standardize decision contexts as long as resources are not sufficient everywhere. In 2021, only a few Member States had funds especially dedicated to financing the implementation of adaptation plans and most national adaptation strategies and national adaptation plans do not present a dedicated budget or financing streams (EEA, 2022).

Reckien et al. (2019) observe that not all local climate plans at the city level follow a mainstreaming approach, meaning that the adaptation and mitigation policies are not always integrated in other sectoral and development planning and decision-making, but rather often in dedicated plans[15]. Whether the climate plans follow a mainstreaming or dedicated approach is different depending on the country in which the cities are located, once again suggesting various decision contexts in Europe (Reckien et al., 2019).

Climate services play a crucial role in integrating climate information into decision-making processes across various sectors. Climate services usually have narrower scopes than adaptation planning because climate services are designed to support concrete decisions (e.g. crop selection, wind plant siting, risk assessment for human mortality) rather than high-level adaptation planning (Boon et al., 2022). To enhance their effectiveness, researchers emphasize the importance of co-production and tailoring services to user needs (Daniels et al., 2019; Williams et al., 2020) (see Section 3.2.2. related to participatory methods). For instance, integrating climate services into spatial planning requires institutional reform, alignment of priorities, local leadership, community trust, and integrated geospatial data (Putra et al., 2020). In the agriculture sector, several EU-funded Horizon research projects deliver climate services. An example is VISCA[16] which proposes a Decision Support System (DSS) that combines climate data, agricultural models, and farmers' management criteria to develop short-term practices as well as medium- and long-term adaptation strategies for climate change. It was tested and validated through real-world demonstrations involving end-users at three pilot sites in Spain, Italy, and Portugal. What makes this project particularly interesting is the possibility for farmers to provide feedback to then improve the climate services included in the DSS, potentially leading toward a standardization focused on answering the needs of the users.

The standardization of climate services may be useful for the decision context for different reasons. For instance, the need to harmonize mechanisms for better integration, such as cross-sector collaborations, may require the standardization of climate services. The nexus approach has been

[14] "Boundary organizations are intermediary organizations that produce information that is useful in policymaking and at the same time qualify as scientific" (Wesselink & Hoppe, 2020, abstract).

[15] Both mainstreaming and dedicated approaches present advantages and disadvantages in terms of implementation of climate adaptation.

[16] See: VISCA - Vineyards Integrated Smart Climate Application - University - Education Joomla Template

identified as a valuable tool for understanding interlinkages across sectors and scales, promoting Sustainable Development Goals (SDGs), and supporting integrated policies (Tudose et al., 2021). The use of boundary organizations to translate high-level climate information into actionable local insights may also necessitate standardization. Indeed, boundary organizations play a crucial role in bridging the science-policy gap by translating climate information into actionable insights, but the effectiveness of their actions depends on various contextual factors, making standardization challenging (Wesselink & Hoppe, 2020), while defined typologies of actionable climate information (and its use) can support scaling up knowledge production and utilization (Jagannathan et al., 2022).

3.2.4 Standardization of delivery mode and evaluation

Concerning the **delivery mode and evaluation**, in addition to the challenges described earlier in regard to the content of the data (see Section 3.2.1. about knowledge creation), the way that data is delivered (if it is accessible)[17] can influence to what extent this information is usable by the recipients. For instance, it is interesting to note that National Statistical Offices sometimes deliver statistics that are not always useful for climate change analysis as such (UNECE, 2024), which can slow down access to relevant information. In addition, there are gaps in some types of data, such as socioeconomic data, sometimes due to a lack of open access (UNECE, 2024). Another example is that climate change projections, while essential for informing mitigation policy, do not always target the appropriate timescale needed for adaptation decisions at a local level (Nissan et al. 2019). These examples illustrate the need for delivering climate data in a form that is directly available and relevant to policymakers.

To face those challenges and limitations of the data delivered by National Statistical Offices or National Meteorological and Hydrological Services, some databases can collect, standardize, and release data related to climate change. This is the case of the Copernicus database[18], a European initiative that provides data related to climate change for all Member States.

In addition to climate data, challenges in climate service development and delivery include limitations in scientific capability, insufficient capacity among providers, and inadequate understanding of user needs (Hewitt, 2020). Overcoming these obstacles requires focused user engagement, collaboration, prototyping, and evolving services based on user feedback (Hewitt, 2020).

MEL (monitoring, evaluation, and learning) is an essential component of the governance of climate policies. The EEA (2022) notes that a growing number of Member States are engaging in these essential reporting activities. In 2021, twenty Member States had established a monitoring, reporting, and evaluation system and engaged in at least one form of those activities, and three other States declared being in the process of establishing such a system. However, only a few countries are explicit on how the monitoring, evaluation systems, and reports are supposed to feed back into policy. As the European Court of Auditors (2024) points out, "member states' reporting on climate adaptation was insufficient and added little value in terms of tracking progress and supporting future policy decisions" (p.5), which raises the question of the use of evaluation. Utilization-focused evaluation requires defining the intended uses of findings and the intended uses of processes, from the point of view of

[17] The obligation of releasing climate data to the public might differ from country to country.

[18] https://www.copernicus.eu/en

the users (Patton, 2008). In 2021, only four countries (Austria, Germany, Spain, and Sweden) clearly indicated that the findings will be fed back into their national adaptation strategy or plan (EEA, 2022).

3.2.5 Note on equity in standardization of climate services

It is important to underline that climate services are not neutral (Vaughan & Dessai, 2014) since the choice of information and the way it is conveyed can favor the use of some information and the help of some beneficiaries over others. One glaring example is the consideration for gender-based differences in access, use, and benefits, from climate services, for instance in the rural context (Gumucio et al, 2020).

ClimatEurope2 recommends placing equity at the center of the standardization process (Climateurope2, 2024). Fairness in the decision-making process for the management of climate risks involves considering at least procedural and distributive justice, the former being about who gets a say in the choice of information and which voices influence the decision, the second one being about who benefits and carries the burden (both directly and indirectly) from the choices that are made (de Goër de Herve et al., 2023). Other aspects can also be considered, such as corrective and recognitional justice. In order to address those issues, equity and inclusion should be reflected in official climate statistics and data (UNECE, 2024).

3.3 Uptake of climate services in climate policies at the national and subnational levels – insights from European case studies

3.3.1 Learnings from the case studies

Climate services uptake in national and subnational climate adaptation policy frameworks

The four national-level case studies showed that the **production of climate services is intertwined with the development of climate adaptation policies.**

The former adaptation policy frameworks, emerging in the late 2000s (France) or the 2010s (Belgium, Poland), were designed with a relatively poor climate services ecosystem to support them. Thus, among the first measures of these policies (and their underlying strategic documents), the development of bespoke and high-quality climate services at the national level was important (e.g. ONERC, National Climate Change Adaptation Strategy, 2006; National Climate Commission, Belgian National Climate Change Adaptation Strategy, 2010; Ministry of the Environment. (2013). Polish National Strategy for Adaptation to Climate Change by 2020 with the perspective by 2030). For these countries, the first major climate service production projects coincide with the draft of the policy framework.

Once climate services have been developed in each country, national adaptation policy documents strongly rely on the information provided by climate services. As an example, the latest National Adaptation Plan drafted in France, and adopted on March 10th, 2025, explicitly revolves around the

latest national climate service developed, called the "Reference Warming Trajectory for Climate Change Adaptation" [the acronym TRACC is used in French language] (French Government, Third National Climate Change Adaptation Plan, 2025).

The next section on climate services ecosystem of actors and co-creation process will underline, from the study of the four cases, the narrow relationship between the political power and climate services production. If the generation of climate services and of adaptation policy frameworks coincide, it is partly because **the momentum for climate services development often spurs from political decision-making and agendas**. The development of an adaptation plan or strategy creates an opportunity window for climate services production or improvement of the existing climate services.

The European Union is also a driving force in the development of climate services. For example, in Poland, the first national climate services development project, Klimada (2010-2013), started in 2010 after the European Commission's White Paper – Adapting to climate change: Towards a European framework for action (COM(2009)147) was published.

At subnational level, the development process of adaptation policies varies greatly depending on the states and their political regime and level of decentralization.

Climate services can be used at various stages of the policy development and implementation cycle. We saw that they often coincide with and inform the development of the adaptation policy frameworks.

They also support the implementation of policies and underpin the correct application of various policy instruments. As summarized by Le Galès in 2010, political sociology often identifies five main types of policy instruments, as shown in the table below.

Table 2 Typology of policy instruments (Le Galès, 2010)

Type of instrument	*Type of political relations*	*Type of legitimacy*
Legislative and regulatory	Social guardian state	Imposition of general interest by mandated elected representatives
Economic and fiscal	Redistributive state	Socioeconomic efficiency
Agreement- and incentive-based	Mobilizing state	Seel direct involvement
Information- and communication-based	Audience democracy	Explain decisions/accountability
De facto and *de jure* standards/Best practices	Competitive mechanisms	Mixed: scientific/technical and/or pressure of market mechanisms

One of the main types of instruments used in the case studies to implement the adaptation policy is the development of **strategies and plans** at various levels, and the mainstreaming of adaptation measures or safeguards in enforceable documents, often planning documents. Here, the climate data is used to clearly identify climate change effects in the documents and to support and legitimate the recommendations or obligations lying in these documents. The governments (either at national or

regional level) can also formally require that local authorities develop climate services to develop their strategies and plans, in climate adaptation, risk management or water management policy areas.

Economic instruments can support the funding of climate services, when governments offer **subsidies** to local authorities or private companies to assess their climate risks and design adaptation strategies. As an example, the French Agency for the Ecological Transition and the French Bank for Public Investment both offer subsidies to territorial and private actors to hire consultants and assess their climate risks. Moreover, governments are strongly financially involved in the development of climate services, at the national level or at regional level, often being the **main source of financing for climate services development**, through the funding of Met Offices, Environment Agencies and research projects.

The use of **information and communication-based policy instruments** has grown in the past decades (Le Galès, 2010), partly due to the development of information technologies which has greatly reduced the costs of information dissemination (Bengtsson et al., 2010). They are well-spread in the adaptation policy frameworks of the case studies. Climate services bear an important underpinning role in the application of this kind of instrument. The climate information produced and disseminated to various stakeholders and at various governance levels relies on climate services generation and delivery. Hence, governments make growing efforts to ensure the dissemination of climate services, whether through the creation of interface organizations (e.g. The Belgian Climate Centre); national or regional online platforms (e.g. AdapteCCa climate change scenario viewer in Spain, Klimada knowledge base platform in Poland, the Klimaaportaal in Flanders); local and sectoral bespoke and easily accessed climate services (e.g. the Climadiag risk synthesis for municipalities and companies in France); as well as the many education and awareness raising conducted in every case studies and at various levels, relying on the availability and communicative format of climate information (e.g. large public consultation for the development of the Adaptation Strategy of Warsaw, the action program "Breizh Hin" in Brittany.

Information and communication platforms developed by governments or environment agencies also often host examples of best practices and methodology elements underlying the harmonization of the adaptation policy implementation across governance levels (e.g. the French Resource Centre on Climate Change Adaptation dedicates several webpages to experience sharing and best practices to inspire decision-makers and technical officers).

Ecosystem of actors and climate services co-creation processes

The generation of climate services and the ecosystem of actors supporting this process is similar across case studies. The national governments (often represented by the Environment and/or Planning departments/ministries) steer the development of climate services by providing fundings and strategic orientations. In more decentralized countries, regional governments can play a similar role.

NMHS are responsible for the technical and scientific coordination of climate services development. In some cases, this coordination role is conducted by Environmental agencies (e.g. the Institute of Environmental Protection in Poland or the Flemish Environment Agency). Various levels of coordination actually often interact. In Spain for example, while the NMHS (AEMET) coordinates the climate service production, the Spanish Climate Change Office (OECC) coordinates the actors, delivery

and uptake of climate services. In Belgium, the Belgian Science Policy Office, BELSPO, also has an overarching coordination role, where the scientific and technical coordination of climate services lies in the responsibilities of the Royal Institute of Meteorology.

Data collected and used for the design of climate services come from observatories and institutes at the European level (e.g. Copernicus Climate Change Service) and national level, or the NMHS.

Scientific institutes and universities are often involved in the generation of climate services, which happens within research projects or schemes, unfolding within multiple-years frameworks.

Environment agencies, knowledge centers and science-policy interfaces play a major role in the delivery and uptake of climate services.

Other stakeholders are involved in co-creation processes on different levels. Sectoral public agencies, practitioners, citizen associations and private companies are involved at various stages of the climate services generation process. They can be part of projects' steering committees (especially for sectoral climate services development) or be part of larger consultation bodies.

Towards standardization of climate services: opportunities, requirements and constraints

Opportunity window for climate services standardization

In the case studies, standards are marginally used, either in the development of adaptation or climate policy framework or in the climate services generation processes. However, policy frameworks and instruments often rely on **international or European guidelines** (e.g. Assessment reports from the IPCC, the European Environment Agency's Adaptation Policy Support Tool or Mission on Adaptation Platform). Similarly, actors involved in climate services development rely strongly on the **latest scientific knowledge** and use **scientific requirements** to assure the quality of their products (WMO operational guidelines or running multiple models to better take uncertainty into account).

In Europe, there is also a strong **circulation of knowledge and exchange of good practices**, either supported by European institutions and agencies themselves (e.g. the European Environment Agency gathers risk assessment and adaptation planning reporting efforts from all Member States and shares best practices on the Climate-ADAPT platform; the Copernicus Climate Change Services, managed by the European Centre for Medium-Range Weather Forecasts, creates opportunities for NMHS representatives and policy-makers across Europe to meet and exchange knowledge and good practices through its National Collaboration Program or through its yearly General Agency), or through the implementation of EU-funded projects (as the Horizon Climateurope2 project within which the current report is being drafted). This creates a **collaboration culture** that allows actors involved in the development of policy frameworks and climate services to meet and exchange ideas. Actors thus seem porous to their counterparts' work in other countries and manifest willingness to share and try to align to best practices.

Another indication of opportunity for production of standards from climate services is the growing willingness of harmonization of climate services generation and use within Member states. This is demonstrated by the growing number of national guidelines for climate risk assessment and

adaptation strategy development. The governance level of the expected harmonization also depends on the nature of the state regime. More decentralized countries (e.g. Belgium) tend to rather harmonize the design, delivery and use of climate services at the regional level. In France, the development of a new and national climate service called the Reference Trajectory for Adaptation to Climate Change directly answers the government's willingness to better harmonize adaptation trajectories in France, especially at the local level where local authorities must conduct climate risk assessments and develop adaptation strategies, which has been lagging behind in the past years. In Spain, this need of standardization will be addressed in the Second Work Program (programa de trabajo 2026-2030), which is currently under development in the context of the National Adaptation Plan. Expected outcomes of this Work program cover an improved coordination between climate service producers, e.g. through the creation of dedicated working groups.

Expected benefits of standardization

The document review and interviews at the national and subnational levels allowed to identify several expected benefits of standardization. Interviewees were all **cautious** with the idea of an increased standardization of climate-services generation processes and uptake, and they underlined several requirements and constraints for climate services standardization. However, they also expressed in which way standards could support a better development and use of climate services.

First, expected standards would rather allow to have common guidelines and methodologies rather than being strict norms. Such guidelines would allow to improve the co-production process of climate services by highlighting the scope of stakeholders to be involved in the process. Standardization efforts could allow to compare data and climate services. While an increasing number of climate services are being developed, it has become more difficult to understand the methodology behind or what data was used, and to compare results among different services. Standardization could thus allow for more transparency. The development of uniform data formats and protocols could facilitate the sharing and interoperability of climate information across different platforms and stakeholders. Standardization can also improve the reliability and comparability of climate data, leading to more consistent and evidence-based decision-making processes.

Standardization can also be seen as a way to regulate the growing private climate services sector and to prevent abuse. Yet, interviewees did not particularly saw standards as a way to assure the quality of climate services. The quality assurance of climate services would rather depend on their alignment with the most recent scientific knowledge and the technical capacity of the service producers. The nature of the producers (e.g. NMSH) is also seen as a guarantee of quality.

Constraints to standardization and requirements

For several of the interviewees, the role of standardization should be limited to methodologies and guidelines only, but they should not alter the national frameworks and the actors' collective organization, based on past experiences and long negotiation and coordination efforts. In some cases (e.g. France and Belgium), the ecosystem of actors has been structured over the course of several years or even decades, until the right coordination systems were found. Some interviewees fear a standard could jeopardize this organic balance with too much rigidity.

Most interviewees underlined the risk of increased rigidity in the development and uptake of climate services that could emerge from standardization. According to them, standardization could introduce rigidity where climate adaptation (and thus climate risk assessment and the design of adaptation strategies) strongly depends on the local context. It is deemed important to remain flexible and be able to adapt the methodology used to the desired result. When developing new services, it is important to consider that each sector has its specificities.

On a market aspect, standardization would increase entry costs but allow a fairer competition. It is important that each climate service provider is transparent on the methodology used and the level of uncertainties included in their service.

3.3.2 Belgium

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Climate services uptake in climate change adaptation policy frameworks

Belgium political regime and its implication for the climate adaptation policy framework

Belgium is a federal constitutional monarchy. In Belgium, decision-making powers are shared between the **Federal government**, the three **Regions** (Flanders, Wallonia, and Brussels) and the three **Communities**, which are language-based (Flemish, French, and German). The Federal state, the Regions and the Communities are equal from a legal viewpoint (Belgian government).

National initiatives, like the National Adaptation Plans, gather the efforts of the three top types of authorities: the Federal government, the Regions and the Communities.

The climate adaptation policy is implemented by various actors, from the national to the local level. The variety of actors involved in the policy process in Belgium is also linked to its **federal political regime.**

The Federal Government is responsible for foreign affairs, the army, large energy infrastructures, nuclear energy, economic regulation, public finances, social security, judicial system, substantial parts of public health, and home affairs.

The Belgian **Regions** have competencies on the following topics: "the economy, employment, agriculture, water policy, housing, public works, energy, transport (except Belgian Railways), the environment, town and country planning, nature conservation, credit, foreign trade, supervision of the provinces, communes and intercommunal utility companies" (Source: Belgium.be). They are also responsible for scientific research and international relations related to these topics.

In addition to the national climate policy and documents, the Regions are in charge of the development and implementation of their own climate policies.

The **Communities** are responsible for cultural, educational, language-related matters, health policy, social policies and scientific research and international relations related to these topics.

Provinces and local authorities are involved in the implementation of adaptation policies according to their competences. Their action is mainly supported by the Regions.

Climate policy frameworks at the national level

At the national level, the adaptation policy is driven by the **Belgian National Adaptation Strategy** and the **Belgian National Adaptation Plan**.

The National Adaptation Strategy was adopted in 2010 by the **National Climate Commission**, an entity supporting cooperation on climate issues between the Belgian Federal Government and the three Regions. Its three main objectives are:

- Improving coordination between existing climate adaptation activities in Belgium.
- Improving communication at national, European and international levels.
- Inducing the definition of a national adaptation plan.

The Strategy describes the main climate change impacts in different sectors, presents adaptation actions in those sectors and sets principles for the climate adaptation policy. It includes a roadmap for the drafting of the National climate change adaptation plan.

The main sectors covered in the Belgian National Adaptation Strategy are:

- Health,
- Tourism,
- Agriculture,
- Forestry,
- Biodiversity, ecosystems, and water,
- Coastal, marine, and tidal areas,
- Production systems and physical infrastructure,
- Transversal issues (e.g. research).

The *National Adaptation Plan* was adopted in 2017 by the National Climate Commission. It provides clear and synthetic information on climate adaptation policies in Belgium and their implementation. It also identifies national-level measures to improve cooperation between the federal government and the regional governments.

The plan contains information of the changing state of climate in Belgium and the leading impacts and vulnerabilities for the country.

The plan describes measures to be taken at the national level to foster climate adaptation as well as a timeline and indicators informing the implementation and monitoring of the measures.

The main climate projections in Belgium were produced in the context of the National Adaptation Plan 2017-2020. Indeed, the 1st measure of this NAP focused on data production.

The Plan has been subjected to 2 evaluations, published in 2019 and 2021. A new National Adaptation Plan and Strategy was supposed to be developed by 2023. The design of this new plan has been pushed back in order to **first carry out a National Climate and Biodiversity Assessment**, which will serve as the basis for the policy measures of the new plan. This risk assessment is due for 2025.

In 2023, a series of new federal adaptation measures for the period 2023-2026 were published under the title "Towards a climate change resilient society by 2050". The sectors covered by these measures are research, biodiversity, infrastructures, natural resources, public health, crisis management, international cooperation

The national climate mitigation policy is supported by a **National Climate & Energy Plan** 2021-2030 and **Belgium's long-term strategy** published by the Federal Government in 2020.

Risk management

The risk management policy framework in Belgium includes several royal decrees.

In 2021, Belgium adopted an integrative National Security Strategy, which defines six national vital interests going beyond security concerns and including climate change challenges. It aims at a long-term resilience for Belgium.

Stakeholders involved in the climate policy design and implementation besides public authorities

Climate adaptation

Coordination Bodies:

The Coordination Committee for International Environmental Policy (CCIEP) focuses on Belgian international environmental policy. Its working group on Adaptation monitors European and international decisions on climate adaptation, which could have consequences for Belgium or lead to obligations (i.e. EU Strategy on Adaptation).

The Directorate-General Coordination and European Affairs (DGE) monitors Belgian's European policy.

The National Climate Commission (NCC), established in 2003, is mainly responsible for implementing and monitoring the National Climate Plan, exchanging data and preparing mandatory reports. It is composed of representatives by the federal and the three regional governments. Its Adaptation working group gathers adaptation stakeholders from the regional and federal governments. The NCC is responsible for drafting the National Adaptation Plan.

The National Adaptation Plan also assigns the implementation of measures to sectoral stakeholders from the national to the local level:

Scientific entities

- BELSPO: The Belgian Science Policy, established in 1968 in its initial form, is a federal coordinating entity on scientific research.
- Federal and regional research institutions
- Universities

Public agencies at the federal and regional levels with competencies on climate matters or sectorial competences (e.g. FPS Public Health, Food Chain Safety and Environment, the Wallonian Climate Agency AWAC, Brussels Environment, Belgian Federation of Electricity and Gas Companies FEBEG, etc.)

Other sectoral stakeholders: the National Adaptation Plan also foresees the involvement of communities of practice, private-sector representatives, civil society representatives, in the implementation of adaptation measures.

More recently, two new federal entities have been created in order to better identify climate-risks, improve knowledge on climate change and favor the communication around climate data and risks towards the society at large:

- **The Climate Risk Assessment Centre:** established in 2021, it is dedicated to the identification and analysis of medium and long-term climate and environmental risks.
- **The Climate Centre:** established in 2021, the center aims at strengthening the scientific research capacity on climate-related issues, facilitating the transfer of knowledge from researchers to various stakeholders, and increasing the applicability of future research programs to climate action

Climate mitigation

Climate change mitigation policies are distributed among federal and regional governments and agencies on a similar pattern as for the climate adaptation policy. The coordination entities aforementioned are involved.

Climate risks

The National Crisis Centre supports governments and security services to strengthen the safety and resilience of Belgium.

It contributes to improving knowledge on risks and resilience, as well as organizing and coordinating emergency planning and crisis management at the national level.

Climate services as part of the climate adaptation policy implementation instruments in Belgium

At the **national level**, the **National Adaptation Plan** includes measures relying on the following type of instruments:

- **Informational instruments**: development of climate scenarios, creation of a Belgian Centre of Excellence on Climate, development of a national online platform, mainstreaming climate change in alien species risk analysis, evaluation of socio-economic impacts of climate change in Belgium, education and awareness raising, etc.
- **Governance/organizational instruments**: facilitated coordination between sectors

The **informational instruments** presented in the National Adaptation Plan mainly focus on the following stages of the climate services supply chain:

- **Production of climate services**: measure 1) Development of high-resolution climate scenarios for Belgium.
- **Uptake of climate services and development of intermediaries between producers and users**: measure 2) the development of the Belgian Centre of Excellence, aiming to develop

scientific expertise on climate issues and to deliver intelligible climate information to various stakeholders; measure 3) development of a national online platform for climate adaptation, which delivers climate information to administrations, businesses, NGOs, citizens and academia.

These **informational instruments require climate services design and delivery**. They aim at:

- ☒ **producing up-to-date climate services** of higher resolutions and better fitting sectoral or policy needs
- ☒ **creating the conditions to produce high-quality climate services**
- ☒ **delivering fitting climate services to various stakeholders**, in an accessible way

The **Federal measures for 2023-2026** also include other types of policy instruments:

- **Legal and regulatory instruments, normalization:** e.g. norms on products (buildings, goods), rules on wastewater spillage.
- **Fundings**: financial support to adaptation initiatives, budgets dedicated to studies or specific projects

This document plans several measures relying on climate services:

- The evolution of the Excellence Centre on Climate Change (named the Belgian Climate Centre) to become a **one stop shop on climate services** in order to facilitate the use of knowledge for effective planification of adaptation
- The Belgian Climate Centre is thus expected to further **develop a catalogue of climate services**
- The **development of high-resolution scenarios**
- An **improved mapping of climate risks**, which should inform Belgian climate policies and allow to evaluate the vulnerability of specific sectors such as energy and transport
- **Linking climate information with the national security program** in order to mitigate climate-induced risks to the society (health and safety)

Use of standards and international frameworks in the Belgian adaptation policy framework

The Belgium National Adaptation Plan refers to the **United Nations Framework Convention on Climate Change** (UNFCCC), the **Paris Agreement** (2015) and the **European Climate Adaptation Strategy** (2013) as a global and European context for the Belgian Adaptation Policy.

