Policy brief: Considerations for enhancing the quality and policy-relevance of climate services through standards

Deliverable 5.4

Authors: Silke Beck, Carlos Cuevas-Garcia, Elliot Honeybun Arnolda, Julian Bräuer (TUM).
Contributors: Carmen González Romero (BSC), Mathilde de Goër de Herve, Victoire Zink (RMC).

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101056933.

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)	T5.3
LEAD ORGANIZATION	TUM
AUTHORS	Silke Beck, Carlos Cuevas-Garcia, Elliot Honeybun Arnolda, Julian Bräuer
SUBMISSION DATE	30 November 2025
DISSEMINATION LEVEL	Public

History

DATE	SUBMITTED BY	REVIEWED BY	VISION (NOTES)
28 November 2025	Carlos Cuevas-Garcia	Mar Rodriguez	Received for official submission
27 October 2025	Carlos Cuevas-Garcia	External commentators	Draft discussed with external commentators from the CS community to gain feedback.
24 October 2025	Carlos Cuevas-Garcia	Asun Lera St. Clair, Kjersti Aalbu	Official internal review. To strengthen definition of quality

			assurance; closer alignment with project definitions and earlier findings; define more clearly the target audience; redraft sections 2, 3 and 4.
1 October	Carlos Cuevas-Garcia, Elliot Honeybun-Arnolda	Silke Beck	To polish language to make it more policy oriented; to change selected empirical materials.
28 August 2025	Carlos Cuevas-Garcia, Elliot Honeybun-Arnolda	Silke Beck	To re-define structure and integrate empirical materials.
8 August 2025	Carlos Cuevas-Garcia, Elliot Honeybun-Arnolda	Silke Beck	Initial draft summarizing lessons learned.

Please cite this report as: Beck, S., Cuevas-Garcia, C., Honeybun-Arnolda, E., and Bräuer, J. (2025), Policy brief: Considerations for enhancing the quality and policy-relevance of climate services through standards, D5.4 of the Climateurope2 project.

Disclaimer: *Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.*

Table of Contents

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 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 labeling, 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.

Executive Summary

This policy brief presents recommendations for enhancing the scientific quality, policy relevance and political legitimacy of climate services (henceforth CS) through standards. It presents five lessons and options to strengthen the quality of CS for producers, policymakers, and standardization bodies: (1) A broad range of quality criteria is needed, including scientific credibility, political relevance and legitimacy; (2) CS quality can be enhanced by engaging with diverse knowledge systems; (3) CS quality can be enhanced by tailoring CS to potential users in the public sector; (4) trust in CS can be enhanced by open, equitable, transparent, and accountable processes, and public accountability of agencies; (5) the use of CS and standards can and must be enhanced by climate adaptation regulation.

Keywords

Climate services (CS), policymaking, policy relevance, public sector, quality assurance, standards.

1 Introduction

CS have been developed to support public decision-making by providing 'usable' information for adaptation policies. They encompass data, products, and processes, as well as their social and human dimensions.

Quality assured data sets and toolboxes have been delivered by international bodies such as the World Meteorological Organization (WMO) and the European Commission's Copernicus Programme. However, it has become evident that improvements in scientific quality alone do not increase the salience and use of CS on the ground[i]. To increase their use in decision-making, "CS should be science-based, user-centered, designed with transparent and collaborative processes, delivered in a timely and accessible fashion, and for public services also sustainable and equitable."[ii]

For this purpose, the specific needs and demands of the target audiences are to be addressed. For instance, the public sector is a distinct type of climate service user. As their role is to provide public goods rather than private goods, their needs differ from those of companies in the energy sector or insurance, for example.

This policy brief presents key lessons from a three-part study on the quality assurance of CS for the public sector. The study involved (1) a review of the literature on quality control and co-production in climate sciences and adjacent social scientific literature[iii]; (2) an analysis of existing standards and guidelines on quality assurance processes and stakeholder engagement from the International Organization for Standardization (ISO), the European Committee for Standardization and the European Committee for Electrotechnical Standardization (CEN-CENELEC), WMO, and Copernicus[iv], and best practices reported by EU-funded projects on CS that involved public administration organizations in their consortia[v]; (3) 24 interviews with climate service producers, users, and user-producers from the public sector including at the national (n=15), regional (n=1), and municipal (n=8) levels from six European countries[vi]. The research questions guiding our study were:

- What forms of quality assurance are used or recommended by agencies and other institutions and projects?

