Climateurope2

Milestone M 20

“First mapping of encounters between users and providers of climate services”

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Content

1. About Climateurope2

Timely delivery and effective use of climate information is fundamental for a green recovery and a resilient, climate neural 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 form 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 be organized.

2. Executive summary

The milestone 'First mapping of encounters between providers and users of climate services' serves as a preparation for the deliverable D5.1 'Assessment report on place-based knowledge needs and narratives of climate change for maintaining trust in standardized CS'. The milestone is closely linked to task 5.2, 'Adding CS support and value to local policy and decision-making', with a special focus on place-based narratives of climate risk assessment. In this milestone, we argue from a decidedly social science and humanities perspective. In the first part, we provide a critical assessment of provider – user interactions in climate service literature. In the second part, we discuss the encounters between providers and users in the context of climate policy. Drawing examples from a great variety of climate service literature and case studies, we discuss in the following the role of narratives of change, of different systems of knowledge and the need to decolonize climate services. In the appendix, we provide elements of three case studies to explore the possibilities of standardization and policy support in the course of Climateurope2. The milestone is written in reference to the framework provided by WP1, the definitions of high-quality knowledge and mapping of provider- and user landscapes in WP4 (D4.1) and the guidelines for engaging with users in WP6 (milestone 6.1), supplemented by case studies from ERA4CS and examples from our own case studies. The goal is to provide first elements for policy support, to highlight the role of narratives of change for building and maintaining trust, and to lay a ground for the identification of processes which are suitable for standardization.

3. Provider-user interactions (Fiona Kinniburgh, TUM)

Based on a review of academic and grey literature on climate services, this section provides a discussion of different elements of CS which are helpful for understanding interactions between providers and users: a) decision-making contexts, b) actors and institutions, c) information and knowledge, and d) processes and interactions. The literature search used the IPCC's review of climate service literature (IPCC 2023) as a starting point. The search was expanded through a snowball approach and using Scopus and Google Scholar to include scientific and grey literature focusing on typologies of providers and users in CS, interactions between CS providers and users, and process-based accounts of knowledge production and its use. This section provides a preliminary discussion of different views expressed in the reviewed literature.

1. Decision-making context

A primary goal of recent climate service literature has been to explain whether and how CS can be "successful" (Boon et al. 2022). While this literature includes a strong focus on adaptation to climate change, Climateurope2 recognizes that CS may need to have a broader focus and be designed for use in other contexts, including climate change mitigation. As emphasized by Vincent et al. (2018, 52) , "a key difference between a climate product and a climate service is that the latter is expressly developed to address an identified user need, and, thus, should be decision-driven." As a result, there has been increasing attention to the decision-making context within which CS are used and how this context influences users' needs and the identification of problems which CS are intended to address (Boon et al. 2022; Vaughan, Dessai, and Hewitt 2018; Vincent et al. 2018).

However, the variety of understandings of climate services (CS) in the literature has led to relative ambiguity in terms of the decision-making CS are meant to inform. Harjanne, for example, states that "Although the concept is still ambiguous, such services can be defined as the production and delivery of climate related information for any kind of decision-making" (Harjanne 2017, 1). In mapping the encounter of providers and users of CS, it is therefore necessary to first draw boundaries around the types of decisions considered relevant to the goals of Climateurope2, namely i.) enhancing the uptake of CS to support adaptation to and mitigation of climate change, ii.) supporting equity in achieving these goals, and iii.) developing standardization procedures for CS.