Moreover, adoption, planning and implementation of Belgian climate adaptation policy is monitored in line with the **European Regulation 525/2013**, which gives a **reporting framework** to member states on climate-related matters.

No standard *stricto sensu* is mentioned in the National Adaptation Plan, and the adaptation policy aligns with non-market and public international and European bodies.

In the 2023-2026 federal measures, the mention of the "do no significant harm" from the **EU green taxonomy** has been added.

Climate adaptation policy framework in Flanders and role of climate services in the design of the policy framework

In 2013, Flanders adopted the **Flemish Climate Policy Plan**, which includes a Flemish Adaptation Plan (VAP). Its goals are to:

- Understand the Flemish vulnerability to climate change
- Improve Flander's ability to address climate change effects.

The Flemish Adaptation Plan favors cost-effective, robust and no-regret measures, including ecosystem-based solutions.

The latest **Flemish Adaptation Plan** was approved in **2022** (Flemish Government, Flanders Climate Adaptation Plan. Arming Flanders against climate change, 2022). It aims to improve Flanders' preparedness to climate risks in the short term (by 2030) and in the long term (by 2050).

It is based on **6 strategic pillars**, each supported by a set of measures for the operational implementation of the plan:

1. Flanders builds and connects green-blue infrastructure, always and everywhere
2. Water availability and water use
3. Space for water in function of water safety and drought prevention
4. Restoration and climate smart management of nature and forests and climate adaptive agriculture
5. Climate adaptive health policy
6. Collaboration and coordination (with focus on communication, monitoring and crisis management)

In Flanders, the **regional government is responsible for the adaptation policy** and the implementation of the Flemish Adaptation Plan. The coordination of the climate adaptation policy lies more precisely in the **Department of Environment and Spatial Development** within the government of Flanders.

Then, the departments of Flanders' government are responsible for adaptation within their policy domain and bear the costs of implementing adaptation actions.

The Flemish Region is responsible for areas related to occupation of a territory such as economy, agriculture, water policy, housing, public works, environment, town planning, transport (excluding the national railway), etc.

The **local governments** have to plan and implement local adaptation policies, supported by policy instruments and financial resources from the Flemish Government.

Citizens, businesses and organizations are encouraged to contribute to climate adaptation through, for example, initiatives such as the Local Energy and Climate Pact (LEKP).

Provincial support and knowledge centers: Like the example of the Knowledge Centre for Urban Nature, which share knowledge and build expertise on sustainable and climate-adaptive living and building.

A comprehensive Climate Risk Assessment has not been carried out for the Flemish Region. However, policy makers rely on the climate data provided by the Flemish Environmental Agency, whose climate portal "Klimaatportaal" hosts climate data with a rather high resolution (community level) and lays out the main climate risks for Flanders. This data was used to draft the latest Adaptation Plan and also plays a strong role in the local implementation of the adaptation policy.

The data available on the climate portal is based on the IPCC's scenarios and available international scientific data.

The policy instruments used to implement the Flemish Climate Adaptation Plan are multifaceted and include the following:

Informational instruments: knowledge and information sharing, education (e.g. the green-blue level, the sustainable metric, specific knowledge for the agricultural sector); monitoring tools (e.g. the Evaluation framework for measures, water safety and monitoring)

Financial instruments: subsidies (for rainwater and drought plans, for the agriculture sector), support of innovative investment and finance, mobilization of EU and international funding

Governance and organizational instruments: plans (local energy and climate pacts)

Legal frameworks: EPB regulations (Energy performance and indoor climate)

Climate adaptation measures in Flanders **rely significantly on climate services**.

Use of Climate Models: Better models play an important role in the development and implementation of climate adaptation measures. These models help predict climate-related risks and determine the most effective measures

Climate portal: This platform acts as a central knowledge source for climate change and climate adaptation. It supports local governments in planning and implementing local adaptation policies by using collected and pooled knowledge.

Monitoring and Evaluation: Flanders is committed to comprehensive monitoring and evaluation systems that use various indicators to measure the effects of climate adaptation and adjust where necessary.

Green Deal and Agricultural Projects: Within the grant instrument 'Agricultural Pathways' and the Green Deal 'Climate-resilient design of open space', climate services are used for knowledge sharing, education and support for innovative investments.

Early Warning Systems: Flanders is working on warning systems that use modelling to make efficient trade-offs in case of emergencies. For example, these systems help issue general notices to evacuate in case of imminent calamities, such as floods. There are also systems in place to warn farmers of incoming hail.

Overall, the adaptation plan shows that climate services are crucial for both the planning and practical implementation of climate adaptation measures in Flanders.

The Adaptation Plan mentions frameworks for specific issues, as listed below. However, no standards or specific guidelines are mentioned *stricto sensu*.

Strategic Vision Policy Plan Space Flanders: The plan regularly refers to the Strategic Vision of the Flanders Space Policy Plan for developing climate-resilient infrastructures and green-blue networks.

Covenant of Mayors: This is a European initiative whereby local governments commit to meet or exceed climate and energy targets. The commitments are translated into climate action plans.

International terminology and nature-based solutions: The plan refers to internationally prevailing terminologies and nature-based solutions as defined by organizations such as IUCN and the United Nations.

EPB regulation: The plan mentions adaptation of the Energy Performance and Indoor Climate (EPB) regulation, updating standards and indicators to improve heat resistance of buildings.

European regulations on invasive species: The plan refers to the European regulation on invasive alien species to limit the impact of these species.

Standards or guidance were not used to draft the Adaptation Plan. Yet, the plan is now under an evaluation, following the results of the European Climate Risk Assessment (EUCRA) as an evaluation framework.

Actually, there is not such a thing as a real framework on adaptation to climate change, neither at the EU level nor at the international level but only reporting obligations.

Ecosystem of actors and climate services co-creation processes

The **provision of climate services** in Belgium is **coordinated by BELSPO**, the Belgian federal Science Policy Office. In 2021, BELSPO initiated the creation of the excellence center on climate change planned in the National Adaptation Plan, called the **Belgian Climate Centre**. The Belgian Climate Centre **facilitates the transfer of knowledge on climate-related issues** from the scientific community to policymakers, the public and private sectors, and the media. It provides **a facilitated access to climate services.**

BELSPO is also funding the main research project aiming at downscaling climate model information in Belgium, **CORDEX.be II project.**

CORDEX.be II project is coordinated by the Belgian Met Office, the **Royal Institute of Meteorology (RMI).** Several universities or research institutes also contributes to the project:

- University of Ghent
- University of Liège
- VITO
- KU Leuven

The Royal Institute of Meteorology is also responsible for meteorological observations.

Users collect the data from the Belgian Climate Centre or the Royal Meteorological Institute, which play the role of intermediaries.

One of the **Belgian Climate Centre**'s missions is to **strengthen stakeholders' engagement in the production of climate services.**

The core stakeholders of the CORDEX.be II are:

- National Crisis Centre – NCCN
- Flanders Environment Agency – VMM
- Agence Wallonne de l'Air et du Climat – AWAC
- Service Public de Wallonie – Mobilité et infrastructures – SPWI-MI
- Federal Public Service – FPS Public
- City of Ghent

The **CORDEX.be II project** is intended to be **stakeholder-driven**, as the core stakeholders represent various interests (water, cities, critical infrastructure, etc.). The **project team and the stakeholders meet on a regular basis.**

The stakeholders involved on a regular basis in the project are federal, regional and local authorities and agencies. **An extended group of stakeholders** also includes representatives from the private sector.

Focus on stakeholders' engagement in climate services production processes at the federal level

To engage with the general population, the department has developed interactive maps that display the environmental risks across the country.

To interact with the **private sector:**

- **Insurances:** the department interacts with the federation of insurances in Belgium, merging the data they have collected with climate modelling. This cooperation can lead to policy changes, like in October 2023 when the ceiling of intervention was raised in the case of natural catastrophe.
- **Agriculture:** the stakeholders are engaged again to merge their knowledge base to modelling, for example in the case of observation of pests. This then leads to deployment of quarantine organisms, and a response plan from the federal level. However, some regions opted not to partake in this effort.

There are communication plans to present results to public and private entities, but this has to be worked out.

Climate Center:

Regarding the **contact book of experts** of the Belgian Climate Center, **the Center contacts experts it finds relevant to cover all the relevant topics**, but researchers can also ask to be part of the contact book. They are sent a survey, where they provide their expertise, contact details, etc. They are asked what the center can do for them, and vice-versa. If relevant, the person is added to the contact book.

For the climate projection project (CORDEX II), **stakeholder engagement was more formal**, and the Center reached out to environmental agencies and the Federal Public Service (responsible for adaptation) and conducted a stakeholder workshop. The different actors were asked which format they preferred for the data they needed (raw model results, indicators, qualitative information).

Use of existing standards or framework for climate services production

The climate service providers rely on state-of-the-art knowledge on climate modelling. **CMIP5** (Taylor et al, 2012) and the **EURO-CORDEX projects** (Jacob et al, 2014, 2020) were followed to set up the downscaling simulations.

There is no "gate" that the climate data goes through in Belgium, it is collectively assessed by the scientific community under the supervision of the Belgian Climate Center. Concerns and issues can be raised by members of the expert group surrounding the Center, leading to a reevaluation of the data.

The way that the model calculations are conducted follows guidelines and standards sets in the broad context of the international modelling community. The added value of CORDEX II is that it brings

together all the climate modelling groups of the country, so it becomes a standard in itself. It combines input from multiple stakeholders to ensure it is based on the latest model developments.

Much of the input for the modelling comes from the Meteorological Institute, which is bound to follow **the standards and guidelines** from the **World Meteorological Organization.**

The **stakeholder engagement** follows a **case-by-case basis** in the climate projections. For the contact book of experts that the Belgian Climate Center maintains, there is a **standard way of adding an expert** to the list, but it is designed at the **Center itself.** Relevant experts are either scouted and contacted by the Center or can approach the Center to be added to the contact book. The profile, publications, and expertise of the applicant is evaluated by the Center before admission.

Flanders' climate service ecosystem and co-production process

In Flanders, the VNM (**Flanders Environment Agency**) produces and circulates climate data, and is also part of the Flemish Taskforce on Adaptation.

After the development of the Flemish adaptation policy, the need for more climate data arose, especially for local territories (i.e. municipalities). The VNM funds the development of climate scenarios and projections up to 2100 at the municipal level.

The Agency and the Flemish government jointly manage various projects. The Flemish government acts as a bridge between federal and local agencies and ensures dissemination of the information.

Knowledge and scientific centers such as the Knowledge Centre on Nature or Science share, monitor and forecast climate-related issues, especially related to health.

Delivery and uptake of climate services

The Belgian Climate Centre is one of the main channels through which climate services are provided at the national level. For now, climate data at the national level can also be accessed through the Belgian federal geodata portal: geo.be

A dedicated Belgian climate data hub should also be created in the coming years. The Belgian Climate Center is itself an intermediary between the research community and the users of climate services.

When it comes to interactions with the private sector, CERAC is an intermediary, acting as a contact point for the insurance, energy / transport sector.

There is no structural basis for contacts with the private sector. The interactions are more punctual to access model results or for help with CSRD.

Climate services delivery and uptake in Flanders

Local governments do use the climate data a lot and were very strongly involved in the development of the online tool (Welkom — Klimaatportaal). This allows them to easily use climate data without needing much capacity. The private sector is not involved in the development of the climate portal.

In Flanders, it is not mandatory for local authorities to design climate plans. Yet, most of Flemish local authorities are signatories of the Covenant of Mayors and have designed a Sustainable Energy and Climate Action Plan (SECAP).

The data produced by the VMM relies on the same models and initial databases as the national climate service project, CORDEX.be II.

The climate data provided at the scale of Flanders is accessible and user-friendly, whether it comes from the climate portal or from studies dedicated to specific climate risks drafted by the VMM. Relevant stakeholders are always involved in the steering committees of the studies or the climate portal.

The Flemish government aims to incorporate a climate reflex in every policy area, which would replicate for each project or construction.

So far, there exists a waterproof test which allows testing water-related risks on projects or constructions.

There is a work in progress on integrating more climate risks to the tool to make it a climate stress-test (e.g. to droughts, heat stress, etc.).

Standardization opportunities, requirements and constraints

At the federal level

Standardization for uptake of climate services within the adaptation policy framework

Harmonization is a complex exercise in Belgium, since it needs to respect local specificities, while also ensuring there is no gap when it comes to implementation.

At the federal level, using climate services in decision making for adaptation and risk management is done on a **case-by-case basis (no standards).**

Since **the federal level** does not have hierarchical authority on the other regions, it **cannot impose standardization.** Although the federal government would like to deploy climate services throughout Belgium, they are tributary to the willingness of the parties.

In the case of one of the tools deployed (interactive maps of the climate risk in Belgium), the **model used for the baselines is different depending on the region**, limiting the comparability and showcasing the need for standardization, ideally at the European scale.

However, the Belgian Climate Center pointed out that although standardization would indeed bring value, **it is a step too far**. The development of climate projections is still in a testing phase in Belgium, hoping to secure perennial support, so **standardization would be relevant only after it has become a structural activity.**

Other intermediaries, like the Belgian National Crisis Center and CERAC, Centre d'analyse des risques du changement climatique) work on risk assessment, and they follow European guidelines and ISO standards.

The Climate Center follows the World Meteorological Organization's guidelines.

Standardization for climate services design and co-production processes

View from the federal government:

The introduction of standards on stakeholders' involvement could **strengthen the co-design** on climate services, e.g. through **guidelines or methodologies** for a better engagement with stakeholders.

In addition, **a broader scope of stakeholders could be involved in the design of the services**. In Belgium so far, users are represented in the design of the main climate scenarios through a rather small group of public entities and private sector representatives, which could limit the representativeness of user needs.

At the same time, **the ecosystem of actors acting on climate services in Belgium is rather small and well interconnected**, even if the political regime inserts complexity in their coordination. If a **standard would introduce rigidity**, this could **harm the balance found in Belgium** to allow for the implication of all levels of governance and institutions depending on both from the federal and regional levels.

View from the Climate Center:

Standards on stakeholder engagement can be very valuable, and it is a gap in the current process at the Belgian level.

On the other hand, the Climate Center thinks it is **important to keep standards flexible and fit for purpose**. It should be integrated, at least as a reminder for the Center not to neglect the stakeholder engagement. But if it is too strict, it will hamper the work of the Center.

At the regional level: insights from Flanders

Guidelines and standards can be valuable as steering tools. However, considering the nature of climate change adaptation, local and regional levels should benefit from enough freedom to adjust to their own context.

The EU is currently working on an EU-level Adaptation Plan. But this should not erase disparities across countries and local specificities.

Standardization of climate services could be helpful. When leading the EU presidency, Belgium worked on spreading the use of climate services across DGs such as DG ENV and DG CLIMA. The Belgium presidency also focused on spreading the data resulting from the EUCRA to different councils.

Now, the EU Commission is developing a climate adaptation plan in line with other sectoral plans.

3.3.3 France

Alice Ferrant and Laetitia Giraud

Climate services uptake in climate change adaptation policy frameworks

Climate services production as a first step of the climate adaptation policy design at the national level

France adopted its **National Adaptation Strategy** in 2006. It has then published **three National Adaptation Plan** (NAP), in 2011, 2018 and in 2025. In 2021, the **Climate and Resilience law** entered into force, covering national aspects through the agriculture sector transformation and biodiversity enhancement and protection schemes.

So far, no Climate Risk Assessment has been conducted at the national level. The climate information underpinning the first two NAPs mainly derived from reports coordinated by the then called "National Observatory of the Effects of Global Warming". Within the Ministry of the Environment (which have changed name many times over the last two decades, and we will use this terminology rather than its current denomination, for clarity purpose), this Observatory plays a coordination role in the design and delivery of climate services, and in the formulation and implementation of the adaptation policy.

One report specially served as a basis for the first NAP, the "**Climate of France in the 21st Century**" series, **ordered by the Ministry of the Environment** to a handful of **scientific institutes and administrations**, among which many are still involved in the production of climate services today: the National Centre for Scientific Research (CNRS), the Met Office (Météo-France), the Pierre-Simon Laplace Institute (IPSL), the Coastal and Environmental Engineering Laboratory (LGCE), the French Geological Survey (BRGM), the French Alternative Energies and Atomic Energy Commission (CEA), the Centre for Maritime and River Technical Studies (CETMEF), the National Centre for Space Studies (CNES).

In 2024, a new national climate service was developed by Météo-France, the French NMHS, and several laboratories. It provides projections on a series of climate variables, aligning with a **warming trajectory**, and not emission pathways. The service is called the Reference Trajectory for Adaptation to Climate Change (TRACC), and it has been developed according to the IPCC's statement that adaptation action is primarily dependent on levels of warming rather than levels of emissions.

The TRACC delivers climate variables projections for 3 levels of warming for France (without overseas yet): +2°C; +2,7°C; +4°C.

The TRACC is the climate service, which **served as a basis for the design of the NAP-3**.

In the French climate adaptation policy, climate services always serve as a **basis from which adaptation policies are derived.** The knowledge on the state of climate and future projections both **instigate the need for adaptation action** and **guide the design of the policy measures** to adapt to the consequence of climate changes.

Climate services as instruments of the adaptation policy implementation

Then, climate services play an important role at the stage of the adaptation policy implementation, both at the territorial level and across sectors.

At the **territorial level**, one of the main instruments of the climate adaptation policy enforcement is **planning**, mainly through planning documents (at the Watershed level with the water management master plans, at the regional level with the regional plan for spatial planning, sustainable development and territorial equality, at the local level with the Territorial coherence scheme and the Air, Energy and Climate Plans). To **mainstream climate adaptation measures** into these plans, the French government supports the **development and the use of climate services**, which will then serve as a basis for the territorial and local adaptation policy design.

Since 2015, the law on the New Territorial Organization of the Republic (NOTRe) has reinforced the territorial aspect of adaptation. The regional plan for development, sustainable development and territorial equality (SRADDET), which is a regional planning scheme, must include a climate change adaptation component. In addition, the territorial climate-air-energy plan (PCAET), which is mandatory for all intercommunity's with more than 20,000 inhabitants, includes a diagnosis of the vulnerability of the inter-municipal territory to climate change; a strategy and quantified objectives; an action program; and a monitoring and evaluation system.

Through public-sector research institutions and administration funding and coordination, the State also spurs the design of **sector-specific climate services**, used to **support decision making of practitioners** in these sectors (e.g. water management, agriculture, snow tourism, etc.).

Insights from the regional level – Region of Brittany

The regional governance of the adaptation policy is shared among five main actors: the DREAL (State's regional direction for the environment, agriculture and housing); the regional office of Ademe, the French Ecological Transition Agency; the Regional Council; the regional office of the French Office for Biodiversity (OFB); and the regional Water Agency. These five institutions gather under a common initiative for climate action called "Ambition Climat Bretagne", translating as "Ambition Climate Brittany" (Ambition Climat Energie – Le site des transitions en Bretagne).

These institutional actors share an action plan as well as adaptation finance schemes. Together with Ademe and the DREAL, the Region coordinates a network of local communities with climate plans in which they present climate risk screening tools already developed. However, these tools have not yet been largely adopted by local authorities which rather buy the services of consultancies because they lack human resources with sufficient time or knowledge to assess climate risks and draft local climate adaptation strategies and plans.

In 2017, the Region launched a regional Conference of Parties, called Breizh Cop, inspired from the UNFCCC's conferences of parties held every year. The Breizh Cop aims at engaging multiple stakeholders (institutions, practitioners and businesses, citizens) through various activities. This stakeholders' engagement vehicle is meant to support the development and implementation of the Regional Sustainable Development and Land Planning Strategy adopted in 2020.

In parallel, a Roadmap for Climate Adaptation in Brittany has been developed and adopted by regional policy makers in 2019, as part of a New Strategy for Climate and Energy (Région Bretagne, 2019). The roadmap evolves around 6 strategic pillars:

- Knowledge, observation and research
- Capacity building of regional stakeholders
- Education and awareness raising
- Land planning and risk management
- Preserving natural heritage (water resources and biodiversity)
- Support to economic players

A regional network of climate adaptation stakeholders was set up: 'Breizh Hin' (which means "Brittany Climate" in Breton language). It gathers more than thirty partners to implement the objectives of the adaptation roadmap and allows information and knowledge sharing.

Regions have also been invited to working groups within the revision process of the NAP (on local authorities and climate data).

In 2023, when the case study was carried out on Brittany, the Region only had a limited access to climate data produced by Météo France and had to pay to access past climate observations data. Indeed, until 2024 1st January, an important share of Météo France's climate data was restricted and were subject to fees. In order to access climate data from Météo France, the Region had to file a request through its Environment Observatory. In 2023, the Region had filed a request for climate data and was expecting to be provided with the relevant indicator in 2025.

Thus, according to interviewees, access to climate data was not sufficient when the first roadmap on climate adaptation was initially drafted. In order to update its adaptation roadmap, the Region was willing to carry out a climate risk assessment and to objectivate projected climate risks through maps. In 2021, a Climate Impact Observatory was created within the Environment Observatory in Brittany.

Nowadays, all climate data produced by Météo France is freely available. The Environment Observatory in Brittany plays the role of an intermediary between the Region and Climate Service providers (whether Météo France or other climate service providers at the EU level such as C3S). Policy officers in the Region and its partnering institutions do not directly use climate services.

The Environment Observatory develops tailored climate services for the region, made available through an online dashboard, where non-climate environmental data is also delivered.

After the publication of the climate data related to the Reference Trajectory for Adaptation to Climate Change (TRACC), provided by Météo France, the Environment Observatory in Brittany developed specific indicators for Brittany at various territorial scales and published them in early 2025. This data

was used for a tailored climate service called "My territory with +4°C", available on the Observatory's dashboard.

When the case study was first carried out (2023), there was no homogenization whatsoever of adaptation and climate risk assessments methodologies or guidelines across regions. If the French government is now increasing efforts to homogenize climate risks assessments and adaptation strategies, it mainly does so at the local level (municipalities and metropolitan areas). As an example, the government strongly emphasizes the role of Local Energy, Air and Climate Plans in assessing local climate risks and mainstreaming climate adaptation strategies at local level. The interviewees from the French Ministry of the Environment also mentioned the local level as strategic for adaptation planning and implementation in France.

Ecosystem of actors and climate services co-creation processes

Ecosystem of actors

Météo-France is the national weather forecast and climate service. Météo-France comes under the authority of the Ministry for Ecological Transition. Météo-France's strategic orientations are set out in a multi-year Contract of Objectives and Performance.

Météo-France also plays a significant role in the main meteorological cooperation organizations: the World Meteorological Organization (WMO), the European Centre for Medium-Range Weather Forecasts (ECMWF), Eumetsat, the operator of European meteorological satellites, and Eumetnet.

The National Center for Meteorological Research (CNRM) is a joint research unit between the National Centre for Scientific Research (CNRS) and Météo-France. It is responsible for most of climate service development activities and coordinates all of the Research and Development activities of Météo-France.

The DRIAS Futures of Climate Portal (DRIAS standing for Giving access to French Regionalized climate scenarios for the Impact and Adaptation of our Societies and the Environment, in French) provides regionalized modelling exercises for the futures of climate, based on the data from Météo-France. Drias Futures of Climate aims to provide regionalized climate projections computed by several French public research centres involved in climate modeling (IPSL, CERFACS, CNRM). Climate information is delivered in a variety of graphical or numerical forms.

Other climate service providers include:

- Public research centers: INRAE (National Agriculture and Environment Research Institute), BRGM (French Geological Survey), IGN (National Institute for Geographic and Forestry Information), ANR (National Research Agency)
- The European Union: in particular, the Copernicus Climate Change Service
- Firms (develop climate products for their clients, e.g. Callendar, AXA and its service Altitude, etc.)

- Sectoral stakeholders (the associative company Solagro and its climate service developed for farmers, CANARI)

Intermediaries are involved in the translation and use of climate information and data: public institutes and agencies (e.g. ADEME, Cerema, etc.); private organizations (data providers, consultancies, NGOs).

End-users of climate services are mainly public-sector players (public institutions and authorities at national, regional or local level). Yet, French authorities increasingly implement initiatives aiming at enhancing climate adaptation in the private sector and increasing climate services uptake by private companies. As an example, Météo France has developed a bespoke climate service for private companies, Climadiag entreprise.

Involvement of users and stakeholders in climate services production

Generally, climate services are produced within dedicated research projects. The main funders of those projects (e.g. Ministries) are invited to follow the production process through the projects' steering committees.

These public funders are also initiating the research themes through calls for projects emitted through the National Research Agency (ANR). Request of climate service production thus mainly comes from national public authorities. Then, the request is implemented based on the service producers modelling capacity and available resources.

End-users are not part of the steering committees but are engaged through thematic committees created by the main climate service producers (e.g. Météo France or other research centers). Once the climate service is published, user committees are set-up to collect user requests and update the service. However, once the first version of the service is published, updates are considered rather incremental.

The dataset of the Reference Trajectory for Adaptation to Climate Change (TRACC) has been developed under the supervision of a closed steering committee, which included the Ministry of Ecological Transition and Cohesion of Territories, which is the main backer of the project.

Once they were validated by the National council of the ecological transition (CNTE), the concept and principles of the TRACC were published in May 2023 to collect feedback from national stakeholders and the broader public on the French Ministry of the Environment's website. The public consultation consisted in three questions:

- *Question 1: Should France adopt a reference warming trajectory by the end of the century to enable climate adaptation, while continuing to mitigate greenhouse gas emissions in line with the objectives of the Paris Agreement?*

- *Question 2: What do you think of a reference warming trajectory for adaptation in France (TRACC) whose reference warming levels would be: +2°C in 2030, +2.7°C in 2050 and +4°C in 2100 (mainland France)?*
- *Question 3: What tools and what technical and financial support should be made available to local authorities, economic players and the general public to enable them to adapt to the anticipated climate change impacts?*

Working groups involved in the co-construction of the third National Adaptation Plan (which was still under development at this time) were particularly invited to submit suggestions to the Ministry. A dedicated email address was created by the Ministry of the Environment to collect feedback on the three questions.