- What processes of quality assurance can be formalized, upscaled and standardized, and what processes are place or context-based and need to be embedded in local practices, cultures and traditions?

We conclude with five lessons and options for CS producers, policymakers, and standardization bodies: (1) A broad range of quality criteria is needed, including scientific credibility, political relevance and legitimacy; (2) CS quality can be enhanced by engaging with diverse knowledge systems; (3) CS quality can be enhanced by tailoring CS to potential users in the public sector; (4) trust in CS can be enhanced by open, equitable, transparent, and accountable processes, and public accountability of agencies; (5) the use of CS and standards can and must be enhanced by climate adaptation regulation.

2 Glossary[vii]

CS: The provision of climate information in such a way as to assist decision-making. The provision of 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.

Quality: The degree to which a set of characteristics inherent to a climate service fulfills specified requirements.

Quality assurance: Processes for providing confidence that quality requirements will be fulfilled.

Standardization: The process of building consensus across stakeholders, coordinated and structured by a standardization body, and leading to standards and guidance documents that benchmark products, processes, and services.

Standards for quality assurance: Rules of procedure to assure the quality of CS. They establish minimum requirements to assure diverse criteria of quality besides scientific credibility such as salience and legitimacy of the service provided.

Credibility: The scientific quality of CS.

Salience: The relevance and usability of the CS for decision-making.

Legitimacy: The quality of the interactions between CS providers and users (inclusiveness, balance, fairness, public accountability, and transparency). Forms of legal legitimacy in terms of the fit to political regulations (including the division of responsibilities and tasks between CS providers and policymakers as users with a democratically legitimate mandate and legally binding regulation for evidence-based policymaking).

3 Why quality assurance of CS matters

CS are produced and provided to support decision-making by credible, salient and legitimate information. The provision of robust CS plays a central role in responding to impacts and cascading risks of climate change[viii], given the short time horizon, high level of uncertainty, and urgency of adaptation. Credible sources of climate information[ix] such as quality-assured CS are needed[x] as a robust foundation for decisions with long-term consequences (e.g., infrastructure and other high public investments[xi]).

Quality assurance of CS mostly relies on traditional scientific processes, such as peer-review as the gold-standard[xii]. To support public planning, CS must be both scientifically sound and usable. For this end, quality of CS must be assessed according to its "fitness for function"[xiii]: Additionally, organizations like the WMO or the Copernicus Programme have been partially regulating the production and provision of CS by publishing guidelines on training and professional development, promoting the adoption of best practices, facilitating international and regional collaboration and committing to regular engagement with users and stakeholders[xiv]. In practice, quality assurance is often conducted in an ad hoc and informal manner with variable outcomes. The goal of Climateurope2 is thus to inform the standardization of CS by taking a holistic perspective on both quality and CS.

4 Challenges of assuring the quality of CS

Quality assurance is a unique but critical task, presenting numerous challenges for both providers and users of CS. For the quality assurance of CS and their standardization, key challenges discussed throughout the Climateurope2 project are outlined below:

- There is flexibility in understanding how and why CS are credible, salient, legitimate, and usable, and how this understanding is achieved. These criteria are always affected by and embedded in the socio-political and cultural context in which they emerge. This makes formalizing and standardizing quality assurance processes difficult[xv].
- Additionally, knowledge quality is interpreted differently by various actors. Broad principles may not be applicable in all contexts of CS provision and use[xvi].
- Climate data-related guidance documents are available, although often incomplete and driven by needs of providers rather than users[xvii].
- Existing standards and guidance documents "are limited to some components or aspects of CS, such as data management"[xviii].
- There are also no recognized guidelines for integrating technical and non-technical data for CS. Integrating diverse knowledge sources is key to transforming climate information into usable services, therefore processes that can support technical and non-technical data integration in a quality-assured way are key.