Several scholars propose to extend the consideration of "climate decision-making" beyond decisions which are considered to be directly related to climate change mitigation and/or adaptation. A definition of climate change-related decisions by Orlove et al. (2020) takes a broader approach:

> "As opposed to a narrow definition of climate change decision-making—which defines decisions with respect to the underlying mitigation-driven or adaptation-driven motives or goals held by the decision-maker—our definition of CCRDs [climate change-related decisions] includes any explicit decisions made by an actor or set of actors (i.e., individual, household, community, organization, society) that have implications from the perspective of the systems that affect, or are affected by, climate change. In other words, *CCRDs may or may not explicitly acknowledge climate change*." (Orlove et al. 2020, 6, emphasis added)

For example, a business owner who decides to build a factory away from current flood zones or a home buyer who chooses to buy a house away from fire-prone areas may not explicitly consider or acknowledge climate change in their decisions. The authors argue that these decisions can, nonetheless, be considered as climate adaptation decisions.

On the other hand, it is critical to note that other users of CS (such as businesses) may explicitly make decisions based on scenarios of future climate change which may not be related to climate mitigation or adaptation, but instead to managing financial risks (Fiedler et al. 2021). While economic actors can make decisions (such may impact adaptation (and potentially lead to maladaptation), its primary goal is not adaptation per se. There is, however, increasing demand for CS from the financial and insurance sectors to manage financial risk across different timescales.

As these examples show, the decision-making context has a large influence on what is considered to be the (most important) problem CS seek to inform and solve. The specific problem a CS user wishes to address within a given context is normatively defined and negotiated through actors' processes of making meaning of the world. How actors frame specific issues, often through specific discourses and narratives, ultimately affects what is considered important in the design of CS (Orlove et al. 2020).

2. Actors & institutions

CS literature typically schematizes two main types of actors: providers and users of climate information (Cortekar, Themessl, and Lamich 2020; Tart, Groth, and Seipold 2020). In CS literature and in practice, there are also ongoing attempts to shift away from the typical "user-provider" dichotomy, for several reasons. First, actors may take on multiple roles as both "users" and "providers" of CS at different times or in different contexts (Daniels et al. 2020; Swart et al. 2017). Second, a variety of typologies have been proposed which distinguish salient roles aside from users and providers, such as "intermediaries" or other roles (Daniels et al. 2020; World Meteorological Organization 2023a). Third, from a practitioner's perspective, referring to predetermined roles can be counter-productive in CS co-production. Based on a project in Norway, Kolstad et al. recommend to “avoid dividing participants into predetermined groups based on their traditional responsibilities. This can have the undesired effect that the participants fall into their usual roles. Tip: Do not refer to the traditional end users (i.e., stakeholders and decision-makers) as “users,” but rather as, for example, “partners,” “practitioners,” or “coproducers. Similarly, do not refer to the climate scientists as “providers”” (2019, 8).

This and other projects have demonstrated the social dynamics which may emerge from a perceived hierarchy of social relationships within co-production processes.

Lastly, from a more theoretical perspective, the term “user” has been subject to academic debate on numerous grounds. For some, the designation of CS “user” itself can take on multiple forms (such as “user”, “next user” and “end user”), where “the important point is for the CS developers and providers to be clear themselves as to who they are providing the service to [...] and then how to best engage with and serve their users as recipients of the service” (Hewitt and Stone 2021, 2–3). For others, however, the discourse revolving primarily around market-based “services” draws attention away from a broader and more inclusive understanding of CS, such as one which focuses more on strongly on the plural functions CS provide and on the decision-making context in which CS are used (Bremer et al. 2022). From this perspective, actors aside from “only” users, providers, and intermediaries may play a role in decision-making vis-à-vis climate adaptation and mitigation, and categorizations based on a market-based logic may be too narrow, excluding other forms of knowledge and approaches towards building resilience and adaptation to climate change.

Rather than focusing on types of actors, it may be more useful to examine the *roles* of actors and institutions, allocated and performed in the interactions between CS producers and users. We furthermore note that institutions may be formal (such as governmental ministries or agencies) or informal (such as communities) (Bremer et al. 2022). The notion of roles bring attention to the mutable function an actor or institution may perform in the interactions providing climate services.