Interviewees from the Ministry of the Environment also mentioned that enhanced user engagement activities were carried out in the development processes of sectoral climate services. As an example, the project Explore 2, running from 2021 to 2024, aimed at producing climate services for water management in France. It was led by the National Agriculture and Environment Research Institute (INRAE) and the International Office for Water (OIEau, a French NGO aiming to build capacity on water and biodiversity management across France and the world). Practitioners in the field of water management (e.g. technical officers in river basin delegations) were particularly involved in the development process, for example, through the collection of their requirements.

Stakeholders' engagement is deemed necessary to assure the added value of the climate services provided. The engagement methods depend on the nature of the project: some climate services are developed to directly answer user needs (especially sectorial users) while others, like the TRACC project, derive more from a top-down approach.

Delivery and uptake of climate services

All climate data from Météo France are freely available since January 1st, 2024.

The DRIAS Futures of Climate portal, is one of the main climate services in France, providing climate projection data. A sister service, DRIAS, les futurs de l'eau, provides climate data on water-related variables.

These services are intended for a wide range of users, from experts (researchers, academics, etc.) to non-specialists (project managers, decision-makers, etc.), involved in impact and adaptation studies on climate change.

The CLIMAT HD platform works as a complement to DRIAS. It provides an integrated view of past and future climate change at national and regional scales with key messages on the current and future effects of climate change.

For local authorities, Climadiag commune provides ready-made climate risks assessment at various temporal horizons (2030, 2050, 2100) following the TRACC data.

For companies, Climadiag entreprise is an accessible vulnerability assessment tool.

Various sectoral climate services are also developed by public players or by private companies with funding of public authorities:

- CANARI and Climadiag agriculture, for the agriculture sector
- Explore2, for water management
- Climsnow is a climate service developed for French ski resort
- Adaptour, a climate risk assessment tool for companies and territories in the tourism sector, funded by the French Ecological Transition Agency
- R4RE (Resilience for Real Estate), is a service designed for the building sector

Thus, a wide range of climate services is made available for various public and private players in France. Some of them, like the Climadiag Commune service, are tailored to facilitate end-user access to climate data and do not necessitate any technical capacity. Others, like DRIAS services, require intermediaries.

Data on the uptake of these various services has not been found for this case study. However, it seems relevant to stress that there is no such thing as an exhaustive mapping of climate services in France. The main entry point for end users is the Resource Centre for Climate Change Adaptation (CRACC) which only lists some of the climate services available on a methodological webpage.

In parallel, the Institute Simon Laplace has been developing a service (ESPRI) integrating a set of databases combined with a calculation service. This tool covers data from observation services and campaigns, in particular for atmospheric data, via the AERIS atmospheric data center and the ACTRIS research infrastructure, and the distribution of climate projections at international level. In particular, ESPRI is responsible for the distribution of climate projections for the Copernicus Climate Change Service (C3S) for the next four years.

Standardization opportunities, requirements and constraints

On adaptation policy frameworks

Policy documents do not mention standards or guidance related to the design and implementation of adaptation and risk management policies.

According to the interviewees, and because climate adaptation is better designed at the local level, standardization of climate services should allow for some flexibility for the use of climate services. A too precise and too constraining standard framework could stem local action. Standardization should thus only focus on generic frameworks and methodologies, as do the existing norms linked to climate adaptation: ISO 14091:2021; 14092:2020; 14093:2022.

The French State is already willing to align as much as possible the climate risk assessment methodologies at the local level, hence the use of the new climate service TRACC.

On ecosystem of actors and climate services co-creation processes

French public actors involved in the development of climate services always align with the IPCC's stakes and datasets. Even if guidance or standards are not mentioned explicitly, they follow internal rules to guarantee the service's quality (multiple models used) and transparency.

Those actors also rely on user engagement to make sure the produced services bring the added value targeted. The engagement methods depend on the nature of the project: some climate services are developed to directly answer user needs (especially sectorial users) while others, like the TRACC project, derive more from a top-down approach.

The introduction of standards could ease the involvement of stakeholders in the climate service's production cycle, for example by giving guidelines on relevant methodologies and tools to increase stakeholders' engagement (e.g. on collecting user requirements).

Besides, more and more private actors develop ready-to-use climate services. If some of these businesses declare providing better quality products than the public climate services freely available, State representatives observe it is not always true. A standard could help limit such downward slides within the private climate services market.

Opportunities for standardization in Brittany

At the regional level, an added value could be to have climate services standards that focus on (1) the development of regionalized data and (2), a process to make available the data in a systematic, free, and comprehensive way. Local authorities need to be able to easily get access to the information to support the development of their local climate risk assessments and adaptation strategies.

Standardization could fasten the decision context and support policy makers and their policy officers (within the region) in designing policies and policy instruments. Standardization could help regional actors accessing climate data to better implement and evaluate adaptation roadmaps.

3.3.4 Spain

Alice Ferrant and Louise de Torcy

Climate services uptake in climate change adaptation policy frameworks

Spanish climate adaptation policy framework

Spain's climate adaptation and climate risk management policy framework is governed by several plans and regulations, including:

The Strategic Framework for Energy and Climate (2019): This framework aligns with the European Union's climate goals and provides a roadmap for achieving emissions reductions and climate

resilience. Under the Strategic framework for energy and climate are several policy instruments which support the implementation energy and climate policies such as:

- **The National Adaptation Plan (PNACC):** This plan lays out Spain's strategy for adapting to climate change impacts. The current PNACC for 2021-2030 was approved in 2020 and focuses on integrating climate risks into public policies, sectoral plans, and territorial development. It promotes a coordinated and coherent action to face climate change impacts. The plan is implemented through 5-years long work programs, which describe measures and entities responsible for their implementation. The work programs also contain information on reporting, monitoring, and evaluation mechanisms.
- **The Climate Change and Energy Transition Law (Ley de Cambio Climático y Transición Energética):** Endorsed in May 2021, this law outlines Spain's commitments to reducing greenhouse gas emissions, increasing renewable energy use, and developing strategies for climate change adaptation. It is one instrument of the Strategic framework for energy and climate, and it stipulates that the PNAC is the primary instrument to organise climate adaptation action.
- **The work plan 1 - 2021-2025 (Programa de Trabajo):** this document is an operational transposition of the Climate Change and Energy Transition Law. It applied for a 5-year period. It aims at:
    - detailing the planned measures, within the specific time frame established, and developing the lines of action defined in the PNACC,
    - identifying priority measures, based on the best available science, as well as the potential benefits
    - identifying the organizations responsible for the development of the measures and the collaborators, spread across 18 topics (Climate, climate scenarios, Human health, Water and water resources, Natural heritage, biodiversity and protected areas; Forestry, desertification, hunting and inland fishing; Agriculture, livestock, fishing, aquaculture and food; Coasts and the marine environment; Cities, urban planning and construction; Cultural heritage; Energy; Mobility and transportation; Industry and services; Tourism; Financial system and insurance activity; Disaster risk reduction; Research and innovation; Education and society; Peace, security and social cohesion).
    - including indicators of compliance with the defined measures to facilitate monitoring and evaluation.
- The **PIMA Adapta** plan, officially known as the **Plan de Impulso al Medio Ambiente para la Adaptación al Cambio Climático en España**, was launched by the Spanish Ministry for the Ecological Transition in March 2015. PIMA Adapta is part of the National

Plan for Adaptation to Climate Change (PNACC) and includes actions in the areas of coasts, public waterways and National Parks.

- **PRTR (Recovery, Transformation and Resilience Plan)**: The Recovery, Transformation and Resilience Plan is a comprehensive initiative by the Spanish government to leverage funds from the NextGenerationEU program, specifically the Recovery and Resilience Mechanism. This plan aims to mobilize significant financial resources, including grants and loans, to support Spain's economic recovery and transformation following the COVID-19 pandemic. The RTRP focuses on several key areas:
    - Ecological Transition (investments in renewable energy, energy efficiency, and sustainable mobility), digital transformation, social and territorial cohesion, gender equality.

Given the convergence between the objectives of the PNACC 2021-2030 and those of the PRTR, some measures of the latter will be incorporated into WP1. Thus, PRTR funds will undoubtedly have an impact on the financing of the measures envisaged in the first work program.

- **Sectoral Plans:** These include guidelines and measures for key sectors such as water management, agriculture, forestry, health, tourism, urban planning, coastal areas, infrastructure, energy and biodiversity. In some cases, the action plan 2021-2025 integrates climate change related measures in existing sectoral plans such as:
    - Strategic Plan for Health and the Environment (Plan Estratégico
    - de Salud y Medio Ambiente)
    - Drought plans (planes de sequia)
    - RN 2000 management guidelines (directrices de gestión de RN 2000)
    - Spanish Forestry Plan (Plan Forestal Español)
    - Irrigation plans (planificaciones de regadío)
    - Maritime spatials plans (Planes de Ordenación del Espació Marítimo)
    - Strategic plan for equal opportunities (Plan Estratégico de Igualdad de Oportunidades - PEIO)

Monitoring

An evaluation of the PNACC was led in 2019 as part of the European Sahara Life project.

Uptake of climate services in the adaptation policy cycle

There are various climate services in Spain, on which policy framework can rely on. One can classify them into two major types:

First climate **projection services,** such as AEMETs climate projections, AdapteCCa climate change scenario viewer, Climate change on Spanish coast (C3E) or Camrec (impact of climate change on water

resources and droughts). Those climate services are mainly developed by institutional organizations and are being broadcasted on AdapteCCa platform, the government platform (OECC- Biodiversity foundation).

On the other hand, other climate and weather **prediction services** that would support Climate adaptation, such as seasonal prediction, early warning systems, alerts on weather extremes, historical data or sectoral index indicators (for example, for the agriculture sector), among others.

Climate risks assessment helps understanding future risk and planning policy frameworks. Here are some examples of the use of climate services in policy instruments:

- Scenarios tools are used in risk evaluation and plan development
- Coastal scenarios in risk evaluation and coastal adaptation planning
- Hydrological projections for the management of water resources

Catalonia adaptation framework

- **Catalan Strategy for Adaptation to Climate Change 2021-2030** (ESCACC30), which aims to reduce the region's vulnerability to climate risks through various measures and objectives. The ESCACC30 analyzes the vulnerability of 17 areas to the risks of climate change: 4 natural systems, 10 socioeconomic areas, and 3 territories. The reduction of the vulnerability of these 17 areas is articulated through 76 operational objectives that are developed through a total of 312 measures. The deployment of the measures is specified in two five-year work programs (2021-2025 and 2026-2030) thanks to the execution of adaptation actions.
- **Catalan Climate change law (2017):** The Catalan Climate Change Act, known as Act 16/2017, was adopted by the Parliament of Catalonia on July 27, 2017, and enacted on August 1, 2017. The Act aims to reduce greenhouse gas emissions and support Catalonia's adaptation to the effects of climate change. Here are some key points of the law:
    - Reduction of emissions: The law sets quantified targets for the reduction of greenhouse gas emissions.
    - Environmental taxation: It strengthens environmental taxation by consolidating the tax on emissions from polluting vehicles and creating new taxes on emissions from polluting economic activities and large ships.
    - Adaptation measures: The law provides for measures to reduce the vulnerability of the population and ecosystems to the effects of climate change.
- **Work program 1 (2021-2025):** the Catalonian Work Program 2021-2025 is designed to operationalize the goals of ESCACC30, ensuring a coordinated and effective response to climate change in Catalonia.

The Third Report on Climate Change in Catalonia (TICCC) is a comprehensive document that analyzes the current state and future projections of climate change in Catalonia, including

contributions from 140 authors and 40 reviewers from major universities and research centers in Catalonia, climate projections, analysis of impacts on ecosystems and society, strategic recommendations and regional focus.

Ecosystem of actors and climate services co-creation processes

There are an increasing number of players producing climate services in Spain, particularly private companies. At national level, the main actors are the AEMET, the national meteorological agency, responsible for developing climate services, the OECC, Spanish climate change office (depending on the Ecological Transition and the Demographic Challenge Ministry - Miteco) bridge between technical (AEMET) and users, the CSIC Spanish National Research Council and the Biodiversity foundation.

Regarding AdapteCCA platform, the national platform of information on climate change and dissemination, there is continuous work to integrate new data and new users' needs. A contact form allows users to communicate their needs to platform developers. A permanent working group from the organizations in charge of the platform (OECC, Biodiversity Foundation) is gathering every 2-3 months to follow up on requests and validate content updates.

In another hand, there is a current work on the development of 10 new climate services as part of a collaboration between the AEMET and the PTI Clima (Plataforma Temática Interdisciplinar Clima). AEMET, mandated to provide these services, works with PTI Clima, which offers scientific and technical support to create a regional climate information system and implement ten new climate services in the field of seasonal forecast, meteorological fire and droughts, climate change indicators, agro climatology, wind, radiation, or extreme events. This initiative is funded by the MITECO and the European Commission through the NextGenerationEU program. The collaboration aims to integrate research and development activities, with continuous interaction between service provision and climate research. AEMET provides climate data and advice, while PTI Clima processes this information to develop and interpret climate products. Users' needs are taken into account in the development of these services, but actors or types of actors are sometimes very concentrated, and the needs are quite similar (e.g. insurance sector). Consultation is therefore sometimes limited to a few major actors. On the other hand, as part of the development of these 10 new services, an interesting example can be presented when developing a new climate service in the agriculture sector, where a tool of adaptation, in real time, is being developed for sectoral users. As this sector gathers various types of end users, a workshop gathering both service providers and users: AEMET, CSIC, research centers, sectoral users (farmers) was organized aiming at identifying user's needs: type of indicators needed, characteristics, type of delivery. Through this interesting setup, it underlines that in order to build efficient climate service, coordination with end users has to be done at the start of the climate service definition.

The following figure summarized the ten services being developed

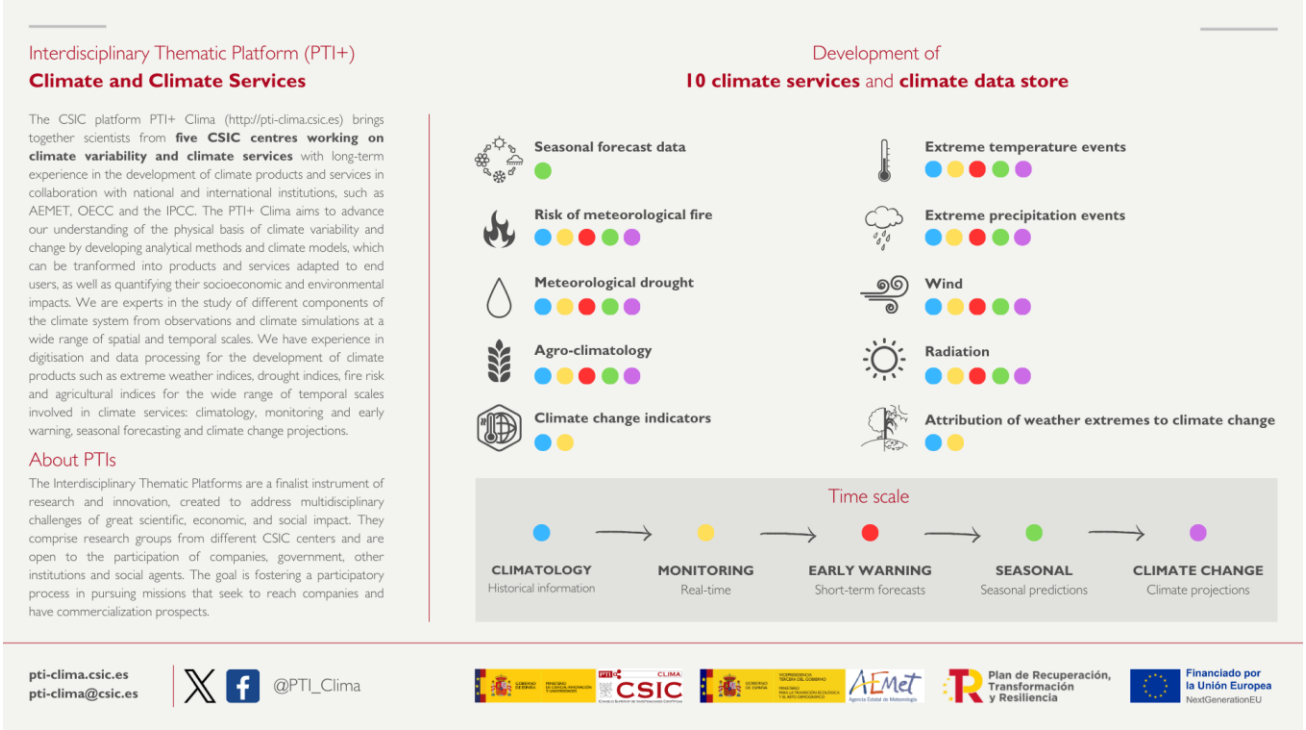


Figure 10 Development of 10 new climate services as part of a collaboration between the AEMET and the PTI Clima

Concerning AdapteCCa scenario viewer, there is a process of continuous improvement. Thus, Predictia, the private company producing the Spanish scenarios viewer, is also working for Copernicus viewer and IPCC Atlas, and then implementing improvement and latest technologies, data and functionalities to the Spanish viewers.

Ecosystem of climate services actors in Catalonia

Regarding regional level, the GTIA allows exchanges between actors, both regional and national, and encourages coordination. Besides, there is ongoing bilateral coordination between AEMET and regions (ex. Catalunya). At regional level, there is a regional planification based on AEMET data and Spanish scenarios but also sometimes on regional climate projection.

Delivery and uptake of climate services

Currently, official Spanish climate services are listed and available on the adapteCCa platform. However, there is an increasing number of climate services developed by private companies or research centers.

In 2021, a national regulation of the insurance sector has required it to assess its climate risks. A new climate service was thus developed for private companies, leading them to modify their rates. As insurance companies are global, this methodology is now being extended to other countries and could lead to European regulation.

The OECC, AEMET, the Biodiversity Foundation and the Spanish National Research Council have developed an online tool: the AdapteCCa Climate Change Scenario Viewer https://escenarios.adaptecca.es/

- **AdapteCCa:** it is a platform for consultation and exchange of information on impacts, vulnerability and adaptation to climate change, led by the Spanish Office for Climate Change and the Biodiversity Foundation (both of the Ministry for Ecological Transition and the Demographic Challenge) in accordance with the objectives and principles of the National Plan for Adaptation to Climate Change (PNACC).
  The objectives of this platform are:
  - Facilitate access to data, information and knowledge on climate change adaptation by building a strong base of consistent and up-to-date knowledge.
  - To be an open instrument of exchange that facilitates multidirectional communication and coordinated work between the different actors in the field of adaptation: Spanish administrations, the scientific community, planners, public and private managers, etc.
  - The ultimate goal of AdapteCCa is to strengthen the capacities of society and administrations in their adaptation actions,

- **Visor de Escenarios de Cambio Climático** The AdapteCCa Climate Change Scenario Viewer. It is a platform allowing to identify impacts of climate change according to different scenarios.it is based on AEMET and euro-cordex datas and has been developed in accordance with the PNACC and funded by a Sahara Life project.
- IH Cantabria: "Climate Change on the Spanish Coast" (C3E) - WEB viewer
- **CAMREC** Assessment of the impact of climate change on water resources and droughts in Spain - CAMREC. The main objective of the CAMREC computer application is to facilitate the consultation and analysis of the maps that summarise the results of the study 'Evaluation of the Impact of Climate Change on Water Resources and Droughts in Spain' carried out by the Centre for Public Works Studies and Experimentation (CEDEX) for the Spanish Office for Climate Change (OECC).

Delivery and uptake of climate services in Catalonia

- PIMA Adapta Costas : this tool has been created as part of PIMA ADAPTA COAST Plan to draw up a 'Plan for Adaptation to the effects of climate change of the maritime-terrestrial public domain assigned to the autonomous community'. The objective of this work is to provide an estimate of the extent of climate change in Catalonia by determining the risk to its socioeconomic and natural systems. To this end, a methodology has been used that

improves the state of knowledge in the characterization of impacts due to climate change. It is part of the Strategy for Adaptation to Climate Change on the Spanish Coast approved by the Ministry of Agriculture, Food and the Environment (currently the Ministry for Ecological Transition and Demographic Challenge).

- Drought Observatory (OSTA) within the framework of the Life Clinomics project, the Terra Alta Drought Observatory (OSTA) has been created, which monitors the water status of vineyards, olive, and almond trees. Every week a bulletin is published with information on precipitation and soil moisture in rainfed farms. For irrigated farms, irrigation recommendations are also made. Bulletins are published every Monday morning. The Observatori de l'Ebre, the Escola Agrària de Gandesa and the Consorci de Politiques Ambientals de les Terres de l'Ebre (COPATE) collaborate in this observatory.
- **Bulletin of Climate Change Indicators for the Pyrenees**: in 2022, the first Butlletí d'Indicadors de Canvi Climàtic dels Pirineus (BICCPIR) has been presented, which provides information on the evolution of the climate of the Pyrenees between the years 1959 and 2020, through a set of indicators grouped by systems. The BICCPIR is one of the results of the Adapyr project, in which 12 institutions from France, Andorra, and the Spanish State have participated under the coordination of the Pyrenean Climate Change Observatory (OPCC) of the Pyrenees Working Community. The bulletin provides, for the first time, a joint vision of the state of climate change in the entire Pyrenees massif and will have an annual periodicity, similar to the Butlletí Annual d'Indicadors Climàtics that the Servei Meteorològic de Catalunya (SMC) carries out for Catalonia. It has been, precisely, the SMC, the entity that has defined the design and contents of the bulletin based on the contributions of the different partners of the project. Within the framework of the Adapyr project, an agreement for the provision of meteorological and snow data has been signed between the five entities that manage official meteorological networks: State Meteorological Agency, Météo France, Servei Meteorològic Nacional d'Andorra, Euskalmet, and SMC. This important cross-border agreement will allow the newsletter to be updated and expanded in future editions.

Standardization opportunities, requirements and constraints

In Spain, there are no standards for risk evaluation, so the government is currently working on the basis of the methodology used in the European Risk Assessment (EUCRA). Standards at European level could be of use. Recommendations on how to evaluate risk would help to develop climate services. For example, different member states use different SSP (scenarios), making it difficult for member states to compare information.

So, on one hand, standardization would be an opportunity to compare data and climate services. Given the increasing number of climate services developed, it has become harder to understand the methodology behind or what data was used, and to compare results among different services.

Standardization of the methodology description when developing new services would therefore help understand how services were developed and in what is their best use. For example, documentation explaining methodological aspects of scenarios developed to show their robustness, to align to, or if not to identify gaps, would help clarify the difference between climate services, what they are useful for or how and when to use them.

Furthermore, policy makers cannot rely on climate services for planning without a clear methodological documentation. Standardization of climate service documentation should thus clarify how to use the service, its pros and cons, and should be readable by all kinds of people regardless of their technical expertise: NGO, company, municipalities, ministry (ex. forestry).

In Spain, this need of standardization will be addressed in the Second Work Program (programa de trabajo 2026-2030), which is currently under development in the context of the National Adaptation Plan. Measures would be developed about coordination between climate service producers such as creating working groups.

A documentation on the methodology used in the national scenarios production is also being provided to facilitate the alignment of other services.

Another argument in favor of document standardization is that it will allow more transparency.

It is currently of common use that OECC scenarios are the "official" ones though the national adaptation plan only refers to AEMET as coordinator for the generation of regionalized projections for Spain and that the possibility of using OECC scenarios as official one in Spanish policy making for every actor has not been validated.

Standardization of methodology is another matter. It is important to remain flexible and be able to adapt the methodology used to the desired result. When developing new services, it is important to take into account that each sector has its specificities.

In Spain, AdapteCCa scenario viewer is the official scenario tool under the PNACC. When working with autonomous regions or communities, actors have to at least align on the scenario methodology (sometimes they use AdapteCCa, sometime no). If the region or community uses other scenario, they are asked to implement at least the same methodology used by AEMET / AdapteCCa or document their decisions.

On a market aspect, standardization would increase entry costs but allow a fairer competition. It is important that each climate service provider can be transparent on the methodology used and the level of uncertainties.

Insights from the Barcelona case

The informants of the Barcelona case study were not familiar with standards relevant for climate services nor climate adaptation. They also showed little awareness of national and regional plans regarding urban resilience.

3.3.5 Poland

Alice Ferrant and Benoît Bulliot

Climate services uptake in climate change adaptation policy frameworks

In 2013, Poland adopted a "National Strategy for Adaptation to Climate Change by 2020 with the perspective of 2030" (NAS). This policy document is supported by the "National Environmental Policy 2030 - Development strategy in the area of the environment and water management".

Adaptation to climate change is promoted in sectoral policies as an underlying objective in strategic documents such as: the long-term national development strategy, the mid-term development strategy and other development strategies; the National Urban Policy; the Plan for Counteracting the Effects of Drought (PPSS).

Thus, the existing policy and regulatory framework around climate adaptation and climate risk management in Poland includes several key strategies, projects, and regulations.

The Polish National Strategy for Adaptation to Climate Change by 2020 with the perspective of 2030 (NAS 2020):

The Government of Poland adopted a position on the White Paper on 19 March 2010 with a decision on the need to develop adaptation strategies for sectors and areas vulnerable to climate change. The NAS 2020, adopted by the **Government** on 16 July 2019, is part of a broader research project called KLIMADA, which covers the period up to 2070.