The IPCC provides an illustrative example of the challenges that arise from establishing quality-assurance mechanisms that can be applied in the context of CS. In response to external criticisms, the IPCC started to "revise and formalize its scientific quality-control procedures", turning to a legal mode of governance and standardizing its rules and procedures for how knowledge was reviewed by expert and governments. This revision resulted in "the challenge of reconciling forms of scientific self-organization with these newly formalized legal modes of coordination"[xix]. The formalization of review procedures contributed to increasing the political robustness of the IPCC performance; however, they also constrained the flexibility of the scientific processes. These examples suggest that information providers and users have distinct needs and expectations that must be reconciled when providing CS for public policymaking.

5 The role of standards in quality assurance

Climateurope2 describes standardization as "a multistakeholder consensus process aimed at building uniformity and interoperability and to create benchmarks"[xx]. To help support quality assurance processes, the provision and implementation of standards can help to navigate some of the challenges above.

Importantly, all standards contribute, in one way or another, to assuring quality. However, standards for specific technical components and their quality cannot speak for overall quality. Standards for datasets, tools and user guides[xxi], for example, cannot contribute to making sure that adaptation measures based on those tools are considered fair for affected populations, or that the decisionmakers know how to prioritize potentially vulnerable territories or protect vulnerable groups. Technical standards are a prerequisite but not a determinant of successful and publicly supported climate action.

The standardization of quality-assurance processes can help guarantee that salience and legitimacy, alongside scientific credibility, are properly understood and assessed. By creating shared reference points for users to navigate, standardization can minimize the impact of varying socio-political and cultural contexts in understanding salience and legitimacy of CS. Specifically, determining and establishing a minimum threshold to ensure CS are fit for purpose and meet the needs of diverse stakeholders is a necessary first step[xxii].

To help avoid different interpretations of knowledge quality, standards can provide clear parameters to support interpretation and aid assurance. No single framework will be sufficient but standardizing processes involved with the production and development of CS can support a more aligned understanding of what constitutes robust and reliable climate information. Currently, there are best practices, guidelines, and protocols that address different dimensions of quality (see Climateurope2 deliverables 1.1., 2.4, 4.1, 5.3), which can be further synthesized.

Establishing agreement on some quality criteria might be more plausible than on others. For example, on what constitutes scientific credibility than on what constitutes salience and legitimacy. But standards also involve "the generation of agreed-upon rules and a common *script".*[xxiii] A helpful script can involve commitment to complementing formal standards – for example on technical details –with less prescriptive best-practice guidance documents that can be more flexibly integrated[xxiv]. Standards can thus establish commitment to giving symmetrical attention to the criteria of credibility, salience and legitimacy, yet allow a flexible approach to the assurance of legitimacy and salience.

The next section presents our main research findings.

6 Key Research Findings

1. **A broad range of quality criteria is needed, including scientific credibility, political relevance and legitimacy.**

The consulted documents, academic literature, and the interviewed public sector actors agree on the need to consider criteria besides scientific credibility to assess the value and fitness for purpose of CS. The following extract illustrates how one interviewee articulated various quality criteria in straightforward terms:

> **Q: Is there any specific quality or attribute that you associate with a good CS?**
>
> **A:** I would highlight the relationship between the CS and the population. From a technical point of view, that the information is available, it is processed, and a prediction is made, but then it needs to be compared with reality to see if the models align or not. However, that connection with the population – the ones who actually suffer the effects of climate, is fundamental. *(Policymaker, regional government, Mediterranean European country)*

Main actors in the CS community (e.g. WMO, Copernicus) have made substantial progress in defining quality assurance, even if guidance on diverse quality criteria is often distributed across different documents and under headings other than quality.

2. **CS quality can be enhanced by engaging with diverse knowledge systems.**

Specialist knowledge and skills other than climate modelling can enhance the salience and legitimacy of CS[xxv]. A case in point is the role of social science specialists and methods in climate adaptation and the contribution to strengthening the salience and legitimacy of CS. Both ISO/TS 14092 and WMO guides acknowledge the relevance of the social sciences. ISO/TS 14092 indicates that social science experts should be included in facilitation teams leading the adaptation planning process. The WMO *Guidance on Good Practices for CS User Engagement* suggests a narrower role, stating that "social scientists should be included in the team of consultants in order to facilitate the interaction between users and climate scientists" (p.33). The WMO *Step-by-step Guidelines for Establishing a National Framework for CS* suggests the importance of conducting an analysis of political, economic,

sociocultural, technological, legal and environmental (PESTLE) factors, where social scientific skills and methods are relevant.