The notion of governance broadens the scope of actors beyond only governments to include private firms and civil society organizations. Decision-making actors relevant to the project may therefore be public or private, exercising decision-making power over themselves and beyond, to the public and/or private spheres. It is important to understand how different forms of governance (private, public...) and the different decision-making contexts matter when it comes to interactions between CS producers and users.

CS literature points to four main roles which may be taken on by actors and/or institutions:

1. **Initial knowledge providers**: actors who provide primary data and/or knowledge about the climate. Such actors could include actors typically considered as "providers" (such as meteorological services or research institutions), but could also include indigenous or local populations providing knowledge grounded in cultural learning and lived experience (Bremer et al. 2022).

2. **Intermediaries/translators**: actors who facilitate access between other actors and mediate between different social worlds. Examples include government ministries, local authorities, NGOs, international organizations, energy and climate consultancies, local forecasters, media organizations, etc). These intermediaries may be intentionally designed or designated as "boundary organizations." They typically play a strong role in facilitating communication between disparate stakeholders.

3. **Decision-makers**: actors who are in the position to make a specific decision (or series of decisions) which could be informed by climate knowledge and information. This means that the actors in question have decision-making *power*: their decision-making capacity has influence on specific outcomes. These actors can be further broken down into two categories:

    a. **Final (target) users**: actors who the beneficiaries of the tailored climate information, as intended by the initial knowledge providers and/or intermediaries. Such users have also been called "champion users," designated as those "who co-develop the service and pioneer its use" (Bojovic et al. 2021, 3). It is often discussed that final users of climate information are not specialists in climate science and have distinct and diverse needs and uses for climate information (Carter et al. 2019).

    b. **Potential users**: actors who may use climate knowledge and information which was intended for use by other actors, in cases where this usable climate knowledge is made publicly available (Bojovic et al. 2021, Cavalier et al. 2017, Chimani et al. 2020, Vincent et al. 2018, Visscher et al. 2020).

4. **Other stakeholders:** actors who do not have direct decision-making power. These can include stakeholders who are affected by projects and initiatives for climate adaptation or mitigation who are involved in the project design through consultation (e.g., Carter et al 2019). Such actors may include citizens or the private sector, among others.

3. Processes & interactions

CS literature portrays three main types of interactions between different stakeholders:

1. **Delivery of climate knowledge (uni-directional)**: an interaction in which one actor actively provides information to other actors in a linear manner.
2. **Use of climate knowledge (uni-directional)**: an interaction in which one actor uses information provided by another actor without active participation from the provider of knowledge (e.g. Larsen et al. 2021).
3. **Co-production of knowledge (two-way)**: an interaction involving co-production between different actors indicates a reciprocal, two-way, iterative process in which knowledge is shared between actors to co-produce new forms of knowledge over time (e.g. Bojovic et al. 2021, Bremer et al 2019).

Participatory processes or modes of participation between different actors in cases of co-production is an area of active research. There is a wide range of participatory processes represented in the literature (Bojovic et al. 2021; Bremer et al. 2022; Máñez Costa et al. 2022; World Meteorological Organization 2023a, Utvic et al. 2023), such as:

- Participatory workshops and roundtables
- Consensus-building activities
- World cafés
- Scoping and co-design workshops
- Questionnaires
- Face-to face and telephone or online interviews
- User surveys
- One-on-one, focus group, or open discussions
- Participatory mapping
- Living or learning lab approaches
- Interviews
- Case studies
- Serious gaming
- Field trials and trips

- Demonstration service testing
- Field and usability lab testing
- Attendance at stakeholder forums, conferences and seminars
- Webinars
- Engagement with or creation of “user” boards
- Training and capacity building
- Online feedback loops.

Different co-production processes may enable different levels of participation, with varying results in terms of learning. Ultimately, these processes and interactions are intended to inform specific decisions (illustrated in the orange box) made by decision-makers. However, as empirical evidence shows, climate information – even if specifically tailored to specific decision-making needs – may not ultimately be used (Porter and Clark 2023).