- This strategy covers sectors such as agriculture, water management, public health, energy, construction, and transport.
- Additionally, adaptation actions also target Biodiversity protection & particularly vulnerable regions in Poland such as the Baltic coastal area, the Carpathians, and the Sudetes Mountains
- It focuses on minimizing vulnerability to climate risks, developing schemes for fast response to climate-driven disasters, and prioritizing cost-effective actions.
- Projects under this strategy are supported by EU funds, mainly through LIFE+ and European Structural and Investment Funds.
- The NAS 2020 has influenced the preparation of adaptation action plans for cities and has emphasized considering climate change adaptation in national frameworks for environmental impact assessments, land use, spatial planning, urban planning, and maritime spatial planning policies.

Klimada 2.0 Project:

Objective: The Klimada 2.0 Project is designed to establish a comprehensive knowledge base for climate change adaptation in Poland. It leverages expertise acquired from large-scale projects focused on planning climate change adaptation to create an accessible online platform for knowledge dissemination.

Key Components of Klimada 2.0:

- **Knowledge Base Development**

Using expertise from extensive climate change adaptation planning projects, the Institute of Environmental Protection - National Research Institute (IEP-NRI) will establish the Knowledge Base.

The information will be progressively available online via the Project's Web Platform, making it accessible to all.

- **Risk Assessment and Mapping**

The project will assess the risks of climate change impacts on the economy, society, and the environment.

The results will be presented in the form of risk maps for different sectors and climatic factors that affect these sectors.

IEP-NRI experts will explain the adopted risk assessment methods.

- **Historical Context and Integration**

The project builds on the previous Klimada project (2010-2013), which analyzed vulnerability and resilience across 17 economic and social sectors in Poland.

Klimada provided climate change scenarios by the end of the 21st century and preliminary cost estimates for adaptation actions.

The findings from the Klimada project form the substantive basis for the Polish National Strategy for Adaptation to Climate Change by 2020 (NAS2020), with a perspective until 2030.

- **Strategic Framework**

The NAS2020 strategy ensures stable socio-economic development despite climate risks, promoting actions that have positive effects on both the environment and economic growth.

It emphasizes minimizing vulnerability to climate risks, developing fast response schemes for climate disasters, and prioritizing cost-effective actions.

- **Coordination and Funding**

The project is led by the Institute of Environmental Protection - National Research Institute (IEP-NRI).

It is co-financed by the European Union from the budget of the Cohesion Fund, under the Operational Program: Infrastructure and Environment, and by the State budget.

- **Urban Adaptation Plans (MPA)**

Separate from Klimada 2.0, the Urban Adaptation Plans (MPA) initiative focuses on large cities with populations over 100,000.

It assesses urban vulnerability to climate change and plans adaptation actions to enhance urban resilience.

The project was ready by the end of 2018, involving 44 cities as partners, and is co-financed by the European Union and the State budget.

Additional Initiatives: The Klimada 2.0 project also highlights efforts in smaller and medium-sized cities through the ClimCities project, which developed adaptation strategies for five cities: Bełchatów, Nowy Sącz, Ostrołęka, Siedlce, and Tomaszów Mazowiecki.

In Poland, the main institution responsible for climate adaptation is the Ministry of Climate and Environment [MKiS] (more precisely, the Department of Air Protection and Urban Policy). Supportive services are provided by the Institute of Meteorology and Water Management (IMGW-PIB), the Institute of Environmental Protection (IOS-PIB), and the Institute for Ecology of Industrial Areas (IETU).

European Union

- *Role: Provides funding and strategic guidelines for member states' climate actions through initiatives like LIFE+ and European Structural and Investment Funds.*
- *Involvement: Co-finances projects and gives recommendations for national adaptation and mitigation plans.*

Ministry of the Environment

- *Role: Oversees national climate policies, including adaptation and mitigation strategies. It is responsible for developing the Polish National Strategy for Adaptation to Climate Change (NAS 2020).*
- *Involvement: Manages projects related to climate adaptation in cities, such as the Urban Adaptation Plans for 44 of the largest Polish cities.*

Institute of Environmental Protection – National Research Institute (IEP-NRI)

- *Role: Provides scientific research and data to support climate policies. Leads the Klimada 2.0 Project, which aims to create a comprehensive knowledge base for climate adaptation.*
- *Involvement: Key implementer of the National Strategy and Urban Adaptation Plans. Assesses risks and develops adaptation strategies for local and regional levels.*

Local Governments and Cities

- *Role: Implement adaptation and mitigation strategies at the local level. Develop Urban Adaptation Plans aligned with national strategies.*
- *Involvement: Significant participation in climate action projects, such as the Urban Adaptation Plans for 44 cities.*

Academia and Research Institutions

Role: Conduct research and provide expert analyses to support climate strategies.

Involvement: Various projects in collaboration with the government, providing scientific assessments, risk mapping, and strategic recommendations.

Non-Governmental Organizations (NGOs)

Role: Engage in public consultations, advocacy, and implementation of local adaptation projects.

Involvement: Participation in developing and implementing strategies and raising awareness about climate issues.

Uptake of climate services in the Polish adaptation policy cycle

Climate services play a critical role in the design, implementation, and monitoring of climate adaptation policies in Poland. These services provide essential data, tools, and scientific insights that inform decision-making processes across various levels of governance. Below is an analysis of how climate services are integrated into policy instruments:

National Level

Polish National Strategy for Adaptation to Climate Change (NAS 2020)

- Climate Data and Projections: NAS 2020 heavily relies on climate data and future projections provided by climate services. These projections include assessments of temperature changes, precipitation patterns, and extreme weather events.
- Risk Assessments: Climate services facilitate risk assessments by providing data on potential impacts on different sectors like agriculture, water management, and public health.
- Monitoring Tools: Tools for monitoring progress and evaluating the effectiveness of adaptation measures are developed based on data from climate services.

Institute of Environmental Protection - National Research Institute (IEP-NRI)

- Klimada 2.0 Project: This project uses climate services to create a comprehensive knowledge base for climate adaptation. The project assesses risks, develops adaptation strategies, and presents results in the form of risk maps for various sectors.
- Scientific Research: IEP-NRI relies on climate services to conduct research, analyze climate risks, and formulate adaptation strategies that inform national policies.

Specific Instruments and Their Dependence on Climate Services

Klimada 2.0 Project

- ***Data Integration:*** *The project integrates comprehensive climate data into an accessible online platform. This data supports local and national adaptation strategies by providing detailed risk maps and assessments.*
- ***Knowledge Dissemination****: Klimada 2.0 disseminates knowledge through workshops, publications, and online resources, enabling stakeholders at all levels to make informed decisions based on robust climate data.*

Urban Adaptation Plans

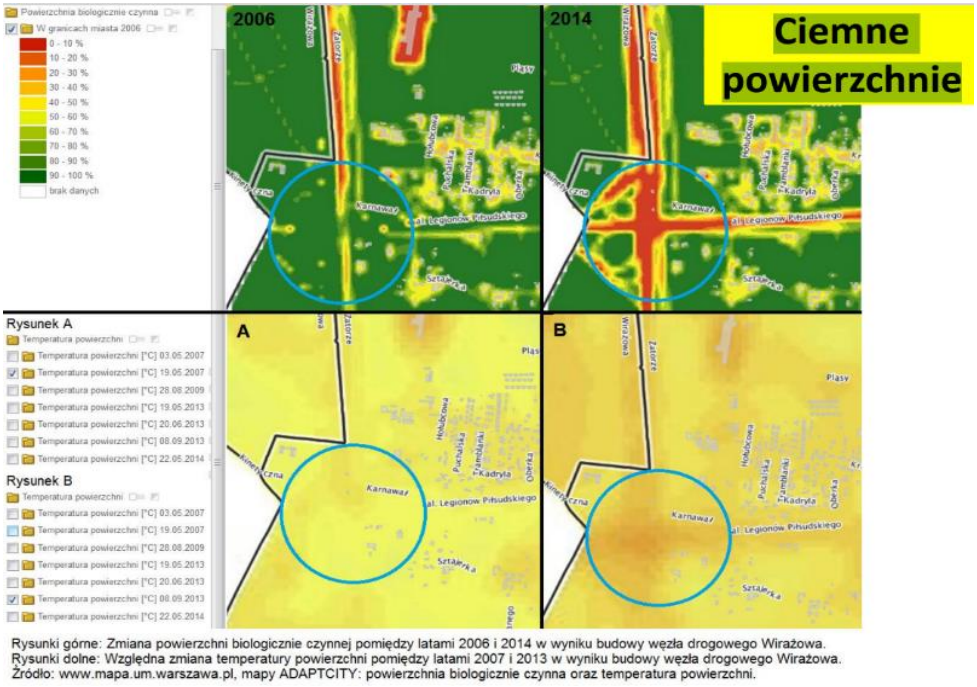
- *Customized Climate Data: Cities rely on climate services to obtain customized data for their specific needs, assessing risks like urban flooding, increased heat events, and infrastructure vulnerability.*
- *Strategic Planning: With data from climate services, cities can plan long-term strategies to enhance resilience and reduce climate risks.*

Sector-Specific Adaptation Strategies

- ***Agriculture**: Climate services provide projections and data that help farmers plan crop cycles, manage water resources, and adopt sustainable practices to mitigate climate impacts.*
- ***Water Management**: Climate data informs the development of water management plans, including flood prevention, drought mitigation, and sustainable water use.*
- ***Public Health:** Climate services support health authorities in preparing for climate-related health risks, such as heatwaves and vector-borne diseases.*

Insights from the local level: the Warsaw Climate Adaptation Strategy

The Warsaw Adaptation Strategy results from an EU funded LIFE project called **ADAPTCITY**, which ran from July 2014 to June 2019. The aim of the project was to use **city climate mapping** and to ensure a **broad participation of the public** as preliminary steps to the design of the adaptation strategy.



One of the main achievements of the project was to **mainstream the use of climate services at city level and within municipal service providers,** through the design of a **Warsaw Climate Map** and the publication of the **Warsaw from Space** report.[19] The Warsaw climate map was directly inspired by the Region Stuttgart Climate Atlas[20].

Figure 11 Example of climate service developed for the Warsaw Climate Map: link between the biologically active surface and air temperature in the city. Source: Dr Wojciech Szymalski, Fundacja InE[21]

[19] ADAPTCITY. About the project. http://adaptcity.pl/english/about/ [accessed on 08/03/2025]

[20] ADAPTCITY. Mapa klimatyczna Warszawy. http://adaptcity.pl/mapa-klimatyczna-warszawy/ [accessed on 08/03/2025]

[21] Dr Wojciech Szymalski, Fundacja InE. Mapy klimatyczne m.st.Warszawy. Klimatyczne Forum Metropolitalne - Łódź 5-6.03.2018. http://adaptcity.pl/wp-content/uploads/2018/03/Mapy-klimatyczne-m.st_.Warszawy.pdf [accessed on 08/03/2025]

The creation of the Warsaw Climate Map involved several key steps including:

1. Data Collection and Analysis:
    - The city conducted a thorough analysis of the existing environmental conditions, collecting data on air quality, water resources, urban biodiversity, and climate hazards such as extreme heat and flooding.
    - A database of 122 indicators was developed to assess the overall state of Warsaw's environment, guided by the EBRD Green Cities program methodology.
2. Climate Change Hazards Mapping:
    - A spatial presentation on the city map, identifying areas at risk for flooding, heatwaves, and other climate-related hazards. Approximately 66% of residents are exposed to an increased risk of severe heat, especially in downtown districts such as Śródmieście, Ochota, Wola, Mokotów, and parts of Praga-Północ and Praga-Południe.
    - Flood risk due to increased frequency and intensity of rainfalls was mapped, especially affecting districts in the south of Warsaw and the city center.

Published in 2019, the Warsaw adaptation strategy includes a climate risk assessment, from which adaptation options were derived. The strategy presents the city's adaptation priorities and lines of action, as well as insights into the document's implementation[22].

The Green City and Climate Action Plan (GCCAP) for Warsaw aims to support the city in reaching climate neutrality by 2050 and includes a mix of short-term and long-term objectives and actions across various sectors.

Interaction with the national policy framework is ensured by aligning the GCCAP with existing national and international agreements and conventions. Specifically:

1. **Alignment with International Agreements**: The plan has been developed in accordance with international frameworks such as the UN The 2030 Agenda for Sustainable Development, the 2015 Paris Agreement, the United Nations Framework Convention on Climate Change (UNFCCC), UNECE, and the Convention on Biological Diversity (UNCBD).
2. **National and Regional Policies**: The GCCAP considers relevant local, regional, and national policies at the time of its creation. It also highlights the importance of the Environmental Protection Program, Climate Change Adaptation Strategy for Warsaw until 2030 with a perspective until 2050, and other municipal development programs.
3. **Enabling Policies and Actions**: The GCCAP lists various enabling actions, such as creating a sustainable energy investments fund, greening urban infrastructure, and more, which collectively support the city's climate goals while ensuring coherence with national and regional requirements.

[22] ADAPTCITY. City of Warsaw. The climate change adaptation strategy for the city of Warsaw by 2030 with the prospects until 2050. Urban adaptation plan. http://adaptcity.pl/wp-content/uploads/2019/11/strategia_2030-ENG.pdf [accessed on 08.03.2025]

Who are the main actors in charge of the adaptation policy in the region?

The key actors are:

1. **Department of Air Protection and Climate Policy**: Responsible for planning climate policy, reducing the city's CO2 emissions, and providing subsidies for renewable energy sources.
2. **Department of Integrated Territorial Investments**: Involved in metropolitan cooperation and the coordination of green energy production.
3. **Municipal Roads Authority in Warsaw**: Responsible for the modernization of city lighting and other urban infrastructure related actions.
4. **Districts of the City of Warsaw**: Each with its own budget and district mayor, responsible for local matters including the development of renewable energy sources in city buildings and infrastructure.
5. **Greenery Board of the Capital City of Warsaw**: Supports actions such as the protection and development of blue-green infrastructure.
6. **Municipal Energy Agency**: Will be responsible for implementing energy efficiency programs, managing renewable energy installations, and supporting the city's pursuit of energy neutrality.

Supporting and cooperating organizations include:

- **Veolia Energia Warszawa S.A.**: Company managing the heating network and supplying system heat and hot water to buildings in Warsaw.
- **Stoen Operator Sp. z o.o.**: Electricity network operator.
- **PGE Dystrybucja S.A.**: Electricity distribution network operator.
- **PGNIG Termika S.A.**: Owner of heat and power plants in the city.
- **Polska Spółka Gazownictwa Sp. z o.o.**: Gas distribution system operator.

Additionally, various non-governmental organizations (NGOs), local community groups, private and municipal enterprises, and academic institutions also play a role in supporting and implementing the adaptation policies and actions within Warsaw.

How are climate services referred to in the regional policy framework and the instruments used for its implementation?

References to Climate Services:

1. **Monitoring and Reporting**: Regular updates and monitoring of the greenhouse gas (GHG) inventories are critical. The city is committed to compiling GHG inventories at least every two years with data no older than three years. This enables comprehensive assessment and adjustments to the climate action plan as needed (pg. 325).

2. **Emission Scenarios and Modelling**: The city carried out modeling exercises using tools like the C40 'Pathways tool' to assess different emission scenarios and develop evidence-based strategies to link these targets to the GCCAP strategies (pg. 97-100).
3. **Data Collection and Indicators**: A database of 122 indicators was developed to assess the state of Warsaw's environment. Indicators were categorized to describe the pressures on the environment, the current state, and the extent of ongoing actions to address environmental changes. This indicator database supports prioritization of actions within the GCCAP (pg. 45-47, 74).

Instruments Used for Implementation:

1. **Municipal Energy Agency**: The creation of the Municipal Energy Agency aims to oversee energy efficiency programs, manage installations of renewable energy, and support the transition to climate neutrality. It acts as a central body for collecting and integrating data related to energy efficiency improvements (pg. 219).
2. **Urban Adaptation Plan**: The Climate Change Adaptation Strategy for Warsaw by 2030 was developed to analyze the impacts of climate changes, present priorities, and actions required to enhance city-wide resilience. This plan is integrated into the GCCAP and supports the city's long-term adaptation efforts (pg. 391-394).
3. **Indicator Database and Stakeholder Involvement**: The development of an indicator database that informs the prioritization of actions and a robust stakeholder engagement process assures the broad participation of city departments, community organizations, and businesses in the climate action planning process (pg. 45).

How climate services are integrated in the policy framework at regional and local Levels

Urban Adaptation Plans

- *Local Risk Assessments: Climate services provide localized data and risk assessments that help cities develop specific adaptation plans. For instance, Urban Adaptation Plans for cities with populations over 100,000 use climate data to identify vulnerabilities and plan corresponding actions.*
- *Implementing Local Measures: Local governments use climate services to guide the implementation of adaptation measures such as improving urban infrastructure resilience, managing flood risks, and addressing heatwaves.*

Regional Collaboration

- *Inter-regional Projects: Climate services support regional collaboration efforts, such as flood management and river basin projects, by providing data on regional climate impacts and facilitating coordinated responses.*

The Warsaw adaptation strategy involves significant stakeholder engagement and addresses local vulnerabilities while considering broader regional and national policies. The strategy is an example of vertical integration, where national guidelines and EU commitments are localized based on specific urban needs.

Thus, the climate adaptation policy implementation process in Poland is organized through a combination of horizontal governance, which integrates policies across sectors, and vertical governance, which coordinates policy implementation between national, regional, and local levels.

Ecosystem of actors and climate services co-creation processes

The ecosystem of actors involved in climate adaptation and risk management in Poland relies heavily on climate services for co-creating effective policies and actions. At the national level, key actors include the Ministry of Climate and Environment, the Institute of Environmental Protection (IEP-NRI), and the Institute of Meteorology and Water Management (IMGW-PIB). These institutions coordinate climate data collection, risk assessments, and policy implementations using climate services. Regionally, cooperation between neighboring municipalities and regional bodies focuses on large-scale projects like flood management and river basin conservation, with climate data supporting inter-regional strategies.

In Warsaw, the Climate Change Adaptation Strategy by 2030 involves a network of local actors including municipal departments, NGOs, community organizations, and businesses. The strategy is supported by the Warsaw Green City and Climate Action Plan, which promotes citizen engagement through initiatives like the Warsaw Climate Panel. This panel fosters democratic decision-making by involving residents in climate-related decisions. The Klimada 2.0 Project further enhances knowledge sharing by providing a comprehensive database of climate adaptation resources.

This multi-level governance structure ensures that climate services inform policy decisions from national to local levels, fostering resilience and sustainable development through shared data, collaborative planning, and stakeholder engagement.

Delivery and uptake of climate services

Climate services are delivered through various institutions and platforms, providing essential data, tools, and information to support climate adaptation and risk management. In Poland, key providers include the Institute of Environmental Protection (IEP-NRI) and the Institute of Meteorology and Water Management (IMGW-PIB), which offer comprehensive databases and risk assessment tools through projects like Klimada 2.0. These services are made available to national and local governments, researchers, and the public via online platforms and specialized reports.

However, there are limitations to their utilization. Challenges include data accessibility, the need for specialized knowledge to interpret complex climate models, and the integration of climate data into decision-making processes. Additionally, regional disparities in capacity and resources can hinder the effective use of climate services. Ensuring continuous updates and maintaining the accuracy of climate

data are ongoing concerns. Despite these challenges, concerted efforts in training, stakeholder engagement, and capacity building are essential to maximize the benefits of climate services and ensure their effective uptake across all governance levels.

Standardization opportunities, requirements and constraints

Standardization of climate services presents both opportunities and challenges in enhancing the effectiveness of climate adaptation and risk management. Opportunities include the development of uniform data formats and protocols, which facilitate the sharing and interoperability of climate information across different platforms and stakeholders. Standardization can also improve the reliability and comparability of climate data, leading to more consistent and evidence-based decision-making processes.

However, several requirements must be met to achieve effective standardization. These include the establishment of clear guidelines and best practices, investment in infrastructure and technology to support standardized data collection and dissemination, and ongoing training for stakeholders to ensure they understand and can effectively use standardized climate services.

Constraints include the diversity of climate data needs across different sectors and regions, which may require flexible approaches rather than rigid standards. Additionally, the integration of standardized climate services into existing governance frameworks and decision-making processes can be complex, requiring extensive coordination and collaboration among various actors. Overcoming these constraints involves balancing the need for consistency with the flexibility to address specific local and sectoral requirements, ensuring that standardization efforts enhance rather than hinder climate adaptation initiatives.

3.3.6 Local level case studies

Carlos Cuevas Garcia

The case of Barcelona

This case study examines climate actions and the implementation of climate services at the local level in the municipality of Barcelona. The research methods and qualitative data used to inform the case include document analysis of the main City Council and other related websites; document analysis of the Climate Plan 2018-2030, a Government Measure for the Climate Plan (Pla Clima) published in 2024 by the City Council of Barcelona, and the support to Pla Clima from the Diputacio de Barcelona (Provintial Council). In order to examine the demand and implementation of climate services, this case study draws on (1) the analysis of deliverables from the Horizon 2020-funded "RESCCUE: RESilience to cope with Climate Change in Urban arEas - a multisectoral approach focusing on water" project; (2) an interview and email exchanges with four participants in this project from diverse departments of Barcelona City Council; and finally, (3) to look beyond this Horizon 2020 project, an exploration for climate services was conducted in the portal for public procurement of Barcelona.

Climate Actions in Barcelona

Barcelona is part of the European Commission's mission "100 Climate Neutral and Smart Cities by 2030". The **Pla Clima** document points to climate commitments of the city in the last 25 years. These include the Energy, Climate Change and Air Quality Plan 2011-2020, the above-mentioned Climate Plan 2018-2030, and the Climate Emergency Action Plan 2030 and the Citizen Commitment for a More Sustainable Barcelona 2024-2034. Other plans and policies that the Barcelona City Council has signed include: the Covenant of Mayors on Energy (2008), Citizen Commitment to Sustainability (2012-2022), the Making Cities Resilient Campaign (2013), the Covenant of Mayors on Adaptation (2014), the Paris Declaration committing cities to the fight against climate change (2015), Barcelona's Commitment to the Climate (2015), and the Compact of Mayors (2015). Additionally, both plans, the 2018-2030 and the 2024 one, include long lists of measures and strategic plans that are relevant for climate change. The image below reproduces the list included in the 2018-2030 plan.

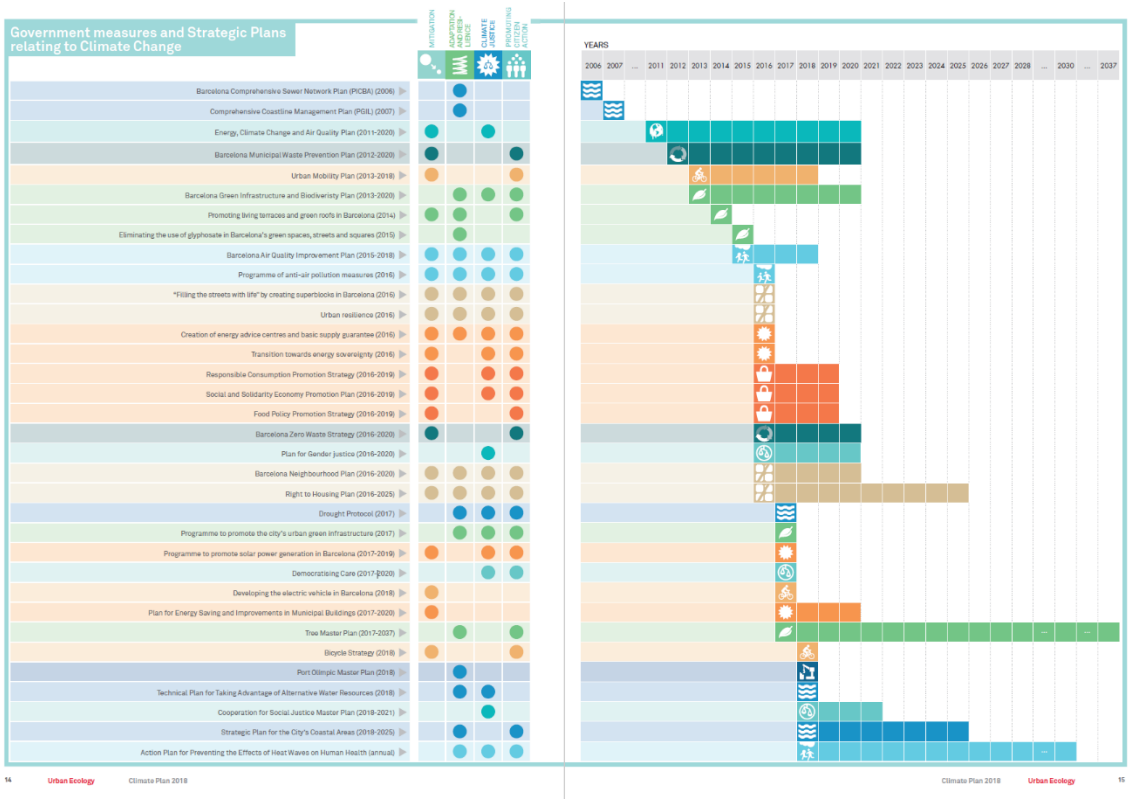


Figure 12 Government Measures and Strategic Plans relating to Climate Change (source: Barcelona Climate Plan 2018-2030)

Climate Plan 2018-2030 and Pla Clima also include goals and lines of action for both climate change adaptation and mitigation. To keep the focus on climate services and rapidly move forward to the next section, the goals and lines of action are not reproduced here. However, it is important to point

out that the Climate Plan 2018-2030 is much more elaborated and provides a broad range of specific actions.