Future guidance documents should pay more detailed attention to the diverse roles that social sciences and other specialist areas can play to help strengthening the usability, salience and legitimacy of CS. Existing best practice examples particularly focused on methods of stakeholder mapping and engagement include RESCCUE project deliverable 5.4 *Enhanced communication system for stakeholder participation* and *B-WaterSmart* project deliverable 5.1 *Manual for stakeholder mapping and engagement*. A future challenge is how diverse knowledge systems can be integrated and their quality assured.

3. **CS quality can be enhanced by tailoring CS to potential users in the public sector.**

Our study suggests there is no homogeneous group of users in the public sector. Given different levels of policymaking, different sectors, different mandates and contexts, the public sector includes a highly diverse group of users. Climate service providers – even from the public sector at the national level – have only limited knowledge of who their users are and risk failing to understand their information needs. We found cases of CS users that rely and trust agencies mandated by respective ministries rather than the national climate service. One interviewee explained:

> We have our own scientific research institutions that advise us on this topic. What we get from them is much less detailed [than the national climate service], but scientifically at the level we need. *(Policymaker, national government, Central European country)*

It is often the case that there is no lack of information. The information available is tailored to the information needs and mandates of regulating agencies in different sectors (such as critical infrastructure, agriculture, environmental protection, etc.). Mirroring the multilayered decision-making structure at the vertical and horizontal level, available information and services are diverse, decentralized, and fragmented. What is needed are interorganizational units and networks for integration of available information.

To illustrate the German context, Figure 1, below, shows the institutional fragmentation in federal countries (Bundesoberbehörden, to the left), and the number of research agencies mandated by federal ministries (to the right) mandated to provide them with information.