As next steps in this project, WP5 will more closely examine co-production processes to unpack different modes of participation and processes of knowledge production, both in and beyond CS. Guiding questions for examining interactions between providers and users of knowledge will include: Who is included? Why are they included? When/at what stage of knowledge production are different stakeholders included? What is the agency of different stakeholders in the knowledge production process?

4. Co-production revisited (Werner Krauß, UBremen)

Following the request to put social sciences into the forefront in climate research (Daly 2021, Findlater 2022), this section examines the provider – user nexus through the lens of social theory. Based on examples from the anthropology of policy, postnormal science and ethnographic case studies, this section further opens the black box of co-production. As seen above, co-production is considered as key for successful climate communication and the appropriate delivery of scientific information. But like Daly (2021) in her review article concludes, this promise has hardly been fulfilled. In the following, climate services will be situated in the context of the “culture of assessment”, and stakeholder analysis will be discussed in the context of the methods of managerial and organizational theory (1). From there, the focus shifts from analyzing climate change as a “matter of fact” to understanding it as a “matter of concern” (2). In the conclusion (3), the need to decolonize climate services as a basis for the identification of equitable and just standards will be highlighted.

1. Climate services and the culture of assessment

Climate services are newly emerging instruments of governance through which global, European and national policies are enacted. For a long time, co-production was hardly discussed in terms of governance, as a political instrument. In the WMO guidelines (2018), communication between science and society is mostly considered as a technical process which has to be carefully implemented with the help of social sciences. Various critical reviews deconstruct this clean version of provider – user interaction and highlight the tensions arising in the process of co-production. From this deconstruction, new opportunities arise towards polyphonic and more democratic forms of co-production.

In his article about "Servitizing climate science– institutional analysis of climate services discourse and its implications", Harianne (2017) states that the concept of co-production has largely failed to fulfill its promises. The term 'servitizing' goes back to an article by Vandermerwe and Rada (1988) who observed that companies were offering "bundles of customer-focused combination of goods, services, support, self-service, and knowledge" – a concept, which made a career in the following years when the "Internet of things" became omnipresent. Providers of climate services have to educate the users how to handle the digital products, like dashboards etc., while the providers themselves need the expertise of the users to make the knowledge more robust.

Turnhout et al (2019) criticize in their literature review the persistence of unequal power relations despite the promise to include the expertise of stakeholders. They argue that in actual practice, it is the scientists and experts who organize the process of co-production, they set the stage and define the context, they chose (and often pay) elite actors for participation, and they set the rules according to their interests and goals. Furthermore, scientific knowledge is generally valued higher than other forms of knowledge. As a consequence, Turnhout et al. argue, existing power inequalities are further exacerbated instead of mitigated. Furthermore, consensus solutions on a rational basis contribute to the depoliticization of societal problems and generally favor "best solutions" instead of acknowledging the complexity and messiness of the problems at stake.

Findlater et al (2021) find in their study that despite the promise of better decision making, climate services "mainly focus on delivering better data". Climate services, they argue, "often generate nominal changes in climate science where transformations are promised". The focus is here on climate science, its norms and institutions, which dominate co-production and produce three key tensions in operationalizing climate services, as summed by Daly (2021):

“The first tension is the continued focus on climate information products than on the underlying processes needed to build relationships and trust between scientists and potential users of climate information. The second tension is that most climate services are not truly demand driven; rather the information needs of potential users are often assumed by climate scientists. The third tension is that the field of climate services has generally failed to undertake comprehensive evaluations to assess whether climate services contribute to improved decisions and outcomes in practice”.

According to Daly (2021), the main results of these critical studies of the co-production process are the urge to rethink the norms and institutions of science and the “need to transform the cultures, norms and institutions of climate science”. As a way out of this dilemma, she concludes “that social scientists must play a leading role in climate services to make it a truly interdisciplinary undertaking”.