Climate services actors and processes for climate adaptation policies, decision making and planning in Barcelona

The elaboration of this case study draws on the Climateurope2 project deliverable **D.4.2 Initial state of the market: actors, sectors, terminologies**. The deliverable collected general information of 75 European funded projects oriented to facilitate the development of climate services. It classified these projects according to the sectors they focused on and the type of partners that formed each project consortia (e.g. private and public sector, research organizations, etc.). In the context of Climateurope2 WP5, we further examined diverse documentation of projects that involved public sector organizations. In the case of Barcelona, only the projects "RESCCUE: RESilience to cope with Climate Change in Urban arEas" and "Climate-fit.City: Pan-European Urban Climate Services" included public entities from Barcelona. Earlier work with organizations involved in the RESCCUE project encouraged us to examine this project in more detail. Furthermore, while RESCCUE is mentioned in the two plans of Barcelona (2018-2030 and Pla Clima 2024), Climate-fit.City is only mentioned in the former. Thus, we assumed RESCCUE deserved, at least for now, more attention. Besides the City Council of Barcelona, the Barcelona Metropolitan Area, a governmental entity constituted by representatives of 36 municipalities, is currently involved in the Horizon Europe funded project "ICARIA: Improving Climate Resilience of Critical Assets."

Besides these European-funded projects, a search in the Portal for public procurement of Barcelona (https://licitacions.bcn.cat/) reveals that the City Council has made a call for tenders for climate services oriented to strengthen the Pla Clima described above. However, only one result was identified in the period 2019-2025. The only result is for "*Support and advisory service for the promotion of the Climate Plan, based on the definition of a specific governance model and support for the Management's technical team in the creation and implementation of the Technical Promotion Office*." The call for tenders was open from 17 to 24 February 2025. The proposed budget is 14.900,00 EUR. The requested services include (copied from a direct translation):

- Critical analysis of the Climate Plan Governance Measure, identifying strengths and areas for improvement, especially with regard to the integration and development of the link between climate action and economic promotion.

- Definition of the most appropriate governance model for the Plan, considering the diversity of stakeholders concerned, which ensures efficient coordination between the different municipal departments and external stakeholders to be involved.

- Support for the technical team of the Mobility, Infrastructure and Urban Services Area Management in the creation and implementation of a technical space to promote the Climate Plan, defining the functions, responsibilities and necessary resources.

No more information is available. However, this might represent a good case to continue studying in the context of the Climateurope2 project, if and when the organizing parties are willing to share more details.

The remaining of this case study narrative focuses on the RESCCUE project and information collected from its public sector participants.

Ecosystem of climate services actors

RESCCUE was funded between May 2016 and November 2020. It was a large project with a budget of nearly 8 million EUR and 23 partners. The partners were academic organizations, climate research organizations, private consultancies, and the city councils of Barcelona, Bristol and Lisbon. It aimed to produce frameworks and tools for "assessing urban resilience from a multisectoral approach, for current and future climate change scenarios including multiple hazards" related to water (CORDIS project objective). Put in simple terms, RESCCUE aimed at producing resilience strategies to water-produced threats drawing on models showing the increase of water in 1, 10, 50 and 500 years and in current levels of water (Baseline), how these threats affected multiple infrastructural services, and how these threats could be reduced. The tools were validated in three cities, which also developed individual Resilience Action Plans. Projects such as RESCCUE are highly relevant for understanding how climate service components can be standardized because these projects establish methodologies that then are tailored to specific municipal contexts.

Despite its international and European character, RESCCUE had a strong presence of stakeholders based in Barcelona (7 in total). The project coordinator was an environmental and water consultancy called Aquatec soluciones medioambientales. Other organizations included Cetaqua, a private research foundation; the also private entity Opticits Urban Engineering; the City Council of Barcelona, the public-private organization in charge of water services Barcelona Cicle de L'Agua (BCASA), Foment de Ciutat, and Fundacio Institut de Recerca de L'Energia de Catalunya.

The constitution of the RESCCUE consortium reveals that there is a well-established level of integration and collaboration between local actors working on climate adaptation. Furthermore, Aquatec seems to be emerging as an established climate service provider. Besides RESCCUE, Aquatec is also the coordinator of the ICARIA project. In 2024 Aquatec won a call for tenders from the water authority of Madrid, which requested technical assistance to assess the impacts of climate change on the urban water cycle of Madrid. But it is also possible to see that the Barcelona-based approach to climate services is being deployed to other countries, either through the RESCCUE project, or through ICARIA.

Climate services for policy development

As mentioned above, the RESCCUE project was included in the Climate plan documents published in 2018 and 2024. In 2018, RESCCUE was included as a short-term action (2018-2020) within Line of action 18 "Let's get organized". Specifically, the document stated "18.14: Learn more about how

climate change will affect Barcelona by taking part in the European RESCCUE project (2020)" (Barcelona Climate Plan 2018-2030, p.141). Six years later, the Pa Clima states:

- **Reducing the risk of flooding due to poor drainage**

Climate change is leading to more frequent and more severe extreme weather events. Both more frequent droughts (and less average annual rainfall) and more intense episodes of rain are expected as a result. In particular, the RESCCUE [...] project predicts a 17% increase in rain intensity for a ten-year recurrence interval, with up to 197 mm/h. The flood risks under Barcelona's current rainfall pattern, without taking the climate change scenarios into account, indicate that drainage system saturation would expose 24% of the city to a high risk for pedestrians and road traffic. If you add climate change scenarios into the mix, this increases by 4% to 28%.

It is therefore crucial to improve the city's drainage capacity using either nature-based solutions (such as sustainable urban drainage systems) or grey solutions (such as upgrading the sewer network or improving the capacity of rainwater collection tanks). Improving the city's drainage and wastewater treatment has the added benefit of discharging less polluted water into the sea. (Pla Clima, 2024, p.45)

The text above reveals that the results of the RESCCUE project have been continuously taken up and used to guide further actions. An interviewee corroborated that RESCCUE's findings were relevant for completing the master plan of Barcelona's sewerage system. In addition, the Department of Ecology, Urbanism and Mobility of the City Council of Barcelona integrated the models developed during the RESCCUE project into the Atlas of Resilience (https://coneixement-eu.bcn.cat/widget/atles-resiliencia/). The Atlas also includes earlier climate projections produced by the Fundacion para la Investigacion del Clima (FIC), the Meteorological Service of Catalonia, and the public-private organization Barcelona Regional. The latter is active providing support to the City Council of Barcelona. One of our local informants referred to it as the most usual go-to climate service, with whom ongoing partnerships exist.

Climate services co-production and user engagement

It was explained above that the climate service –oriented procedures and results of the RESCCUE project were identified as helpful by the public authority end-users. But they were also co-producers of the local implementations, either by sharing climate data locally collected and by explaining the city needs. As a deliverable explains:

A huge amount of weather data was collected from the three research sites thanks to the collaboration with different entities, such as AEMet, Servei Meteorològic de Catalunya or Lisbon City Council, amongst others, in order to characterize their current climate and trends. After that, all this data was checked and homogenized to avoid noise and disruptions in the next steps (RESCCUE project E-book, p.23).

Moreover, the plan to elaborate the Resilience Action Plan for Barcelona started by looking at ongoing and existing work in this city – see step 01 below.

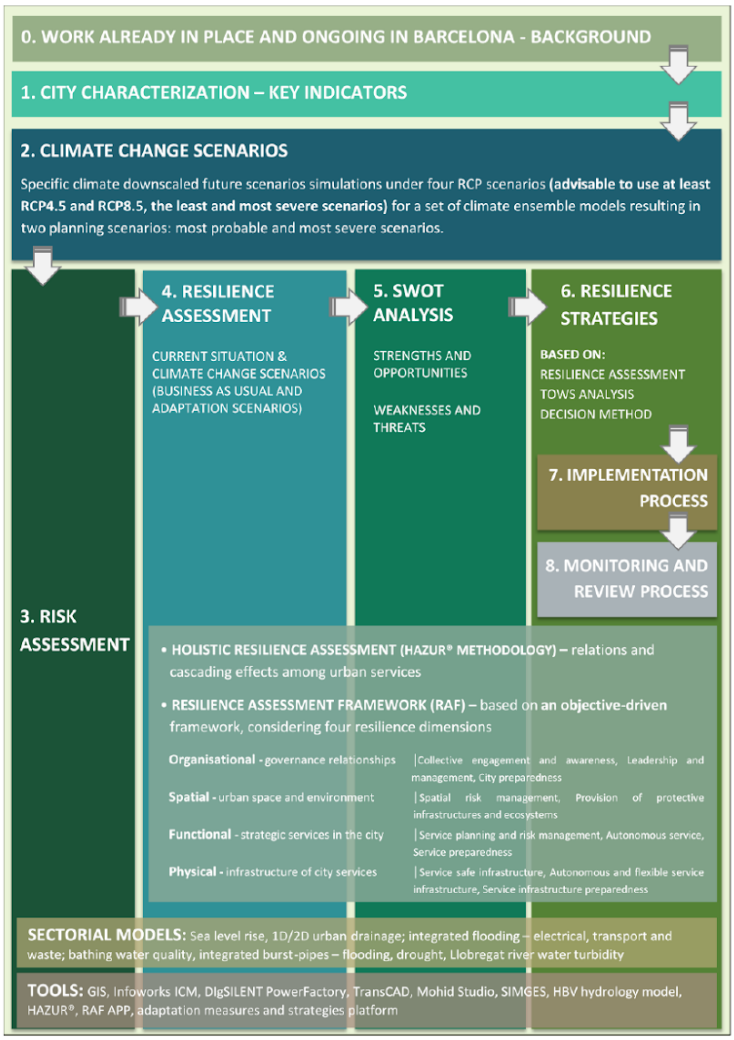


Figure 13 RESCCUE project plan (Source: Barcelona Resilience Plan 2020-2030)

Stakeholder engagement is also demonstrated in a scheme from the RESCCUE project Ebook, as the following figure shows. The images, however, leave the reader wishing to know more about which of the existing activities in Barcelona were more strongly taken up by the project consortium. The image below also explicitly includes "stakeholder engagement" only in the beginning of the process.

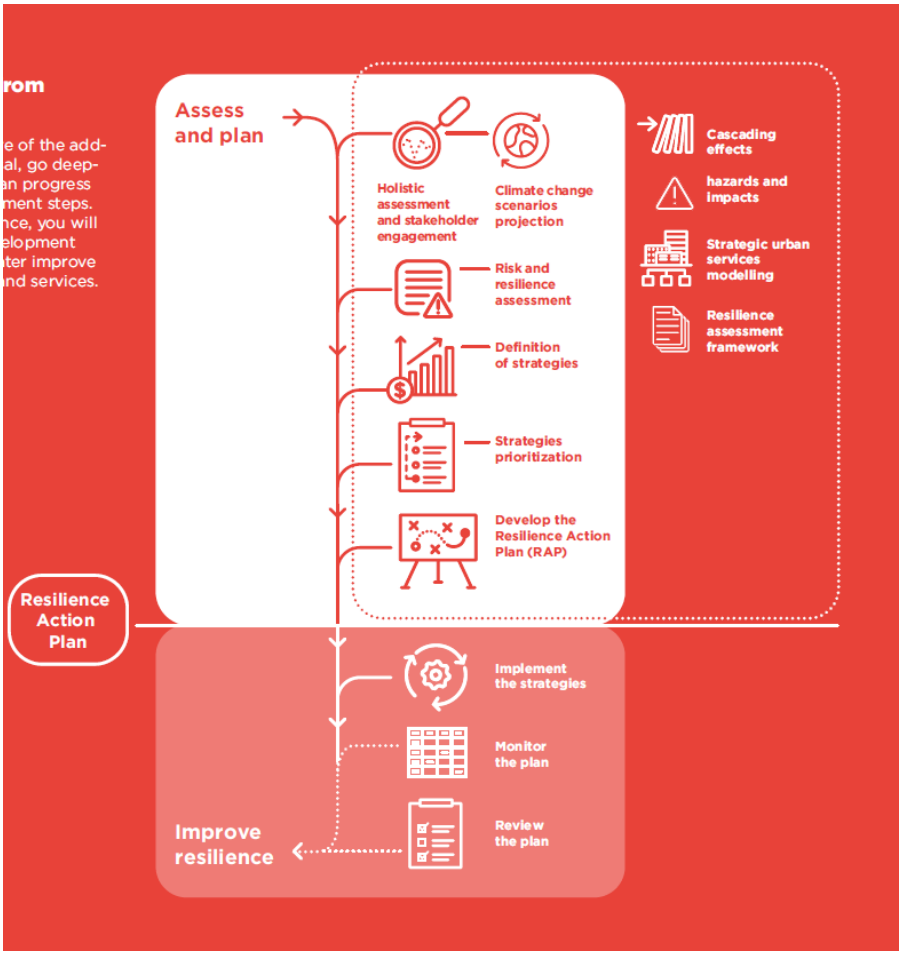


Figure 14 RESCCUE suggested co-production process (Source: RSCCUE project Ebook)

Yet, to compensate, stakeholder participation is extensively addressed in another project deliverable. Project participants from the Barcelona City Council also elaborated a deliverable entitled "D5.4 Enhanced Communication System for Stakeholder Participation". The deliverable also integrated the perspectives of public authorities from Bristol and Lisbon. The document contains advice and diverse methodologies gathered from the experience in the three cities and by academic stakeholder theory literature. It includes, in particular, participatory resource management and studies focused on participatory urban resilience. A self-descriptive account of the project and its co-creation and co-production processes reads:

The RESCCUE project has been a real opportunity for three research sites to enlarge their experience in the field of stakeholders' co-creation and co-production processes. Aware of the importance of developing projects based on consensus and cooperation, the consortium's partners adopted a collaborative and open attitude from the beginning of the project where communication has been a key element in the success of research, study and development tasks of the different tools generated with the purpose of facilitating cities to improve their knowledge of the resilience of urban services and increase their capacity to anticipate, respond and recover from adverse climatic phenomena that the

future holds for urban environments. The internal relationships created by the partners of the RESCCUE project have facilitated an environment of collaboration and mutual recognition of the capabilities of each participant in a wide range of scientific fields that have managed to converge towards a common goal. In this sense, the role played by local governments, exercising their leadership has been able to generate the appropriate means for the conjugation of the holistic approach and the sectorial approach of the project in large part thanks to the experience in conducting participatory processes, both at the local level and in participation in international networks. Good examples of co-creation and co-production within the project can be seen in the generation of the database of adaptation measures and strategies or the development of the resilience assessment framework (RESCCUE project deliverable 5.4, 2020, p.81).

The case of Barcelona is possibly very different from other locations. Since 2017, the City Council approved Citizen Participation Regulations "setting out the rules for promoting and developing participatory democracy in Barcelona" (RESCCUE project deliverable 5.4, 2020, p.12). The regulation contained 116 articles and a number of additional provisions, however it was abolished and updated in 2022. The new regulation contains 112 articles and additional provisions. To name a couple of features of these regulations, they include a chapter on digital participation and states that citizens can directly decide on how a certain percentage of the city budget should be spent. But one should bear in mind that these regulations are much broader than climate adaptation actions, and that these were presented in the RESCCUE project to discuss only about urban resilience.

Discussion

Barcelona and the RESCCUE project are interesting examples to think of best practices and standardization of climate services. However, it is of utmost importance to bear in mind that the three cities where the RESCCUE toolkit was implemented are very particular and those successes may not be so easily transferred elsewhere. As the project coordinator stated, Barcelona, Bristol and Lisbon, "were selected because of their strong engagement with urban resilience, as demonstrated by their selection and participation in the 100 Resilient Cities program founded by The Rockefeller Foundation" (RESCCUE project Ebook, 2020, p.6). Moreover, it would be illusive to expect that other cities would establish regulations for citizen participation just like Barcelona. The unique case of Barcelona and their highly situated modes of exercising citizenship have been formed by decades if not centuries of continuous efforts and negotiation of its inhabitants. In these regards, the possibilities of co-production are closely entangled with the climate service "decision context" component.

This short case study presents a number of limitations that should be acknowledged. First, the direct experience of public sector participants and of other consortium members are limited. Since the project was completed five years ago, many of them have moved on in their personal and professional careers and have not yet been willing to share their direct opinions. Second, the search for climate service procurement in the Barcelona portal can be enhanced by using more search keywords.

The next Climateurope2 deliverable (5.3) will continue exploring the experiences of other climate service-oriented projects that have implemented similar methodologies – therefore semi-standardized processes – in the production of climate adaptation and mitigation strategies.

Utilization of climate services in Germany at regional and local levels

Grit Martinez

In 2024 the German Competence Centre for Climate Impacts and Adaptation (KomPass) invited members of the KlimAdapt Provider-User Network to a meeting where the results of an interview series on the utilization of climate services in Germany were presented and discussed (UBA, 2024). These interviews were conducted between September and October and their results presented in December 2024. In total, 24 interviews targeted regional and local decision-makers—including state and local government representatives, environmental organizations, civil society groups, companies, trade associations, researchers, and media professionals—to assess the utilization of climate services in their community. The survey was also addressing the needs for standards on which climate services are based without further differentiation in terms of specific standards used or requested.

The interviews aimed to

- Evaluate the practical benefits and added value of climate services.
- Identify barriers to their use.
- Determine additional needs concerning the type, characteristics, and areas of application of climate services.

1. Added Value of Climate Services

- Recognizing risks and the need for action.
- Developing and planning (implementing) measures.
- Strategy development and updating.
- Legitimizing policies.
- Sensitization and public relations.
- Networking, exchange, and learning

2. Barriers to the Use of Climate Services

- Adaptability to local conditions.
- Lack of a sense of urgency.
- Overwhelming amount of information.
- Lack of overview of available services.
- Lack of overview on portals themselves.
- Lack of interpretation aids.
- Bureaucratic hurdles.
- Timely availability.

3. Needs Regarding Characteristics of Climate Services

- Actual Needs:
  - Information on legal regulations and preparation for political developments.
  - Experiences from recent extreme events or new data.
- Application-Oriented Needs:
  - Simple explanations.
  - Problem solutions.
  - Target group-oriented preparation.
- Access Needs:
  - Freely available, verified, digital open data accessible to everyone.
- Quality Assurance Needs:
  - Bundling of scientifically sound information.
- Standardization Needs:
  - Uniform standards on which services are based and in the use of the service itself.

Figure 15 Main findings from interviews

Discussion

These interviews provide crucial insights into the current use and needs for climate services in Germany. By engaging a diverse range of decision-makers, including government officials, environmental organizations, companies, and researchers, the results highlight both the benefits and challenges in the application of climate services at regional and local levels.

One of the key findings is that climate services are widely recognized for their value in identifying risks and informing action. They support the development of strategies, legitimizing policies, and enhancing public awareness and engagement. These services also foster networking and knowledge

exchange, which are essential for building resilience and adaptive capacity. However, despite these advantages, several barriers hinder the broader utilization of climate services. Notably, the adaptability of these services to local conditions, a lack of urgency among stakeholders, and the overwhelming amount of information available, which often lacks clear interpretation aids, pose significant challenges. The complexity and bureaucratic hurdles associated with accessing and implementing climate services also limit their effectiveness.

The Case of Ammerland, a rural district in Northern Germany

Werner Krauß

Multi-Level Governance and Climate Protection Initiatives: The Case of Ammerland, a rural district in Northern Germany

This case presents insights from research in the rural district of Ammerland, an administrative unit in Lower Saxony (Germany), consisting of several municipalities. The research focuses on climate protection initiatives, encompassing both mitigation and adaptation strategies and structured along questions concerning the use of climate services and standards, based on the four-components approach of Climateurope2 described earlier in this report. The material is derived from desktop- and literature research, ongoing ethnographic fieldwork in Northern Germany, active participation in a local climate initiative, and several participatory activities and interviews.

The main emphasis is on the implementation of so-called "climate managers," a recent development in German climate governance that has already been established in thousands of municipalities, and on a local climate initiative of concerned citizens ("Klimamarkt Ammerland"). The first part illustrates the structure of multi-level climate governance in Germany, followed by a description of the role of climate managers and the preparation of an Integrated Climate Protection Strategy (IKK) in selected municipalities, including the role of private consultants in climate data management. Finally, grassroots-perspectives of the Climate Market (Klimamarkt) initiative will be acknowledged.

Multi-Level Governance and Climate Protection

Climate adaptation and mitigation policies are implemented within a multi-level governance framework, involving national, regional, and local authorities, as well as private sector actors and civil society organizations. In Germany, climate governance is structured across different levels:

- **European Level**: The European Green Deal provides overarching targets for climate neutrality and adaptation, influencing national and regional policies.
- **Federal Level**: The federal government establishes overarching climate policies and targets, such as the Climate Action Plan 2050, which outlines Germany's strategy to achieve greenhouse gas neutrality by 2050. Enactment of laws like the Federal Climate Change Act (Klimaschutzgesetz) sets binding emission reduction targets and mechanisms for monitoring progress. The Climate Adaptation Act (KAnG) and the National Climate Initiative (NKI) provide funding and guidance for regional and local climate actions and help to ensure that Germany reaches its goal of climate neutrality in 2045.

- **State Level (Länder)**: The 16 federal states develop and implement their own climate action plans, aligning with federal objectives but tailored to regional contexts, such as regional climate strategies and support for municipalities in developing adaptation plans.
- **Local Level**: Cities and municipalities implement specific climate projects, such as promoting renewable energy installations, enhancing energy efficiency, and developing sustainable urban mobility plans. They initiate their own climate protection strategies, formerly under the umbrella of Agenda 2000 or other sustainability strategies and applies state and federal directives. Districts coordinate between municipalities and provide additional support for local climate actions.
- **Municipal Level**: Implements climate policies through integrated climate protection concepts (IKK) and local climate managers who coordinate actions with stakeholders.
- **Public Engagement:** Local governments engage with communities to raise awareness and encourage participation in climate initiatives.

This multi-level governance structure reflects how decentralized political systems address the challenges of climate change. It highlights the principle of subsidiarity, where climate action is delegated to the lowest effective administrative level. However, municipalities often face challenges in integrating climate policies into local planning due to coordination complexity, funding constraints and (lack of) policy coherence.

Case study: climate protection and adaptation in the district of Ammerland / Lower Saxony

The administrative district of Ammerland consists of four municipalities (parishes), which have developed local climate strategies under the framework of the NKI and other funding programs. The case study focuses on the municipality of Edewecht. Mitigation (reducing emissions) and adaptation (adjusting to impacts of a changing climate) are both key aspects of their climate strategies.

The "Integrated climate protection concept" (Integriertes Klimaschutzkonzept IKK) of Edewecht (Ross 2022) is an example of local climate governance in action. Developed as part of the National Climate Initiative (NKI), the IKK aims to reduce greenhouse gas emissions and enhance climate resilience at the municipal level. The program is quite successful; by the end of 2019, 3650 municipalities had employed a climate manager (Klimaschutz Niedersachsen).

Climate managers

A climate manager (Klimaschutzmanager*in) is a professional responsible for planning, coordinating, and implementing climate mitigation and adaptation strategies at the local, regional, or institutional level. Climate managers often work within municipal governments, regional authorities, or organizations and play a key role in ensuring that climate policies are translated into concrete actions.

Their work focuses on reducing greenhouse gas (GHG) emissions, increasing energy efficiency, facilitating climate adaptation measures, engaging stakeholders and the public, and securing funding and managing climate-related projects.

The role of climate managers implies strategic planning and implementation, such as to

- develop and oversee local climate action plans (e.g., integrated climate protection concepts – Integrierte Klimaschutzkonzepte).
- align municipal strategies with national (e.g., Climate Action Plan 2050, Federal Climate Protection Act) and international climate goals (e.g., EU Green Deal, Paris Agreement).
- identify priorities for mitigation and adaptation, such as energy transition, sustainable mobility, or nature-based solutions.
- act as a link between government, businesses, NGOs, and citizens to ensure broad participation in climate initiatives.
- organize public consultations, workshops, and awareness campaigns to foster local engagement.
- work closely with urban planners, industry representatives, and environmental organizations to integrate climate goals into broader development policies.
- secure financial support from national and EU programs, such as the National Climate Initiative (NKI) or EU LIFE programs.
- manage budgets and oversee the implementation of specific projects, such as energy efficiency programs, sustainable transport projects, or renewable energy installations.
- track progress on climate action goals and report on GHG emission reductions and other key performance indicators.
- assess the effectiveness of local climate policies and adapt them as necessary.
- provide data for national and regional climate reporting requirements.
- advise local decision-makers on integrating climate considerations into urban planning, infrastructure investments, and zoning regulations.
- advocate for stronger climate policies at the regional and national levels.
- work with external research institutions to apply scientific insights into local policymaking.

In Germany, climate managers are often funded through the National Climate Initiative (NKI), which provides subsidies for municipalities to hire professionals dedicated to climate protection. Their role is embedded in Germany's multi-level governance system, working between federal, state, and municipal levels to ensure climate policies are effectively implemented at the local scale.

Climate managers play a crucial role in translating climate policies into local action. They serve as key facilitators in multi-level climate governance, ensuring that national and international climate goals are implemented in practical, community-based initiatives. However, to maximize their impact, they require strong political support, adequate resources, and long-term institutional frameworks. The program is quite successful; by the end of 2019, 3650 municipalities had employed a climate manager (Klimaschutz Niedersachsen).

Despite its success, the implementation of climate managers is highly contested in many places. In various municipalities in Northern Germany and elsewhere, enraged politicians vehemently argued against 'another administration', another 'bureaucratic nuisance' or a 'green paper tiger' expected to cost a lot of money in the long run. Others considered climate managers as agents of the 'green ideological agenda'(Krauß 2023). In other municipalities and districts, the process went more smoothly; climate managers were welcomed and served as a sign that climate change is a matter of municipal concern.