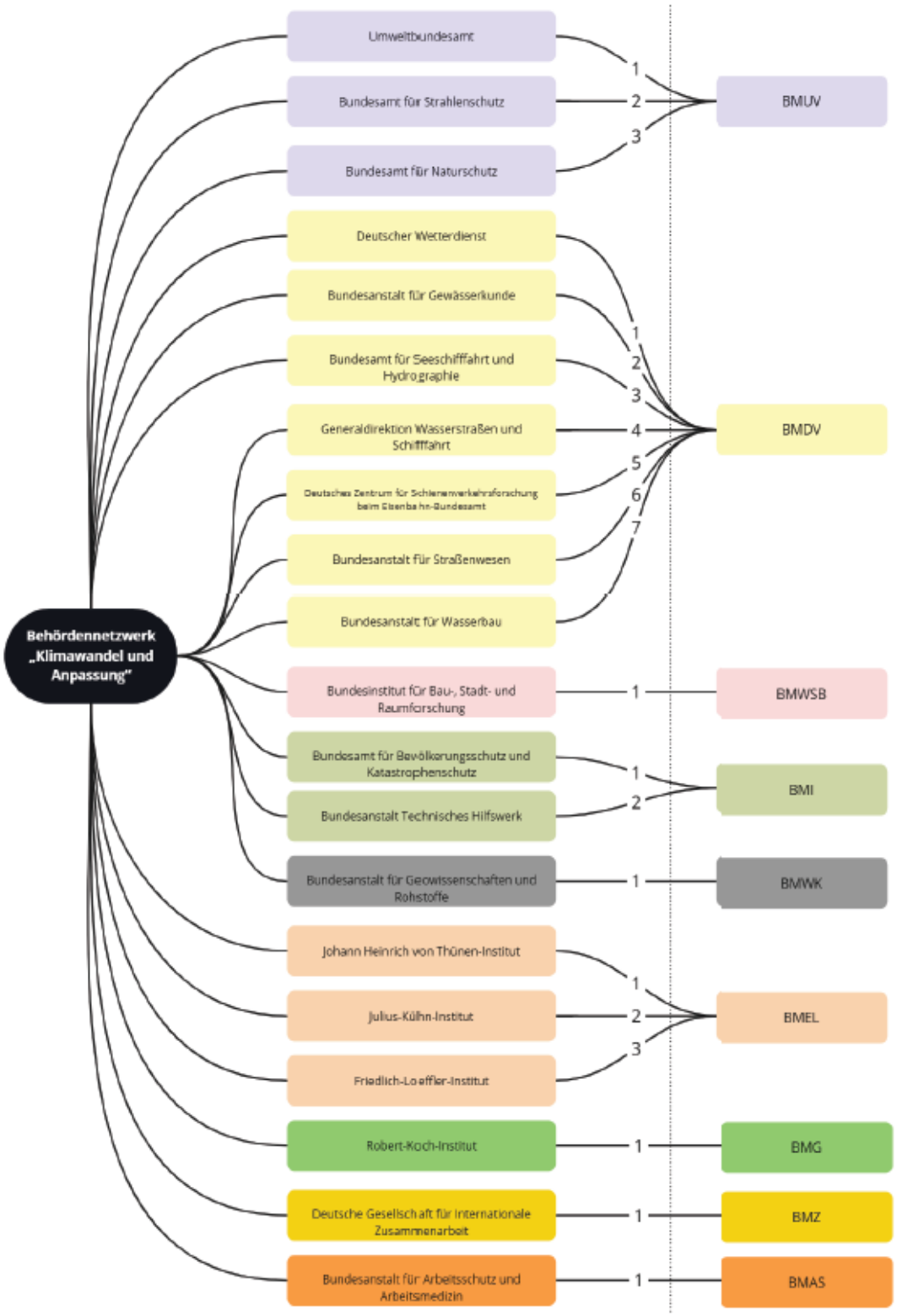

Fig 1. Representation of the German Climate Change and Adaptation Network (elaborated by Julian Bräuer).

4. **Trust can be enhanced by open, equitable, transparent, and accountable processes, and public accountability of agencies.**

Empirical findings indicate that political effectiveness and public trust cannot be reduced to a function of the breadth and depth of scientific consensus alone. As responses to the so-called 'climategate' affair show, public trust in experts is also related to the performance and persuasive power of the people and institutions who speak for science[xxvi]. What matters is also the performance and the ways how experts react and respond to public scrutiny rather than the content and quality of science only. Trust thus is a function of the relation with the public: a willingness to show why experts should be believed ("show your work") and how the public is invited to ask questions.

The extract below shows how one of our interviewees described the open, transparent and accountable process through which a regional government acquired and installed an Early Warning System (EWS) in several municipalities:

> Staff from our department attended meetings with the external company to assess the pros and cons of the service. They analyzed how the EWS responded during specific events, went on-site, and spoke with local municipal staff to see whether the tool was effective in issuing alerts and whether those alerts were appropriately identified. In the process of reviewing, calibrating, and operating the tool, all parties are involved. *(Policymaker, regional government, Mediterranean European country)*

The WMO *Guidance on good practices for CS user engagement* distinguishes between different forms of engagement, from "passive" to "active" engagement. The extract above illustrates what "active engagement" might look like.

5. **The use of CS and standards can and must be enhanced by climate adaptation regulation.**

The use of CS and the compliance to standards can and must be strengthened by the development of effective legal mechanisms. In some EU countries and policy fields, CS, standards, and political regulation are aligned in an efficient way:

> It is compulsory for our municipalities to measure their carbon footprint. In that case, we ask them to do it using a specific standard. *(Policymaker, national government, South-Eastern European country)*

However, standard development by itself neither automatically leads to adoption nor to regulatory change. For instance, although the ISO/TS 14092 standard on climate adaptation for municipalities has been available for several years, it is not necessarily used by policymakers on the ground:

> We know that ISO standards on adaptation for municipalities exist, but we don't really use them in our legislation yet. *(Policymaker, national government, South-Eastern European country)*

7 Takeaway Lessons

Finding	Lessons for stakeholders
	CS providers: Develop rules of procedure for assuring legitimacy and salience of CS.