From an STS and anthropology of policy perspective, these tensions also arise from the permanent pressure in the current scientific landscape to produce results in short-term projects; because of the lack of time, the outcomes of the research more often than not are designed to fulfill the project goals instead of the actual societal needs. The average time for projects is two to five years, which leads to a “slash and burn” mentality of initiating co-production processes which are abandoned with the beginning of the next project. The anthropologists Shore and Wright compare the culture of permanent assessment in science to the newly emerging political “culture of assessment” in England and elsewhere, where experts replace democratic processes by

“*analysing* the problem and appraising the range of possible responses, *selecting* a response on sound and rational grounds, *implementing* the chosen course of action, *evaluating* whether the action produced the desired outcome and, in the light of that, *revising* the policy to be more effective in future.” (Shore and Wright 2011, 4).

This process is assumed to be linear or circular, and it is normally visualized in a graph. These visualisations and flow-charts are normative and “portray a mechanical model of policy as something ‘out there’ to be managed clinically and instrumentally” (2011, 5). It is assumed that “…economic actors pursue purposeful goals, decision makers make fully informed strategic choices and analysts measure policy effects in terms of calculable costs and benefits” (2011, 6).

Shore and Wright deliver here a description which sheds light on some aspects of the culture of climate services, which emerged simultaneously with the vision of a new scientific expert culture which “breaks down walls between public and private; pure and applied; science and industry” (WMO Bulletin in Harjanne 2017). Managerial and organizational theory entered the world of climate services, for stakeholder analysis (Baulenas 2023) and when climate science meets specialized experts to co-develop tools to improve clearly defined processes in production, for example in vine cultivation (Terrado 2023).

But from early on, there were also critical voices and warnings, as expressed by Hulme and Dessaj (2008: 14) in their assessment of British climate scenarios and models:

“(t)here is a tendency, emerging form the epistemological hegemony of natural science-based climate models (….), that debates about scenario construction revolve around technical details – spatial downscaling, construction of probabilities, temporal resolution, more climate variables – rather than around different ways of seeing world futures or of articulating the particular decision-contexts in which scenarios will be used.”

This discussion about the appropriate use of climate science is inherent in the development of climate services and culminates in the debate about the scientification of politics and the politization of science (von Storch, Krauß 2013). Shore and Wright show a way out of this debate in recourse on discourse theory. They are interested in the messiness and complexity of these policy processes, and in how these policies are enacted by different people at the same time. They focus on the productivity of climate services as a practice, in opening the black box of the culture of measurement and assessment:

“It asks: what does policy mean in this context? What work does it do? Whose interests does it promote? What are its social effects? And how does the concept of policy relate to other concepts, norms or institutions within a particular society?” (Shore and Wright 2011, 8).

In respect to climate services, Bremer et al (2019) take a step into this direction by providing a “multi-faceted conception of co-production of climate services”. Instead of engaging in a binary debate about the appropriate use of climate science for society, they suggest an eight-folded prism to analyze the co-production processes. They ask how climate services extend into new modes of communicating science, how they shape the representation of nature, how they interact with other institutions and systems, how they build governance capacity, how they support public services, how they empower marginalized knowledge systems and how they facilitate social learning and promote interactive research. In asking these questions, Bremer et al. open the black box of co-production.

2. From matters of fact to matters of concern

Climate change always happens somewhere and in some place. It takes a land(scape) and a people that have to find out how to cope with the effects of climate change or to mitigate them. More specifically, each climate-related problem takes its own assembly to come to a decision about how to shape the future. This is the point where non-human actors enter the stage.