Furthermore, climate managers have a difficult career track. Mostly fresh from university, they are to the larger part financed for two years by the NKI. After the completion of the IKK report, the municipalities must consolidate their position; in one of the cases in the district of Ammerland, the contract with the climate manager was ended after the delivery of the IKK report. Communal politics often are based on established networks between an administration, personal and/or party affiliations and representatives of various public interests, and it can be difficult to establish new issues on the political agenda (Krauß 2023). In the Ammerland municipalities, the reports were accepted by the local parliaments.

The Role of Private Consultants and BISKO Standards

Private consultants play a crucial role in assisting municipalities with greenhouse gas (GHG) accounting in accordance with the BISKO (Bilanzierungs-Systematik Kommunal) standard. The Municipal Accounting System (BISKO) was developed in 2014 as part of the National Climate Initiative (NKI) project to enable uniform and therefore comparable GHG accounting in German municipalities. Since then, BISKO has established itself as the central accounting standard, but it is not an ISO or DIN standard. Almost three quarters of current municipal GHG balances have been prepared according to the BISKO standard (UBA 2024).

The calculation of emission values is based on a combination of data collection, modeling and analysis. Here are the steps performed in the process of calculating emissions according to the BISKO standard:

- **Collection of relevant data:** Data is collected on current emission sources at the municipal level, e.g. from transportation, industry, residential buildings, agriculture and energy consumption. This data is taken either from local statistics, building and energy consumption data or measurements.
- **Determination of emission factors:** Emission factors are the measures of how much CO_2 or other greenhouse gases are released per unit of activity. These factors can be taken from existing databases (e.g. from the Federal Environment Agency or international sources such as the IPCC) or adapted locally.
- **Modeling and calculation:** Emissions models are used to calculate emissions for different sectors of the municipality. The models consider both the current status and potential changes due to planned climate adaptation measures, such as the use of renewable energies or improving energy efficiency in buildings. From here results the modeling of future climate scenarios at local level
- **Consideration of adaptation measures:** To assess the impact of climate adaptation measures on emissions, scenarios are developed based on the planned measures. For example, switching to green infrastructure, improving water retention or promoting cycling could lead to a reduction in emissions, which are included in the calculations.
- **Monitoring and reporting:** The calculated emission values are regularly reviewed and summarized in a report. These reports serve as a basis for the regular evaluation and adjustment of the climate protection strategy at municipal level. In many cases, the results are also published for the public to ensure transparency.

The increasing demand for specialized services has led to the emergence of a growing market for climate consultancies. Diverse private companies provide professional GHG accounting services,

supporting municipalities and businesses in measuring, managing, and reporting their carbon footprints. The climate managers are in permanent contact with the chosen private consultants who help to fulfill the requirements of the BISKO standard.

Elements of the IKK

The municipality of Edewecht has developed a climate protection concept that serves as a strategic basis for action for local climate protection. This concept was drawn up with the broad participation of various stakeholders and takes into account the regional technical and economic possibilities. It comprises 32 climate protection measures and defines four overarching climate protection goals:

Reduction of greenhouse gas emissions:

By 2030: reduction of 45% compared to 2019

By 2035: 60% reduction compared to 2019

By 2045: Reduction of 84% compared to 2019

Renewable energies: By 2030, 100% of the municipality's total electricity requirements are to be covered by locally generated renewable energy.

A particular focus of the climate protection concept is on moorland protection. As around 46% of Edewecht's area consists of moorland and drained moors release considerable amounts of greenhouse gases, the municipality is planning measures to rewet and sustainably use these areas. The aim is to reduce CO_2 emissions and promote biodiversity at the same time.

To support citizens, the municipality has introduced the "Edewechter Klimabonus", which will continue in 2025. This support program offers financial incentives for climate-friendly measures and investments.

The climate managers involve a steering group at a very early stage, made up of business, agriculture and sustainability groups, which then accompany the development process of the climate protection concept for each field of action, discuss the individual measures and made suggestions for improvement. (https://edewecht.de/klimaschutzkonzept/)

Discussion: climate service components in the Edewecht Climate Strategy

Decision context

In Edewecht and the district of Ammerland, the decision context is shaped by both national climate protection laws and state-wide initiatives (e.g. the Climate Protection Act in Lower Saxony). At municipal level, climate protection is further substantiated by specific programs and initiatives, such as the "Moorkataster" or the "Solarkataster" as developed in the IKK. These programs reflect a combination of bottom-up and top-down decisions.

The national level sets the framework through laws and targets (e.g. the Paris Climate Protection Agreement, the Climate Protection Act of Lower Saxony), while at the local level the concrete implementation and adaptation to local conditions takes place through climate managers, but also through the commitment of municipalities and companies. Subsidiarity comes into play here by giving

municipalities and districts the responsibility to develop and implement concrete measures that meet their specific needs and possibilities.

Ecosystem of actors

The "ecosystem of actors" refers to the multitude of actors involved in the decision-making process. In Edewecht, the ecosystem includes not only the administration (climate managers, districts, municipalities), but also external actors such as companies, NGOs and citizens. A central element in this ecosystem are the climate protection managers, who act as an interface between the administration, political decision-makers and actors from civil society.

Important players in this ecosystem are

- Climate protection managers and local authorities who coordinate the implementation of climate protection measures.
- Companies that are involved in climate protection projects on their own initiative (e.g. through internal climate protection concepts) or through cooperation with local authorities.
- Citizens and local initiatives that contribute to implementation through commitment and local projects (e.g. the peatland register).
- Research institutes and advisory bodies that act as knowledge and innovation partners at regional and national level.

The cooperation of these different actors in an ecosystem of actors is central for the success of the respective climate protection strategies.

Different systems of knowledge

The diversity of actors also brings into play a variety of knowledge systems that are relevant for climate protection. These include both technical knowledge (e.g. on the efficiency of photovoltaic systems or the renaturation of peatlands) and social and political knowledge, which is necessary for mobilizing citizens and shaping political processes.

Different knowledge systems come together in Edewecht and Ammerland:

- Technical knowledge about climate protection technologies (e.g. renewable energies such as solar energy) is contributed by specialists and engineers.
- Standardized scientific knowledge derived from the IPCC, Copernicus, Gerics and others
- The creation of an "integrated climate protection concept" requires the assistance of planning offices that specialize in processes such as the collection of municipal emissions data, etc.
- Social knowledge about the needs and perspectives of the local population is taken into account through citizen participation and cooperation with local stakeholders.
- Political knowledge is provided by the administration and political decision-makers who create the framework conditions for the implementation of climate protection measures.

These different types of knowledge must be combined and integrated in a consensual decision-making process in order to develop effective climate protection strategies.

Modes of delivery and evaluation

In Edewecht and the district of Ammerland, climate protection measures are delivered through systematic controlling and the creation of specific programs such as the "Solar Cadastre" and the "Moor Cadastre". These programs are digitally accessible, which enables broad and easy use by the population.

Regular progress reports are produced for evaluation purposes, in which the effectiveness of the measures is reviewed. One example of this is climate protection controlling, in which each measure is evaluated in terms of its target achievement. Such evaluation mechanisms are crucial for checking whether the climate targets are being achieved and where adjustments may be necessary.

The mode of delivery and evaluation in this case relies heavily on transparent communication of progress and regular review of measures to ensure that the climate action plan is implemented sustainably and effectively.

Klimamarkt Ammerland

The Klimamarkt Ammerland is a citizens' initiative in the Ammerland district of Germany, dedicated to promoting climate protection and sustainability through various community-driven activities. Established in 2019, the initiative developed from a series of workshops initiated by the ERA4CS project "Co-development of climate services for action" (CoCliServ, Krauß 2023). The initiative serves as a public forum to foster dialogue, raise awareness, and implement projects aimed at reducing CO_2 emissions and preparing the community for the impacts of climate change. The author of this report, previously a researcher in CoCliServ, is still an active member in the Klimamarkt Ammerland initiative.

Main Activities of the Klimamarkt

1. **Public Climate Markets:** Organizing events where local groups, institutions, and initiatives present ideas and activities that highlight accessible and attractive pathways to climate protection and adaptation. These markets showcase the diverse engagement within the community and encourage participation in sustainable practices.
2. **Workshops and Discussions:** Facilitating workshops that encourage participants to envision a climate-friendly future for the Ammerland region. These sessions cover topics such as energy, mobility, food and agriculture, land use, water, construction, and health, leading to the formation of working groups that delve deeper into specific areas.
3. **Educational Events:** Hosting informational sessions and lectures on various climate-related topics, including sustainable heating solutions, energy independence, and the importance of biodiversity. These events aim to educate the public and provide practical solutions for everyday life.
4. **Art and Cultural Initiatives:** Organizing art competitions and exhibitions that explore the local impacts of climate change, thereby engaging the community through creative expression and fostering a deeper connection to environmental issues.
5. **Political Engagement:** Arranging dialogues with political candidates and representatives to discuss climate protection and adaptation strategies specific to the Ammerland region, ensuring that climate considerations are integrated into local policymaking.
6. **Collaborative Projects:** Partnering with local organizations, such as the BUND Ammerland, to conduct activities like guided bicycle tours focusing on upcycling in gardening and visits to herbal labyrinth gardens, promoting sustainable practices within the community and fighting against the construction of a new Autobahn crossing the moors of the Ammerland.

(source: Klimamarkt Ammerland)

Through its diverse activities, Klimamarkt Ammerland aims to shape a sustainable future for the region by fostering community engagement, education, and the implementation of practical climate solutions. As an independent initiative—without even claiming NGO status—Klimamarkt actively participates in discussions on municipal policies and the implementation of the IKK (Integrated Climate Protection Concept).

The group has protested the abrupt termination of a climate manager's contract after their work on the IKK, attended public workshops and events, and invited climate managers to participate in climate markets and discussions. However, in the long run, its members express frustration over the limited impact of these local efforts. Their main concerns include:

- **Agriculture's exclusion from the IKK**: Although Ammerland is a predominantly rural district, the IKK largely ignores agriculture due to the territorial BISKO standard, which excludes private land. Overgrazing, monocultures driven by biogas production, and EU funding policies that contribute to an "agrarian desert" and biodiversity loss are among the key climate challenges left unaddressed.
- **Minimal real-world impact**: Since the IKK applies only to public property, its effects are, some members say, largely limited to measures such as replacing windows and acquiring a few electric vehicles—changes that some members see as superficial.
- **Non-binding policies**: The IKK's scenarios require approval by the local parliament, and their implementation depends on political goodwill. Additionally, some worry that the IKK has become yet another bureaucratic burden.
- **Bureaucratic Monster**: Climate governance, Klimamarkt members fear, get increasingly stuck in the administration – due to the lack of funding, of competent administrative stuff, and of political will.
- **Climate protection as a political battleground**: Despite its foundation in science and technology, climate action remains highly dependent on political processes. Klimamarkt members increasingly discuss this challenge, especially in light of the rise of right-wing politics in Germany. Climate protection is no longer a broad societal consensus, and support for climate governance is weakening. In recent elections, climate change has played little to no role.

Given these challenges, Klimamarkt and other initiatives are exploring alternative ways to highlight the urgency of climate governance and bring it back into the public sphere.

Conclusion

The case of Edewecht and Ammerland illustrates both the potential and the limitations of municipal climate governance. While climate protection strategies rely on an intricate web of actors, knowledge systems, and policy frameworks, their implementation remains constrained by political will, administrative capacity, and systemic exclusions—most notably in the case of agriculture. The Klimamarkt Ammerland exemplifies the agency of civil society in keeping climate action on the public agenda, yet it also reveals growing frustrations with bureaucratic inertia and the political contestation of climate governance. This tension underscores a central paradox: while climate policies are

increasingly institutionalized, their real-world impact often remains marginal. Against this backdrop, the challenge ahead lies not only in refining policy instruments but in rethinking the relationship between local initiatives, governance structures, and the socio-political conditions that shape climate action.

3.4 Results from discussion with local and regional policymakers at Climateurope2 festival

On 12 March 2024, during the CE2 Festival held in Venice from 11-13 March 2024 WP 5 team met with representatives from local and regional authorities and enterprises in the U.K., Estonia, Poland, Romania, Bulgaria, Italy, and Spain. The discussion on stakeholder requirements in the context of climate services for urban adaptation highlighted several critical challenges that must be addressed to enhance the effectiveness of climate service integration into decision-making processes. Through the fishbowl format titled "Climate adaptation in urban regions: How can climate services support decision-making?", key insights were gathered on the difficulties stakeholders encounter and the areas where climate services need to be improved.

A major concern voiced by stakeholders from Eastern Europe was the lack of coherence between national and local regulations, particularly as many local regulations remain outdated and do not address emerging climate risks like heat waves and tornadoes exacerbated by urban infrastructure. This disconnection presents a significant challenge in translating climate knowledge into practical, actionable steps for adaptation. Data users, especially in public administration, often find it difficult to implement climate policies effectively, despite the availability of national and regional climate data. The real difficulty lies in converting raw data into actionable information that can drive decision-making processes.

Another significant issue raised was the inconsistency and lack of reliability in the data provided. For example, in flood management scenarios, the absence of standardized data complicates legal matters, such as determining liability for flood damages. The discussion also pointed to the social dimension of integrating climate data into decision-making. It became evident that technical solutions alone are insufficient—political and social acceptance are crucial factors. A key example discussed was the construction of urban waterfronts, where political and economic interests often overshadow climate data insights, resulting in development in flood-prone areas that could have been avoided with more informed decision-making.

In conclusion, this discussion underscored the need for improved coherence between regulations at different governance levels, more reliable and standardized data, and greater emphasis on the social dimensions of climate adaptation. Overcoming these barriers will not only help ensure the effective use of climate services but also facilitate more resilient and sustainable urban adaptation strategies in the face of increasingly complex climate risks. Addressing these challenges requires a collaborative approach, involving policymakers, data users, and communities to ensure that climate services truly support the decision-making process in urban regions.

3.5 Results from the survey

Grit Martinez

In research projects like Climateurope2 and others, we have observed a steady decline in the willingness to participate in public surveys. Despite the comprehensive introduction of this survey and collaboration with renowned institutions and widespread platforms at the EU, national, and regional levels (see section 2.3), the number of responses remained relatively low. With 73 participants, alongside empirical data from case studies conducted at national, regional, and local levels across Europe, we were still able to gather insides on the knowledge and usage of climate services and standards. The stakeholders who responded to the survey represent a diverse range of sectors, including regional and local administrations, civil society, the non-profit and private sectors, as well as researchers from universities and think tanks. The largest group of survey participants however were researchers, followed by a relatively high number of individuals who chose not to disclose their professional field of activity, selecting the "prefer not to disclose" option. This indicates also a growing skepticism towards the sharing of personal data. The remaining participants were almost equally split between regional and local administrations, civil society, the non-profit sector, and the private sector (see Figure 16). However, since only 11 participants are from the policy sphere in a narrower sense (regional and local administrations) the information obtained in this survey are a general impulse.

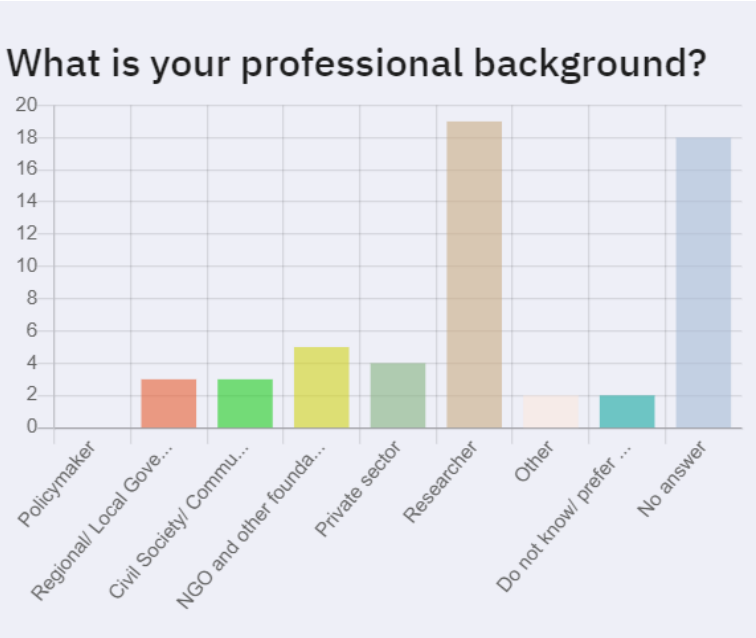


Figure 16 Respondents' professional background

Survey participants come from 13 European countries with the highest number of responses from Germany, followed by the Netherlands, Bulgaria, Italy, Sweden, France, Spain, Slovakia, Greece, Poland, Estonia, Finland and Croatia. (Figure 17)

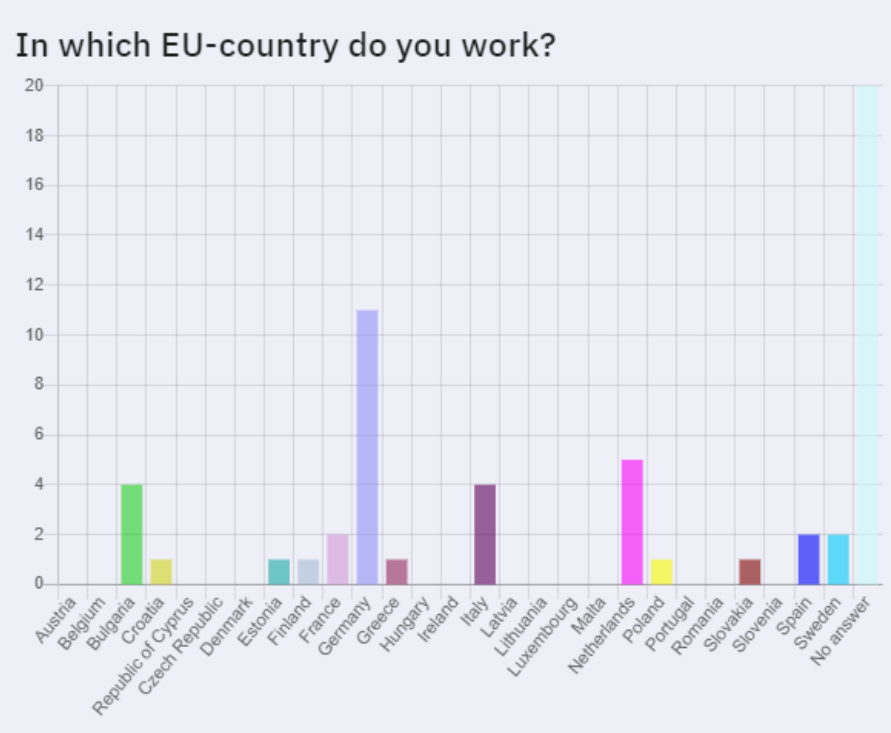


Figure 17 Respondents' countries of work

The number of participants who report occasionally using climate services for mitigation or adaptation purposes is slightly higher than those who do not. (See Figure 18). Additionally, the number of interviewees who indicated that they have never used a climate service is relatively low.

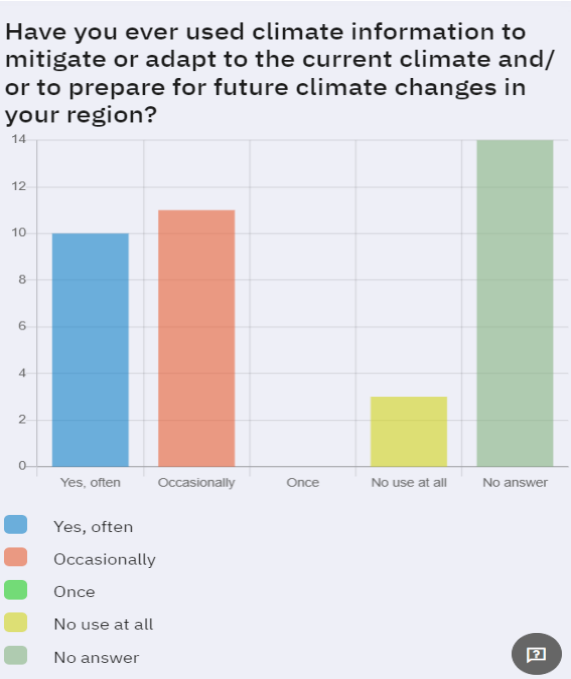


Figure 18 Use of climate information



Figure 19 Use and production of climate services

When asked about their use of or participation in the design of a climate service, a significantly higher number of stakeholders confirmed involvement compared to those who stated they had neither used a climate service nor participated in its design. However, the number of "no answers" to this question appears relatively high in comparison to the responses in the categories "yes, often," "occasionally," and "no use at all." (See Figure 19)

When asked about the reasons for using or participating in the production of a climate service, responses were distributed across all available categories. However, the most common reason cited was "To assess vulnerability impacts and/or complete a risk assessment," followed by "To implement regional or local adaptation or mitigation measures," "To monitor and evaluate whether procedures for adaptation or mitigation planning are being followed," and "To monitor or report on the progress of regional or local adaptation or mitigation strategies, plans, or measures." (See Figure 20)

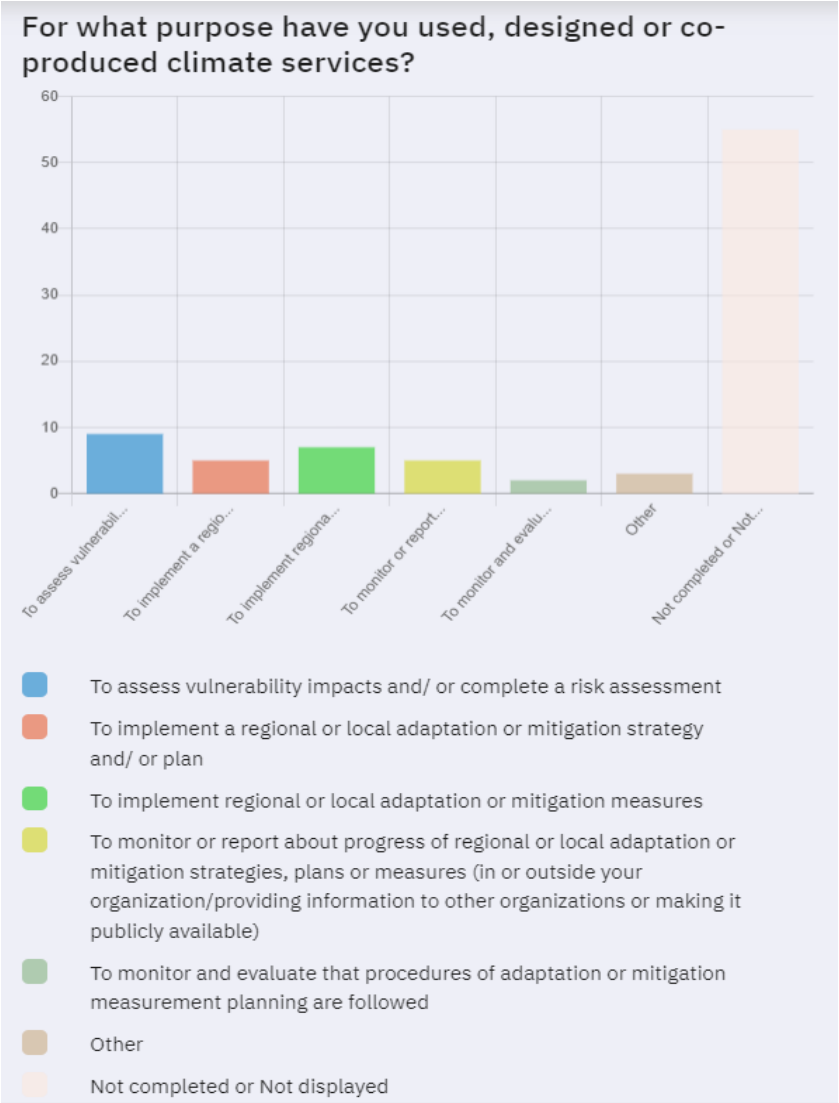


Figure 20 Purpose of production, use or design of climate services

When asked to assess the transparency and traceability of the climate data and information provided through climate services, most interviewees gave affirmative responses. (See Figure 21) In contrast, the evaluation of climate services in terms of quality and accuracy is more varied. While most ratings fall under the categories "very good/good," there are also responses in the "fair" and "poor" categories. (See Figure 22).