1. A broad range of quality criteria is needed, including scientific credibility, political relevance and legitimacy.	***Policymakers:*** Enroll in and monitor standardization processes to ensure your needs and decision-making procedures are considered.
	Standardization bodies: Include CS users as early as possible to jointly develop rules of procedure for assuring legitimacy and salience of CS.
2. CS quality can be enhanced by engaging with diverse knowledge systems.	***CS providers:*** Identify roles for diverse knowledge systems in the design, delivery and assessment of your services.
	Policymakers: Develop networks of diverse and pertinent expertise to enhance and complement existing quality-assurance capabilities.
	Standardization bodies: Suggest a broader range of methods that can be used in CS development and quality assurance.
3. CS quality can be enhanced by tailoring CS to potential users in the public sector.	***CS providers:*** Identify who is the user group of CS; recognise their decision-making contexts including information needs, mandates and institutional/legal regulations.
	Policymakers: Establish interorganizational units and networks for integration of available climate adaptation-relevant information.
	Standardization bodies: Identify areas where needs for CS (knowledge gaps) exist and areas where they are already being provided.
4. Trust can be enhanced by open, equitable, transparent, and accountable processes, and public accountability of agencies.	***CS providers:*** Continue developing mechanisms of user and stakeholder engagement. Strengthen communication channels with service beneficiaries beyond the direct users of information systems.
	Policymakers: Identify knowledge needs as well as areas where capacity building is needed.
	Standardization bodies: Develop criteria to evaluate user and stakeholder engagement mechanisms.
5. The use of CS and standards can and must be enhanced by climate adaptation regulation.	***CS providers:*** Comply with climate law, remaining flexible to different legal requirements in different national contexts.

	Policymakers: **-**
	Standardization bodies: Monitor the demand for and use of standards and readjust if necessary.

[i] Baldissera Pacchetti, M & St. Clair, A.L. (2023), *ibid.*; see also Bremer, S., Wardekker, A., Baldissera Pacchetti, M., Bruno Soares, M., & van der Sluijs, J. (2022) Editorial: High-quality knowledge for climate adaptation: Revisiting criteria for credibility, legitimacy, salience, and usability. *Frontiers in Climate*, 4, 905786.

[ii] Villwock, A., (2023) Literature based guiding principles for high-quality climate services, D4.1 of the Climateurope2 project.

[iii] We collected a sample of articles from journals such as *Nature Climate Change*, *Climate Risk Management*, *Climate Services*, *Environmental Science and Policy*, *Climate Policy*, *Global Environmental Change*, *Frontiers in Climate*, *Current Opinion in Environmental Sustainability*, *Climatic Change*, *Social Studies of Science*, *Science, Technology & Human Values*, *Science and Public Policy*. Keywords included "climate adaptation", "climate services", "climate information services", "co-production", "quality", "public sector".

[iv] Drawing on the climate service definition of the Climateurope2 project, we revised sources addressing scientific credibility but also engagement with users. Examples include ISO ISO/TS 14092, CEN-CENELEC Guide 32, WMO Step-by-step guide for establishing national frameworks on climate services, WMO Strategic Plan 2024-2027, WMO Guidelines for user engagement in climate services, WMO Quality Policy Statement Res.19 (EC-69), Copernicus' Quality Assurance for the Copernicus Climate Change Service.

[v] These included deliverables from the *RESCCUE*: *RESilience to cope with Climate Change in Urban arEas* (D5.4), *B-WaterSmart*: *Accelerating Water Smartness in Coastal Europe* (D5.1, D5.6), *Climate.fit.City*: *Pan-European Urban Climate Services* (D2.2), and *ERA4CS: The European Research Area for Climate Services* projects.

[vi] The interviewees were involved in the development and implementation of the German Climate Impact and Risk Assessment (KWRA, and EU LIFE programme projects from Spain, Greece and the Netherlands. They worked at ministries for the environment, climate change offices, and urban resilience departments. Additional interviewees were recruited from a policy event in Belgrade in September 2025.