For example, Bremer et al (2019) exemplified their eight-fold prism at the example of the Norwegian town Voss, where concerned citizens and scientists discussed how to deal with floodings of the river Voss in the future. In this example, climate science is not leading the process, instead they are part of a multi-faceted process. Climate issues like flooding, draughts, or emission reduction goals etc. assemble diverse actors, human and non-human, around an issue. Basic questions are: Who is concerned, who is allowed to participate and who is allowed to speak? Who is excluded, and who can provide which knowledge? In terms of postnormal science (Funtowicz and Ravetz 1993), these are cases where knowledge is uncertain, stakes are high, morals are involved and decision have to be made anyway. These issues cannot be solved by providing matters of fact (science) to satisfy a demand (decision context); instead, at stake are complex "matters of concern" (Latour 2004) which demand place-based forms of societal and democratic decision-making. Funtowicz and Ravetz (1993) suggest to form extended peer communities where all those who are concerned with a specific issue are engaged, discuss the issues at stake and evaluate the outcome.

The way how the inhabitants of a specific landscape frame for example current extreme weather events depends of their memory of past and current weather events. People make sense of a changing climate on local knowledge, which acts in both ways – it is infused by science, and it informs science. Local knowledge is defined by the IPCC as

"the understandings and skills developed by individuals and populations, specific to the places where they live. Local knowledge informs decision-making about fundamental aspects of life, from day-to-day activities to longer-term actions. This knowledge is a key element of the social and cultural systems that influence observations of and responses to climate change; it also informs governance decisions" (IPCC 2018).

There are further differentiations such as practitioners' or tacit knowledge which are crucial for the formation of extended peer communities. Meisch et al. 2022 show at the example of their CALENDAR and CANAL projects the value of tacit- and local knowledge about weather. In doing so, they counter the common belief that climate is not weather and show the value of local knowledge for place-based climate services. Anonymous populations turn into individual life stories, data transform into stories, place-based narratives become archives of the past and point to ways into the future. Narratives of change play a crucial role for the co-production of knowledge about climate change, as exemplified here at the German North Sea coast:

"Climate change materializes in form of extreme weather events, changes in the seasons and sea level rise. Local narratives represent these changes, expand the problem definition of climate change and express the multiple entanglements of weather, climate and society. Past flood disasters and interactions with the sea are presented in different configurations of time and space that put emerging forms of climate services into context. Narratives of change serve as a localization device and as starting point for the co-development of climate services for action." (Krauß 2020).

From the ERA4CS project "Co-development of place-based climate services for action" (2017-2021) resulted several case studies with a refined methodology, based on social sciences and the humanities. In the center of the analysis where the analysis of landscapes as continuous geo-social practices in space and time, narratives of change, senses of place, structures of feeling and political ecology (Krauß et al. 2018). Narratives of change play a role for the understanding of how climate change emerges as a risk in the city of Bergen (Bremer 2020), for the building of local resilience in Dordrecht (Wardekker et. al 2020), for local adaptation planning in France (da Cunha et al. 2020), for local meaning of climate risk in diverse locations (Vanderlinden et al.), for facing climate injustices (Baztan et al. 2020) or the role of citizen science for adaptation (Wildschut et al. 2020).

Climate science still plays an important role here, but they do so among other forms of knowledge, which are summarized under the vague labels of "local knowledge" or "tacit knowledge". Science becomes "situated knowledge" (Haraway 2016), too. In actual practice, climate services cover a huge span of diverse functions, from supply and demand to social functions – they inform and support different forms of activities, from citizen science over NGOs to public administrations. An ethnographic study from Northern Germany shows that in one and the same district, there is the science-based provision of downscaled climate information for the region; there is the assessment of municipal emission- and energy balanced based on standardized software, and there is a citizens' initiative promoting societal transformation to reach carbon neutrality and a post-growth economy (Krauß 2023). From this perspective, the request by Daly (2021) for social sciences to take the lead does not mean a replacement of climate sciences with social sciences; instead, it shifts the focus on the productivity of the manifold activities concerned with the effects of climate change, from individual life-style decision to municipal initiatives to scientific data about global climate change. Climate as a matter of concern means shifting attention from the provider – user interaction towards care for the people, the climate and the land. This raises a last point, which is environmental justice and the decolonization of climate services.