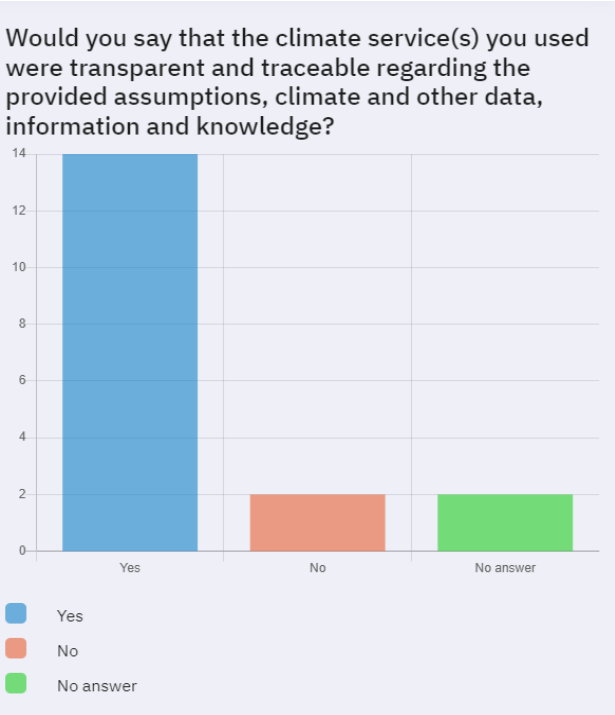


Figure 21 Respondents rating of the quality and accuracy of climate services used

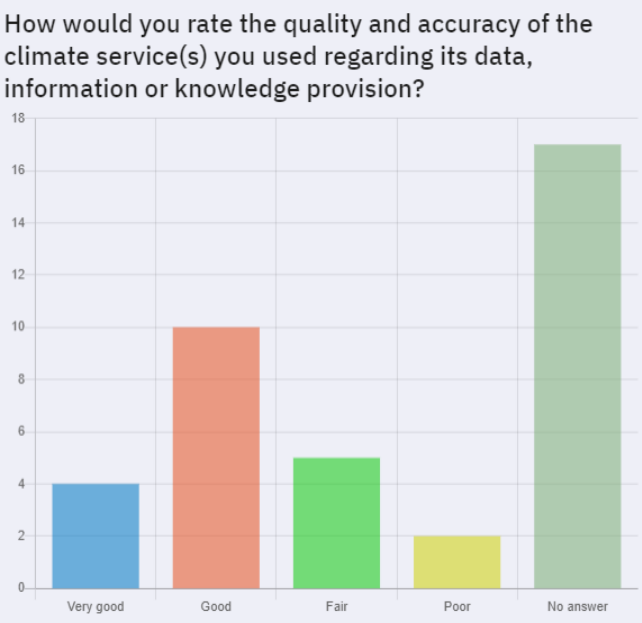


Figure 22 Proportion of respondents considering climate services used were transparent and traceable

When asked about the main challenges in using climate services (see Figure 23), "transparency and traceability regarding the provided assumptions" and "application of data and information at regional and local levels" were identified as slightly more significant obstacles compared to others, such as "quality of scientific data/accuracy for risk assessment/accessibility," "personal resources," "visions and wider system analysis to support holistic policies for multifunctional mitigation and adaptation at regional and local levels," "support from the national level," and "application by the private sector."

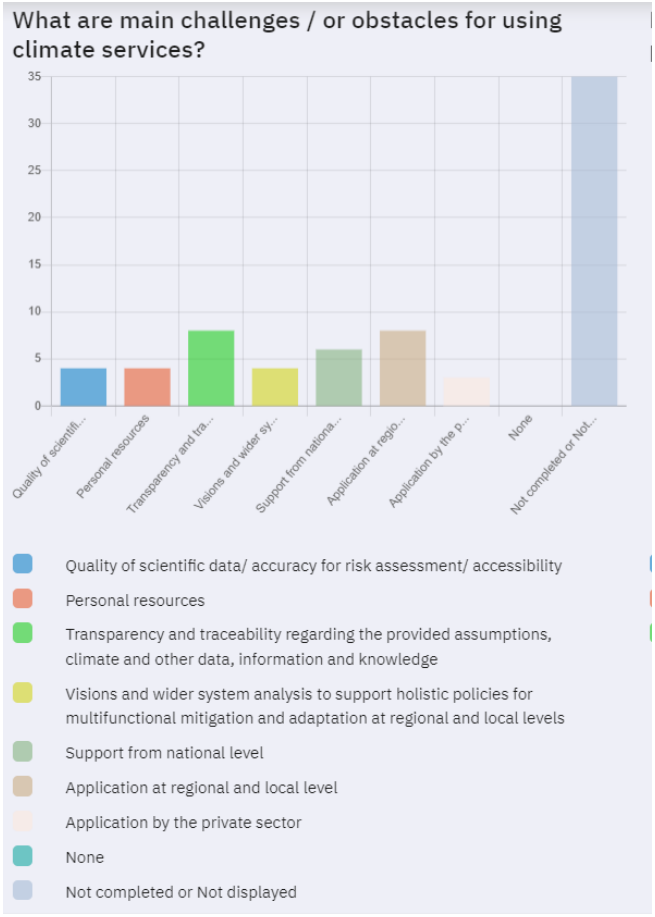


Figure 23 Main challenges and obstacles faced when using climate services

In question 9, we asked whether interviewees had previously participated in the design and/or production of a climate service. The number of participants who confirmed they had was only slightly higher than those who indicated they hadn't. As illustrated in Figure 24, interviewees who reported using climate services to generate science-based information had the highest scores, likely due to the relatively high number of participants from research institutions. This was followed by "other" unspecified types of information and, lastly, the category "evaluating products." Notably, the number of people who did not answer this question was higher than the total number of responses in all the other categories (see Figure 25).

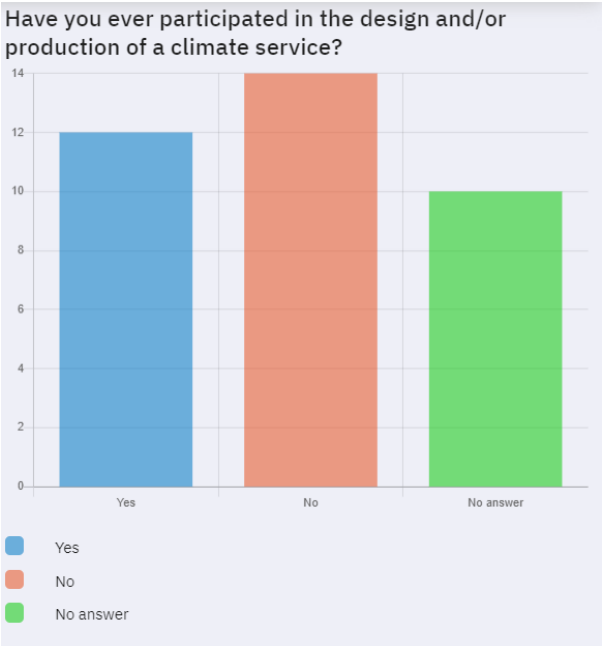


Figure 24 Respondents' participation in the design of co-production of climate services

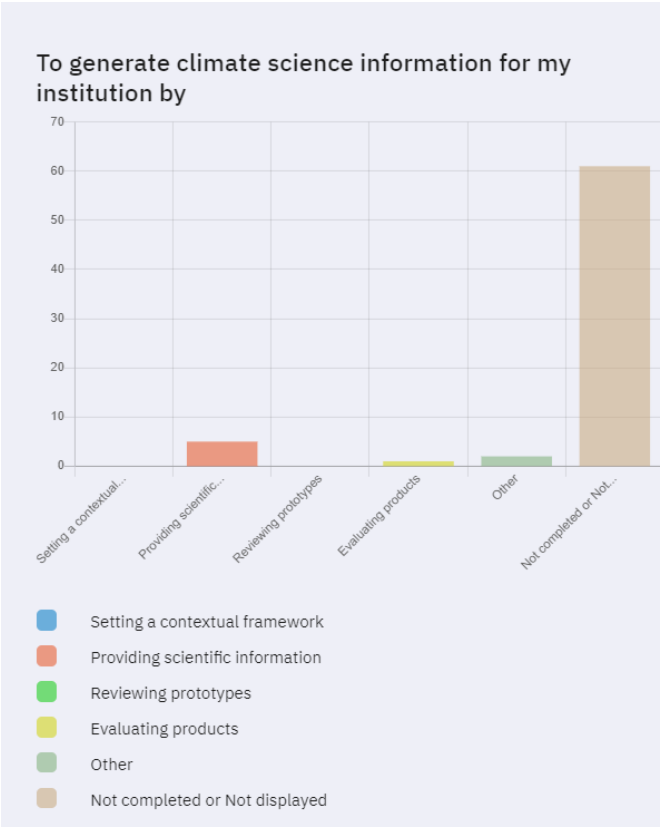


Figure 25 Ways of generating climate science information

For interviewees who participated in the production/design process of a climate service, the motivations were primarily (a) training, capacity building, and co-creation, (b) generating products and tools, and (c) other reasons (see Figure 26). They achieved this through (a) surveys, (b) benefit-cost analysis, and (c) peer reviews (see Figure 27). However, the number of interviewees who responded to both questions illustrated in Figures 26 and 27 was relatively low.

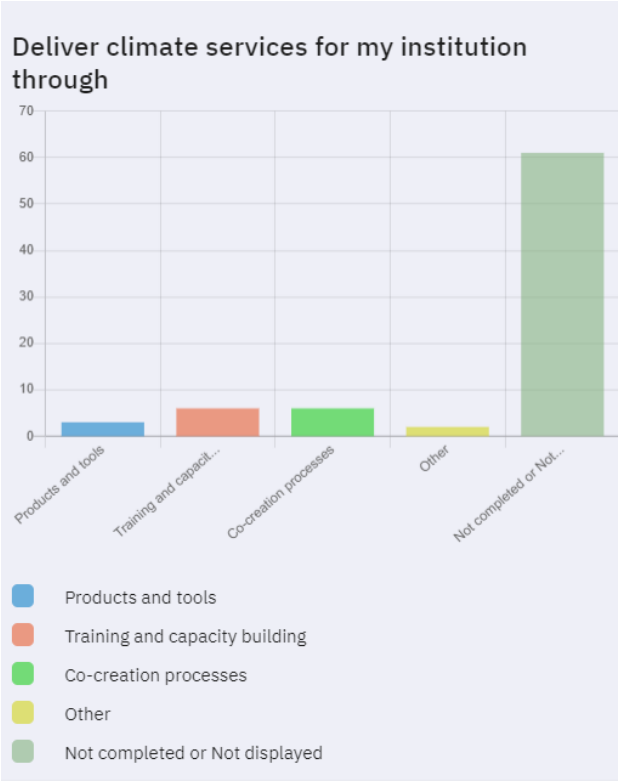


Figure 26 Items used to deliver climate services

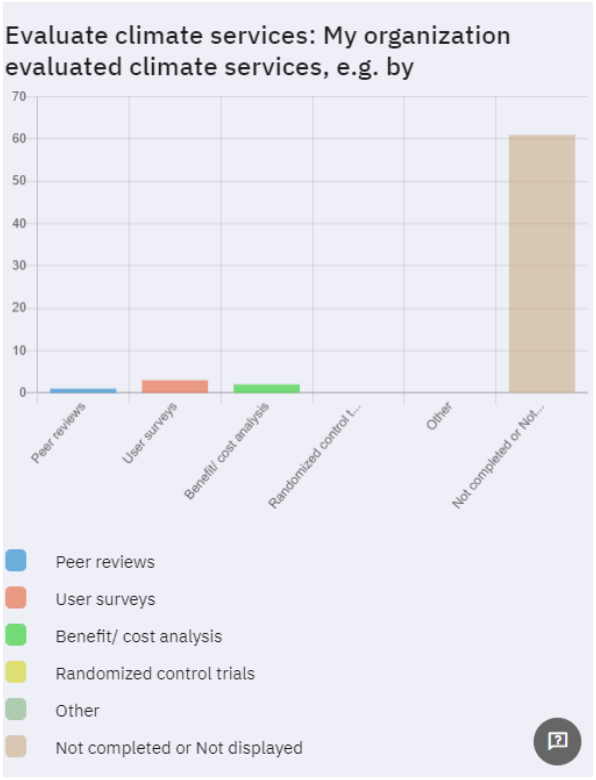


Figure 27 Climate services evaluation

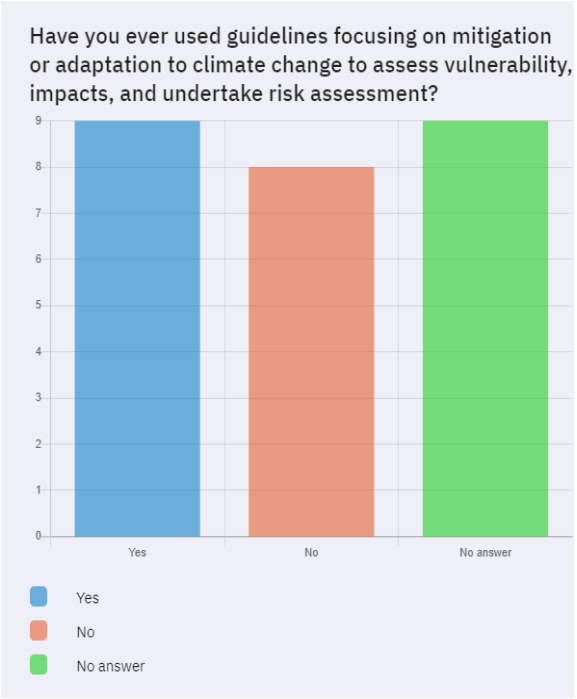


Figure 28 Use of guidelines

When asked whether they have ever used guidelines focusing on mitigation or adaptation to climate change to assess vulnerability, impacts, and conduct risk assessments, slightly more participants confirmed that they have (see Figure 28). Additionally, most interviewees indicated that they believe standards could support national, regional, and/or local mitigation and adaptation efforts (see Figure 29). The reasons named were almost equally distributed, including the provision of guiding principles, certification and labeling, examples of implementation and performance, and quality assurance and trust (see Figure 30).

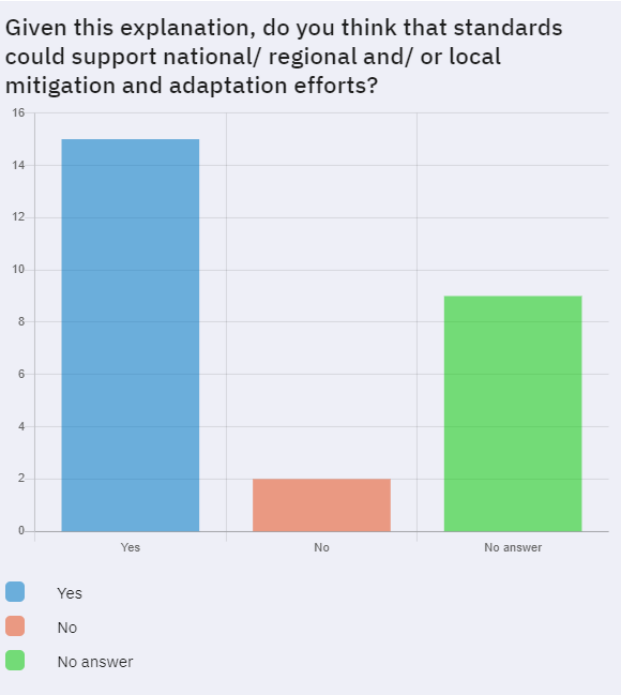


Figure 29 Support of standards to national, regional or local mitigation and adaptation efforts

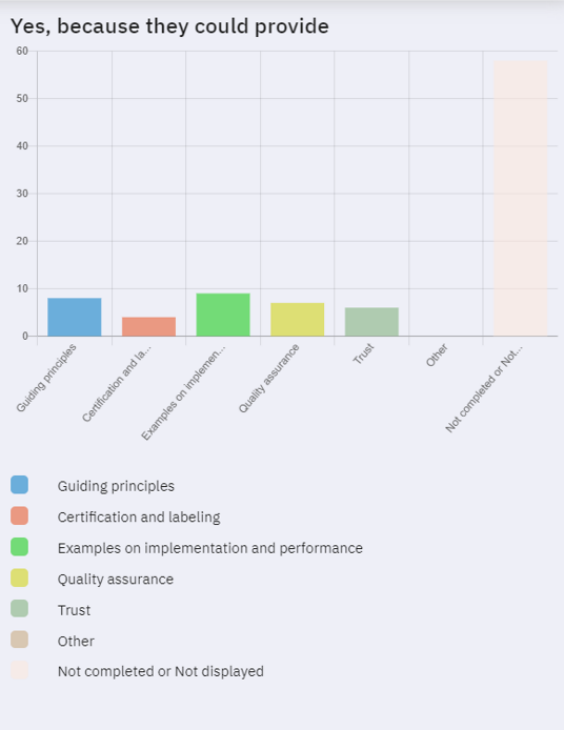


Figure 30 Potential role of standards in climate policies

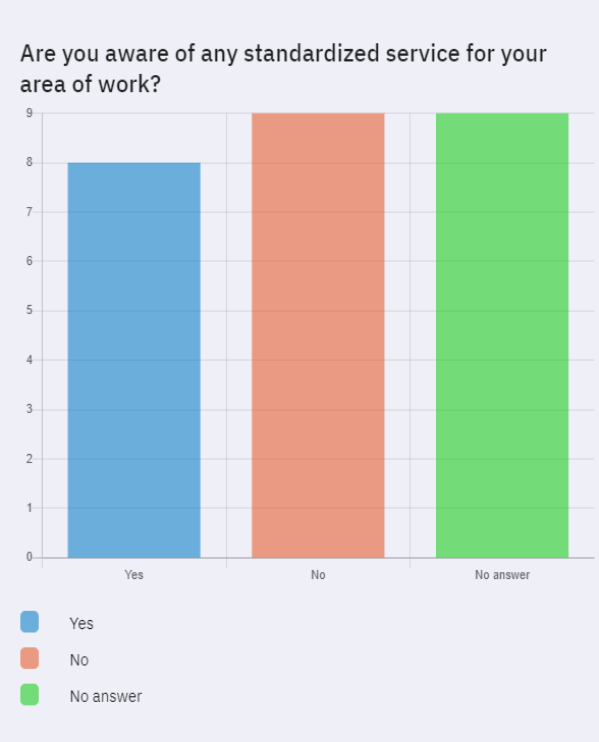


Figure 31 Awareness of standardized services

Almost 50% of the participating interviewees are aware that standardized services exit in their working domain (Figure 31).

While most interviewees confirmed that they are aware of a specific standard, the number of participants familiar with ISO 14091:2021 and ISO 14092:2020—two standards that allow for the assessment of changes in risk, vulnerability, and preparedness in a consistent, clear, and comparable manner—was 50% lower than those who are not aware of these standards (see Figure 32). Correspondingly, the percentage of participants applying these standards is also 50% lower (see Figure 33).

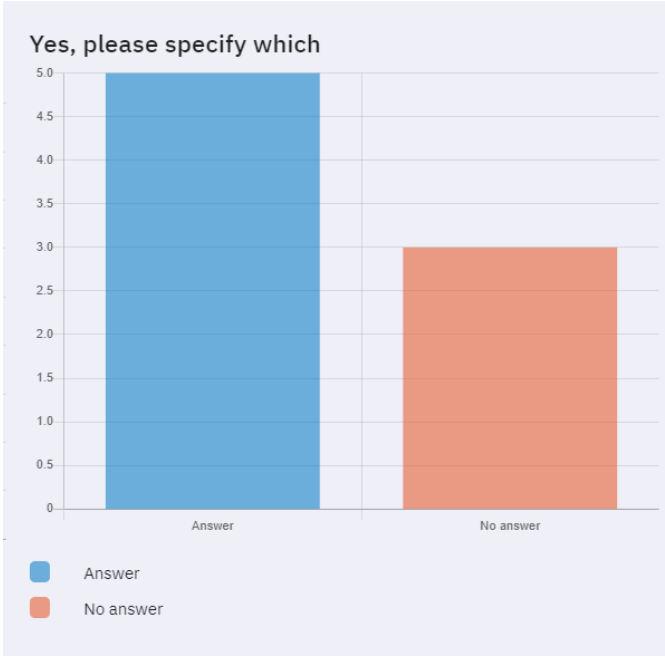


Figure 32 Number of participants familiar with ISO 14091:2021 and ISO 14092:2020

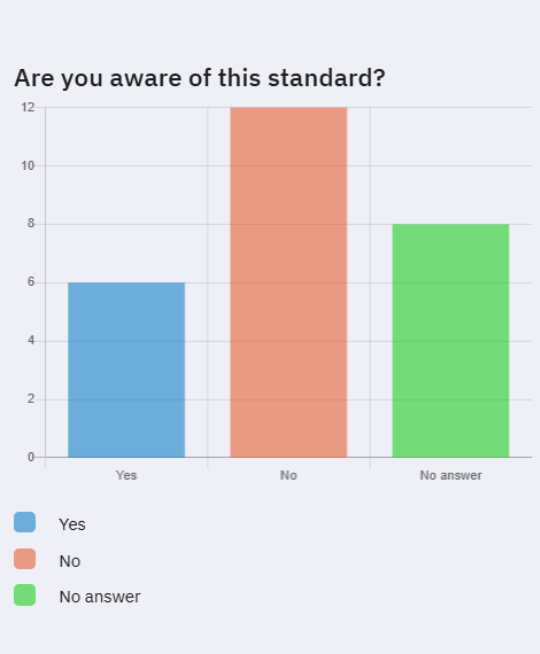


Figure 33 Awareness of standardized services

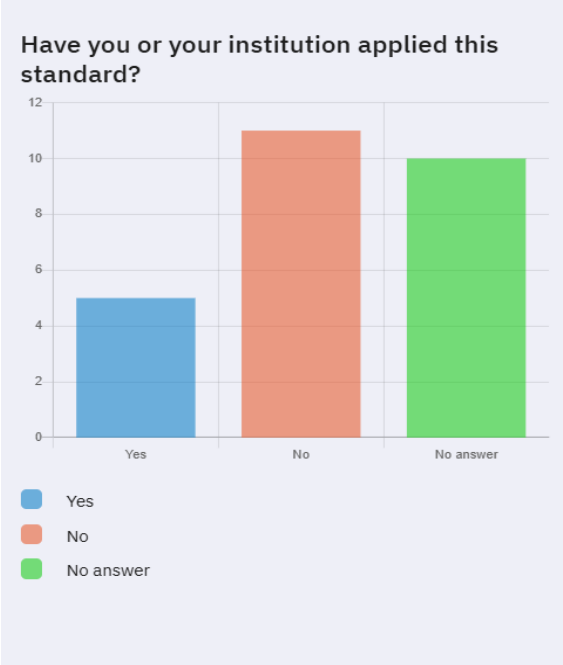


Figure 34 Application of respondents' institutions to the ISO 14091:2021 and 14092:2020 norms

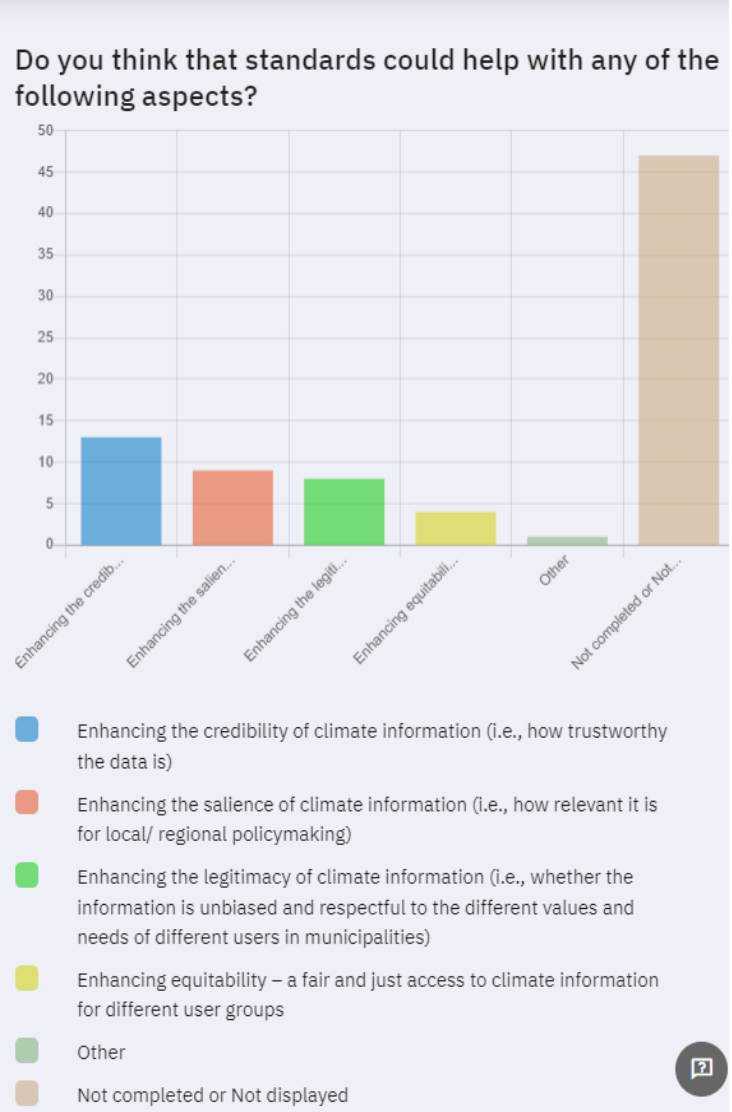


Figure 35 Possible benefits of climate services standardization

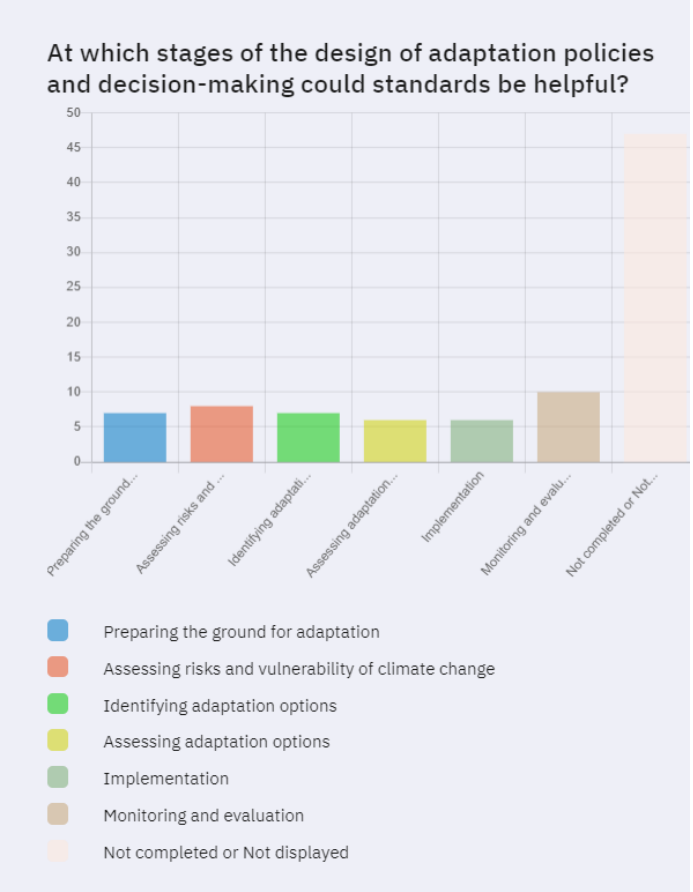


Figure 36 Helpfulness of standards in different phases of adaptation design and decision-making

Most of the participating interviewees think that standards would help a) enhancing the credibility of climate information (i.e., how trustworthy the data is); b) enhancing the salience of climate information (i.e., how relevant it is for local/ regional policymaking); c) enhancing the legitimacy of climate information (i.e., whether the information is unbiased and respectful to the different values and needs of different users in municipalities; d) enhancing equitability – a fair and just access to climate information for different user groups and e) state other, not further specified reasons for their assumption (Figure 34). Finally, the different stages of the design process of adaptation policies and decision-making where standards could be most helpful is almost equally acknowledged by participating interviewees reaching from a) monitoring and evaluation to b) assessing risks and vulnerability of climate change; c) preparing the ground for adaptation; d) identifying adaptation options; e) assessing adaptation options and f) implementation.