[vii] Definitions for CS, quality, quality assurance and standardization are taken from the Climateurope2 project glossary. Definitions for credibility, salience and legitimacy have been adapted from those found in: Cash, D. W., Clark, W. C., Alcock, F., Dickson, N. M., Eckley, N., Guston, D. H., ... & Mitchell, R. B. (2003). Knowledge systems for sustainable development. *Proceedings of the national academy of sciences*, *100*(14), 8086-8091. Definition for standards for quality assurance is our own.

[viii] Baldissera Pacchetti, M & St. Clair, A.L. (2023), Framework to support the equitable standardization of climate services, D1.2 of the Climateurope2 project.

[ix] Doblas-Reyes, F. J., St Clair, A. L., Pacchetti, M. B., Checchia, P., Cortekar, J., Klostermann, J. E., ... & Zorita, S. (2024). Standardisation of equitable climate services by supporting a community of practice. *Climate Services*, *36*, 100520.

[x] Climateurope2 (2024). Climateurope2 synthesis report: Key Messages on standardization of climate services.

[xi] Bremer, S. Wardekker, A., Schøyen Jensen, E., & van der Sluijs, J.P. (2022). Quality Assessment in Co-developing Climate Services in Norway and the Netherlands. *Frontiers* in Climate, 4, 905786.

[xii] Baldissera Pacchetti, M & St. Clair, A.L. (2023), *ibid*.

[xiii] Bremer, S. Wardekker, A., Schøyen Jensen, E., & van der Sluijs, J.P. (2022), *ibid.*

[xiv] Domingo, X., Stockhause, S., Spinuso, A., Thijsee, P., Bärring, L., Cripe, D., Delju, A., Krzic, A., Mihic, D., Obregon, A. (2024) Overview of procedures for data verification, including FAIRness and quality management of climate service data sources and processing methodologies – Deliverable D2.4 of the Climateurope2 project.

[xv] Baldissera Pacchetti, M & St. Clair, A.L. (2023), *ibid.*; see also Bremer, S., Wardekker, A., Baldissera Pacchetti, M., Bruno Soares, M., & van der Sluijs, J. (2022) Editorial: High-quality knowledge for climate adaptation: Revisiting criteria for credibility, legitimacy, salience, and usability. *Frontiers in Climate*, 4, 905786.

[xvi] Bremer, S., Wardekker, A., Baldissera Pacchetti, M., Bruno Soares, M., & van der Sluijs, J. (2022), *ibid*.

[xvii] Climateurope2 (2025). Climateurope2 second synthesis report: Key Messages on standardization of climate services.

[xviii] Baldissera Pacchetti, M & St. Clair, A.L. (2023), *ibid*., p.9.

[xix] Beck, S., & Siebenhüner, B. (2022). Learning. In K. De Pryck & M. Hulme (Eds.), *A Critical Assessment of the Intergovernmental Panel on Climate Change* (pp. 49–58). Cambridge University Press, p. 53. https://doi.org/10.1017/9781009082099.008

[xx] Baldissera Pacchetti, M & St. Clair, A.L. (2023), *ibid*., p. 25.

[xxi] See guidance from The Copernicus Climate Change Service (C3S) for more detail: https://climate.copernicus.eu/quality-assurance-sectoral-information-system,

[xxii] Baldissera Pacchetti, M & St. Clair, A.L. (2023), *ibid*.

[xxiii] Timmermans, S., & Epstein, S. (2010). A world of standards but not a standard world: Toward a sociology of standards and standardization. *Annual Review of Sociology*, *36*(1), 69-89. Quote from page 71.

[xxiv] Key message 3 of the Climateurope2 synthesis report states: "Formal climate service standards go hand-in-hand with flexible and accessible best practice guidance for adequate and equitable climate services" (p.5)

[xxv] Key message 3 of the Climateurope2 synthesis report states: "There is a need for technical standards that address the integration of climatic and non-climatic data, information and knowledge" (p.4).

[xxvi] Hajer, M. (2009). *Authoritative governance: Policy making in the age of mediatization*. Oxford: Oxford University Press; Hilgartner, S. (2000) *Science on stage. Expert advice as public drama*. Stanford: Stanford University Press; Jasanoff, S. (2012) *Science and public reason*. Abingdon: Routledge.