4 Summary

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Climateurope2 takes a holistic approach to climate services, emphasizing the decision-making context, the ecosystem of actors, diverse knowledge systems, and the modes of delivery and evaluation as interconnected components. A key aspect of climate services is their governance, which determines their role in supporting climate adaptation. The governance of climate services requires adaptive strategies tailored to regional and local needs while being embedded in broader national and European policy frameworks. Multi-level governance is particularly relevant in this context, as climate services must operate across different administrative levels, ensuring coherence between national adaptation plans and local implementation efforts. Climate services development and climate policy frameworks structuring are closely intertwined. In recent years, EU Member States have boosted efforts to provide climate services to various stakeholders as part of the climate policy implementation.

The ecosystem of actors involved in climate adaptation is diverse, comprising national, regional, and local governments, public administrations, stakeholders, political networks, and citizen initiatives. For climate services to be effective, they must engage equitably with these actors, ensuring their knowledge and perspectives are integrated into decision-making and evaluation processes. The standardization of climate services remains a contested issue: while some stakeholders see harmonization as an opportunity to enhance quality control, facilitate comparisons, and improve co-creation processes, others warn against excessive rigidity, fearing it could hinder the adaptability of climate services to specific local needs. For instance, the Belgian case highlights both the opportunities and constraints of standardization, as federal authorities lack the hierarchical power to impose standards on regions. While comparability and transparency in climate services would benefit from harmonization, key actors emphasize the need to first establish structural support for climate projections before moving toward standardization.

4.1 Key findings

Key findings from case studies at national and regional level

Climate services development and climate policy frameworks structuring are closely intertwined. In recent years, EU Member States have boosted efforts to provide climate services to various stakeholders as part of the climate policy implementation.

In the four countries studied at the national and regional level, ecosystems of actors have been established around cornerstone projects to develop climate services. Landscapes of private and public intermediaries and users have flourished with various degrees of complexity. Policy officers are at the forefront of the design and implementation of climate policies, and especially climate adaptation policies, who act as driving forces for the development of climate service, now focus on climate services uptake, which is still lagging behind.

We found that at present an opportunity window for climate services standardization exists with the strong willingness of harmonization within member states drawing on an established collaboration culture. For instance, standardization of climate services could be helpful when leading the EU presidency, Belgium worked on spreading the use of climate services across DGs such as DG ENV and DG CLIMA. The Belgium presidency also focused on spreading the data resulting from the EUCRA to different councils.

- Climate services development is closely intertwined with climate policy frameworks. In the studied countries, national and regional adaptation plans provide an essential governance framework for climate services.
- Ecosystems of private and public intermediaries have emerged to support climate services, yet the uptake of climate services remains slow, despite increased policy attention.
- Standardization efforts at the EU level highlight the growing push for harmonization within member states.
- Key benefits of standardization include quality control, methodological consistency, and greater stakeholder engagement.
- In general, stakeholder engagement in climate services co-design seems to be underdeveloped, with a narrow representation of public entities and private sector actors. Formalized guidelines could expand user involvement while maintaining flexibility.
- Standardization could also address existing barriers to climate services uptake. The Polish case study underlines challenges in data accessibility, the need for specialized knowledge to interpret certain climate models, and the lack of integration of climate data into decision-making processes.
- However, several interviewees were cautious, fearing that rigid standards might disrupt existing governance structures and limit the ability to adapt climate services to local and sectoral needs.
- Some national players, such as in Belgium, argue that standardization is premature, as climate projections are still not yet structurally embedded in governance systems. Thus, at the federal level, Belgium uses climate services in decision-making without imposed standards, creating regional discrepancies in methodologies (e.g., different climate risk map baselines). Standardization at the EU level is seen as a potential long-term solution.
- For others, there are some bare requirements to consider supporting a standardization process, such as investment in the right infrastructure and technology to support data collection and dissemination, necessary human and financial resources to train various stakeholders so that they can understand and use climate services effectively.
- In Poland, the integration of Klimada 2.0 into Poland's climate governance is a significant step forward, but challenges remain in ensuring that the services are operationalized at the local level. Despite national initiatives to embed climate projections, the uptake of climate services at the regional and local levels is slow, hindered by structural and financial barriers.
- While in France substantial progress has been made by embedding climate services within national adaptation frameworks, particularly through the National Low-Carbon Strategy (SNBC), regional variations persist in the application and integration of climate services, and further alignment between national and regional policies is needed.

- Spain's case highlights the importance of strengthening the connection between national strategies and local governance structures. The regional implementation of climate services varies considerably, with some regions more advanced in integrating climate projections than others and being pioneers in co-designing of climate services. Key challenges include ensuring consistent and accessible communication between stakeholders at all levels and improving data-sharing mechanisms. Furthermore, Spain underscores the need for more robust capacity-building at the local level, particularly for smaller municipalities, to effectively implement climate adaptation strategies.

From Local Case Studies

- Cities and regions increasingly rely on climate services to enhance resilience to climate change, but there is limited awareness of climate service standards.
- The Barcelona case study illustrates successful co-creation processes, where climate adaptation measures were developed collaboratively with city authorities. However, this level of engagement is not yet widespread across Europe.
- The Ammerland case study presents a contrasting picture: while local initiatives play a crucial role in driving climate action, frustrations with bureaucratic inertia and political contestation highlight the disconnect between institutional climate policies and real-world implementation. This tension reflects a broader paradox—while climate policies are increasingly institutionalized, their on-the-ground impact remains limited.
- Across all case studies, a key challenge is ensuring that climate services and their governance remain flexible and adaptable while also maintaining scientific robustness and policy relevance.

4.2 Recommendations on the standardization of climate services

1. **Enhance Coordination Across Governance Levels:** Multi-level governance should be strengthened to ensure better alignment between national frameworks and local implementation. Climate services should be positioned to support decision-making at all levels while maintaining adaptability to regional and sectoral needs.

2. **Balance Standardization and Flexibility:** While standardization can improve quality assurance and interoperability, it should remain flexible to allow local and sector-specific customization. The Belgian case illustrates how premature standardization may disrupt established governance balances and should only be introduced after climate projections become structurally embedded.

3. **Improve Stakeholder Engagement:** A key gap is the lack of systematic feedback loops between climate service providers and end-users. Co-creation should be institutionalized at all governance levels, ensuring a broader and more inclusive range of stakeholders are involved.

4. **Integrate Local Knowledge:** The Ammerland case study underlines the importance of grassroots initiatives in shaping climate adaptation. Strengthening the interaction between local initiatives and formal governance structures is crucial for effective climate action.

5. **Ensure Equitable Access to Climate Services:** Publicly funded climate services should be made widely accessible to avoid the dominance of private sector-driven models that might limit transparency or affordability.

4.3 Final Thoughts

The discussion on standardization highlights the need to balance consistency with flexibility, ensuring that climate services remain both scientifically robust and adaptable. The Belgian case study underscores the complexities of harmonization within multi-level governance frameworks, while the Ammerland and Barcelona case studies illustrate the contrasting realities of climate governance at the local level: while co-creation can enable successful climate adaptation strategies, bureaucratic inertia and governance fragmentation can impede progress. This reinforces the need for a multi-level governance approach that connects local innovation with national and EU-level policy frameworks.

Climate services are widely recognized as valuable tools for risk assessment and adaptation, but their full potential remains unrealized. Moving forward, collaborative, adaptive, and inclusive governance approaches will be essential to ensuring that climate services contribute effectively to both local and global climate resilience.

5 Annexes

5.1 Annex 1. List of references

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5.2 Annex 2. Case studies: Selection criteria and analytical framework

Selection criteria

Selection criteria		Belgium	France	Poland	Spain
Geographical position	**European region**	Western	Western	Eastern	Southern
	Transnational regions	North sea North Western Europe	Alpine space Atlantic area Mediterranean area North sea Northwestern Europe	Baltic sea Central Europe	Atlantic sea Mediterranean area Southwestern Europe
Adaptation policy, climate services and MRE status	National Adaptation Strategy	Adopted	Adopted	Adopted	Adopted
	National Adaptation Plan	Superseded	Adopted	NA	Adopted
	Regional Adaptation Plan	Adopted	NA	NA	NA
	Climate Risk Assessment	In progress	NA	In progress	Completed
	Meteorological observations	Established	Established	Established	Established
	Climate projections and services	NA	Established	Established	Established
	Adaptation portals and platforms	NA	Established	Established	Established

	Monitoring, reporting and Evaluation Indicators and methodologies	NA	NA	Established	Established
Main climate risks assessed	Drought	X	X	X	X
	Heat wave	X	X	X	X
	Changing temperature	X	X	X	X
	Flood	X	X	X	X
	Heavy precipitation	X	X	X	X
	Precipitation and/or hydrological variability	X	X	X	X
	Storm	X	X	X	X
	Changing precipitation patterns and types	X	X	X	X
	Coastal erosion	X	X	X	X
	Landslide	X	X	X	X
	Wildfire	X	X	X	X
	Soil erosion	X	X		X
	Sea level rise	X	X	X	X
	Temperature variability	X	X	X	X

	Soil degradation	X	X	X	X
	Cold wave/frost		X	X	X
	Saline intrusion	X	X		X
	Snow and ice load	X	X		
	Avalanche		X		X
	Water scarcity	X	X		X
	Cyclone		X	X	X
	Changing wind patterns		X	X	
	Subsidence				X
	Tornado		X		
	Change in sea ice cover		X		
	Ocean acidification	X	X		X
	Solifluction	X			X
	Permafrost thawing		X		

Analytical framework

Table 3 Analytical framework used for the document review of the case studies

Decision context: Climate policy governance and implementation

Theme	Questions
Decision context **(what)**	What is the existing policy and regulatory framework around climate adaptation and climate risk management in the country? • *What are the main policy documents?* What are the sectors covered by this policy framework?

Actors
(who)
	Who are the main actors in charge of climate action (adaptation, mitigation…) and risk management in the country and what are their roles in the policy implementation process?
	• State actors (ministries, public agencies)
	• Non-state actors:
	  ○ Regions and local authorities
	  ○ Companies and their representative associations, groups of interest
	  ○ Academia
	  ○ NGOs and civil society

Policy implementation **(how)**	How is the climate adaptation policy implementation /decision-making process organized at the national level (horizontal governance)? How is the climate adaptation policy implementation organized between levels of governance (regions, local authorities)? Through which instruments are climate and risk management policies implemented? • Non-market instruments: legislation, regulation, norms and standards, subsidies and taxes, PP partnerships, contracts, etc. • Market-related instruments (bonds, loans, payments for ecosystem services, etc.) To which extend do these policy instruments rely on climate services? Do these policy instruments require climate services design and delivery? • *Data collection: climate services references in policy documents.*
Standardisation	Do policy documents mention any standards, guidance or conventions related to the design and implementation of adaptation and risk management policies? If yes, where do these standards or guidance come from (national bodies, international organisation, etc.)? Are these standards public/private and market/non-market based?
Value	What value would standardisation bring to the decision context? What potential harm could it do?

Climate services ecosystem of actors and co-creation processes

Theme	Questions
Description of the ecosystem (what)	What are the different categories of actors involved in the governance of climate services? (from the provision to the delivery and use)

	How are these actors organized? How do they interact? Are there any networks of actors?
Processes	How are users engaged in the climate services development processes? How do climate services providers and users interact? ● *At what steps of the services development processes are user engaged?* ● *What forms does user engagement take?*
Standardisation	Do actors involved in the climate services ecosystem rely on any standards, guidance or conventions regarding cocreation processes and users' engagement? If yes, where do these standards come from (national bodies, international organization, etc.)? Are these standards public/private and market/non-market based?
Value	What would the introduction of standards add to the co-creation processes? What potential harm could it do?

Climate services data and related selection, evaluation, and translation processes: producers' and users' perspectives – knowledge system

Theme	Questions
Description	What are the main characteristics of the climate information and data mobilized for climate policy and governance in the country/region? ● What are the main climate hazards targeted? (Category: acute – chronic) ● What types of indicators (ECV?) are used? ● What are the datasets / databases being used? ● What is the temporal resolution? ● What are the geographical and spatial resolutions? ● How is the data stored and managed?
Processes	**Climate services data provision:** Under which policy/ governance framework is the climate information and data produced? (e.g. the data is produced in the context of the development of the National Adaptation Plan…) How is uncertainty presented/taken into account? How is uncertainty managed? How do providers ensure their credibility? (i.e. "the scientific adequacy of the technical evidence and arguments") **User requirements and needs:** In what format do users need data? How and at what stage do they integrate it into their decision making? At what steps of the climate services data provision are user engaged? What forms does user engagements take?
Actors	Who are the main climate information and data providers?

	Who are the main decision-makers involved in the selection of the climate information produced? Are there intermediaries involved in the selection/ translation and use of the climate information and data?
Standardisation	Are there any existing standards /guidance/conventions relevant for this component mentioned in the policy/ regulatory documents? For instance regarding the following: - Uncertainty, credibility, salience of climate data - Frequency and type of updates - Evaluation of climate data If yes, where do these standards come from (national bodies, international organization, etc.)? Are these standards public/private and market/non-market based?

Delivery mode: climate services communication, uptake and user engagement

Questions
How are climate services delivered at the regional level? Who are the actors involved in CS delivery?
Who are CS users? When and how do they use CS, in relation with their decision context?
What is the evaluation process of climate services delivery? Are users associated to it?

5.3 Annex 3. Interview guide for the case studies

Interviewee information

Name:

Organization/ position:

Missions, especially related to climate policy and use of climate services:

Context setting

Introduction of Climateurope2 and its purpose.

Climateurope2 is a 4.5-year Horizon Europe project that addresses the need for timely delivery and effective use of climate information. The project aims to support the climate services community and propose standardisation procedures for future equitable and quality-assured climate services, useful for decision making in all sectors of society.

The project strives to enhance the uptake of quality-assured climate services to support adaptation and mitigation to climate change and variability. This will underpin the leading role of Europe when it comes to the production of trustworthy, user-relevant knowledge to manage climate risks and enhance adaptive capacities, while benefiting climate services at the global scale.

Definition of climate services. Climate services involve the provision of climate information in such a way as to assist decision-making. The service includes appropriate engagement from users and providers, is based on scientifically credible information and expertise, has an effective access mechanism and responds to user needs (IPCC, 2021: Annex II: Glossary).

The generation, translation, transfer and use of climate information and knowledge (Vaughan and Dessai, 2014)

A climate service is a decision aid derived from climate information that assists individuals and organizations in society to make improved ex-ante decision-making. A climate service requires appropriate and iterative engagement to produce a timely advisory that end-users can comprehend and which can aid their decision-making and enable early action and preparedness. Climate services need to be provided to users in a seamless manner and, most of all, need to respond to user requirements (WMO, 2013)

Definition of (climate services) standards. A document, established by consensus and approved by a standardisation body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context.

NOTE1 In particular, the activity consists of the processes of formulating, issuing and implementing standards

NOTE 2 Important benefits of standardisation are improvement of the suitability of products, processes and services for their intended purposes, prevention of barriers to trade and facilitation of technological cooperation" (ISO/IEC Guide 2:2004).

Definition of (climate services) standardisation process. A standardisation process refers to the systematic process of developing, establishing, and implementing standards. The standardisation process is a collaborative and iterative process that involves the participation of diverse stakeholders, including experts, industry representatives, and consumers. (CEN website and ISO website).

Interview guidance

Highlighted question are to be prioritised for their added-value on standardization processes.

Climate policy governance and implementation

Remind the policy framework identified and ask for completion if needed.

To what extend were climate services used for the design of this policy framework?	
Were standards, guidance or conventions used in the design of the policy framework? (*market-based vs. non-market)*	
At which stage of the climate (adaptation) policy implementation process are climate services used?	

In relation with which types of policy instruments?	
What value would standardisation bring to this policy framework? Does decision-making regarding adaptation/risk management (and which may require the mobilization of climate services) follow a standard/guidelines?	
What potential harm could standardisation do to the policy design or implementation processes?	

Climate services ecosystem of actors and co-creation processes

Who are the main actors involved in the regional/national climate services ecosystem? How are they organised?	
What are the relations between the national and regional level in terms of climate services production and provision?	
Who are the climate services users?	
Are there any user-engagement processes at the regional/national level? [user requirements collection, participation methods, feedback on climate services use and accessibility] **At which stage of the climate services production and provision cycle?** What is being done to engage with stakeholders ?	
If yes, does the user-engagement process follow any guidance or standard?	
How could the introduction of standards on stakeholders' engagement improve or alter the involvement of users in the production and provision of climate services? What would the introduction of standards add to the co-creation processes? What potential harm could it do?	

Climate services data and related selection, evaluation, and translation processes: producers' and users' perspectives

What are the climate data available at the regional/national level?	
Who is the main data provider? What are the databased used? Who are the main decision-makers involved in the selection of the climate information produced?	
How are climate services selected (if they are)? Are there intermediaries involved in the selection or translation of climate information and data?	
How is uncertainty presented to users?	
How do climate services providers ensure their credibility and the quality of their services?	

What are the evaluation processes of the CS? Is there a continue feedback process with the users to update the services if/when needed? How often do they get this feedback- if any?	
What types of climate services do users need? When do they use them (at which stage of the decision process on climate policies: state of play, planning, implementing, monitoring)?	
Are standards used in the production of climate services, on the following matters? - Uncertainty, credibility, salience of climate data - Frequency and type of updates - Evaluation of climate data	

Delivery mode: climate services communication, uptake and user engagement

How are climate services delivered at the national level? What form does the delivery take: online platform, processed data (maps, indicators), raw data, reports? Who are the actors involved in CS delivery?	
What is the evaluation process of climate services delivery? Are users associated to it? What is the process of engagement between data providers and users during the delivery of CS? Who are the potential intermediaries and how are they involved?	
Does the delivery of climate services rely on standards or guidance?	
Are there good practices associated with the delivery of climate services?	
Are there gaps and overlapses in the delivery of climate services?	
How the introduction of standards on climate services delivery could improve or alter the delivery of climate services?	

5.4 Annex 4. Survey questions

Future equitable and quality-assured climate services

The Climateurope2 project aims to develop future equitable and quality-assured climate services of greater value to society that provide trustworthy, user-relevant and usable information.

Thank you for taking the time to answer our questions! We will evaluate all responses anonymously and take them into account as the project progresses. In spring 2025, we will also publish the report "Mapping the State of the Art of CS Standardization from a Multi-Level Governance Perspective". If you would like to receive the report, please indicate this at the end of the survey.

Personal information

1. In which EU country do you work?

Please select only one of the following countries:

- ☐ Austria
- ☐ Belgium
- ☐ Bulgaria
- ☐ Croatia
- ☐ Republic of Cyprus
- ☐ Czech Republic
- ☐ Denmark, Estonia
- ☐ Estonia
- ☐ Finland
- ☐ Finland France
- ☐ France Germany
- ☐ Germany Greece
- ☐ Hungary
- ☐ Ireland
- ☐ Italy
- ☐ Latvia
- ☐ Lithuania
- ☐ Luxembourg
- ☐ Malta
- ☐ Netherlands
- ☐ Poland

- Portugal
- Romania
- Slovakia
- Slovenia
- Spain
- Sieden

2. What is your professional background?

Please select only one of the following:

- Policy maker
- Regional/local government
- Civil society/community representative
- NGO and other foundation
- Private sector
- Researchers
- Other
- I don't know/ don't want to specify.

3. Have you ever used climate information* to mitigate or adapt to the current climate and/or to prepare for future climate changes in your region?

Please select only one of the following:

- Yes, often
- Occasionally
- Once
- Not used at all

*Climate information is e.g. seasonal forecasts, weather forecasts/information, early warning systems, inspiring examples/case studies, training, etc.

Climate services are defined as products and services that involve the production, translation, transfer and use of climate knowledge and information for climate-based decision making.

4. Given this definition, would you say that you have either used climate services or been involved in their design?

Please select only one of the following:

- ☐ Yes
- ☐ No

5. For what purpose have you used, designed or co-produced climate services?

Please select all applicable answers:

- ☐ To assess vulnerability impacts and/or conduct a risk assessment
- ☐ To implement a regional or local adaptation or mitigation strategy and/or plan
- ☐ To implement regional or local adaptation or mitigation measures
- ☐ To monitor or report on the progress of regional or local adaptation or mitigation strategies, plans or measures (within or outside your organization/provide information to other organizations or publication)
- ☐ Monitoring and evaluating compliance with adaptation or mitigation planning procedures
- ☐ Other

6. Would you say that the climate service(s) you used were transparent and traceable regarding the provided assumptions, climate and other data, information and knowledge?

Please choose only one of the following:

- ☐ Yes
- ☐ No

7. What are the biggest challenges / or barriers to using climate services?

Please select all that apply:

- ☐ Quality of scientific data/ Accuracy of risk assessment/ Accessibility
- ☐ Personal resources

- Transparency and traceability of the assumptions, climate and other data, information and knowledge provided
- Vision and broader systems analysis to support holistic strategies for multifunctional mitigation and adaptation at regional and local levels
- Support from the national level
- Application at regional and local level
- Application by the private sector
- None

8. Designing climate services

Have you ever been involved in the design and/or production of a climate service?

Please select only one of the following:

- Yes
- No

9. Why did you participate in the production/design process of a climate service?

Please select all applicable answers:

- Establishing a contextual framework
- Provision of scientific information
- Testing prototypes
- Evaluation of products
- Other

Evaluate climate services

10. My organization has evaluated climate services, e.g. by

Please select all that apply:

- Peer reviews
- User surveys
- Benefit/cost analysis
- Randomized control trials
- Other

Guidelines and standards

11. Have you ever used climate change mitigation or adaptation guidelines to assess vulnerability and impacts and conduct a risk assessment?

Please select only one of the following:

- ☐ Yes
- ☐ No

Standards are defined as a mechanism to guarantee the suitability, quality and performance of solutions and provide common terminologies between users and providers of services.

12. Given this statement, do you believe that standards could support national/regional and/or local mitigation and adaptation efforts?

Please select only one of the following:

- ☐ Yes
- ☐ No

12a. Answer was "Yes" to the question (Given this statement, do you believe that standards could support national/regional and/or local mitigation and adaptation efforts?)

Please select all that apply:

- ☐ Guiding principles
- ☐ Certification and labeling
- ☐ Examples of implementation and performance
- ☐ Quality assurance
- ☐ Trust
- ☐ Other:
- ☐ No, please specify why not

12b. Answer was 'No' to question ' (Given this statement, do you think standards could support national/regional and/or local mitigation and adaptation efforts?)

Please enter your answer here:

13. Do you know a standardized service for your work area?

Please select only one of the following options:

- ☐ Yes
- ☐ No

13a. Yes, please specify which one:

Only answer this question if the following conditions are met:

The question “Yes” (Do you know of a standardized service for your work area?)

Please enter your answer here:

ISO 14091:2021 and ISO 14092:2020 are two standards that provide a consistent, clear and comparable assessment of change in risk, vulnerability and preparedness.

These standards are a guide for identifying and prioritizing vulnerabilities to climate phenomena such as droughts and floods and for developing an adaptation plan.

14. Do you know this standard?

Please select only one of the following:

- ☐ Yes
- ☐ No

15. Have you or your organization applied this standard?

Please select only one of the following options:

- ☐ Yes
- ☐ No

16. Do you think standards could help with any of the following?

Please select all that apply:

- ☐ Improving the credibility of climate information (i.e. how trustworthy the data is)
- ☐ Improving the validity of climate information (i.e. how relevant it is for local/regional policy making) Improving the legitimacy of climate information (i.e. whether the information is unbiased and takes into account the different values and needs of different users in communities)
- ☐ Improving equity - fair and equitable access to climate information for different user groups
- ☐ Other

17. In which phases of the design of adaptation measures and decision-making processes could standards be helpful?

Please select all that apply:

- ☐ Preparing the ground for adaptation
- ☐ Assessing risks and vulnerability to climate change
- ☐ Identification of adaptation options
- ☐ Evaluation of adaptation options
- ☐ Implementation
- ☐ Monitoring and evaluation

Thank you for completing this survey.