5. Conclusion: Decolonizing climate services

Mainly, there are three distinctive knowledge systems: science, local knowledge and Indigenous knowledge. Especially concerning local knowledge and Indigenous knowledge, it is important to note that "the scope of knowledge is broader than facts, hypotheses, and observational techniques" (Orlove 2022). In her book on "Braiding sweetgrass", Potowatomi scholar Kimmerer (2013) argues that scientific observation dismisses the “grammar of animacy” and turns animated land into facts and numbers, obliterating the knowledge and memory of its Indigenous populations. There are many examples in anthropological literature about the different ways of perceiving and sensing the land, about different ontologies and the respective epistemologies. The increasing relevance of the term Indigenous knowledge is closely related to the history of extractivism and of settler colonialism. Grossmann (2023) argues that colonial settlers turned the land into a commodity with the help of meteorological data about weather. Scientific data qualified the land along its availability for agriculture, plantations or other forms of extraction, while annihilating the history of the Indigenous people, their knowledge and their ways of using the land. Other contemporary examples are the misreading of landscapes through environmental-, development- and climate science. The anthropologist Dewan (2022) recently published her ethnography about ”Misreading of the Bengal Delta”, where dams were built in the name of climate protection while ignoring the detrimental effects on the local population who was never asked in the process. Similar effects are to be observed inside of Europe vis-à-vis forms of local knowledge and local practices, which are still hardly considered as an adequate source of knowledge. Orlove et al (2022) argue in their article about “Placing diverse knowledge systems at the core of transformative climate research”

“…that solutions-based research must avoid treating climate change as a merely technical problem, recognizing instead that it is symptomatic of the history of European and North American colonialism. It must therefore be addressed by decolonizing the research process and transforming relations between scientific expertise and the knowledge systems of Indigenous Peoples and of local communities”.

From Indigenous communities, there are requests for full consultation, for free, prior, and informed consent, for recognition of customary law, for intellectual property rights, for Indigenous data sovereignty, and the preservation and promotion of Indigenous languages (Orlove et al. 2022). These cases provide a lesson that environmental justice and equity are not to be found outside of co-production or should be added a posteriori, but that they are an integral part of it. At the same time, these requests might serve as a basis for policy support of local communities and the standardization of climate services.

6. Appendix: Case studies

In this section, we provide summaries of three case studies which exemplify various elements of the user and provider nexus as outlined above. The case studies are organized along the four components of climate services as defined in WP1. They will serve in the future for the further identification of elements for policy support and for the identification of processes which are mature enough for standardization.

1. Guadeloupe (France) (Grit Martinez, ecologic)

Decision context (what is at stake, who is involved)?

The territory of the French West Indies (France) extends over the archipelago of Guadeloupe and the island of Martinique. It is part of the so-called 5th worldwide hot spot of biodiversity, and it is highly exposed to climate change. The main economic sectors of both islands are tourism, followed by agriculture. Moreover, farming remains historically, socially and culturally important to the identity of the islanders. About one-third of the land is occupied by crops which are highly sensitive to pests also influenced by the tropical climate. Building resilience to natural disasters and committing to the agro-ecological transition from mainly large commercial-scale monoculture (sugar and banana) to a better balance with more diverse and sustainable farming for local use are two main challenges in the French West Indies. Moreover, food sovereignty is one of the main issues as the islanders depend on more than 80% of imported food from France, generating, at the same time, a huge ecological footprint.

Like other Caribbean islands, the French West Indies, are shaped by its colonial heritage. Today's economic structures are a legacy of the colonial era. The population of Guadeloupe and Martinique is mostly composed of people of African descent with a smaller part composed of European and Asian (Indian and Chinese). After World War II, in 1946, Guadeloupe and Martinique received the status of French overseas departments, which meant that they became an integral part of France. Nevertheless, the agro-export status quo is based on the concentration of production in the hands of land oligarchies. These benefit from agreements that protect their interests through quotas or rights of access to the French market. This economic model also results in a low diversification of production and a high degree of extroversion. Food staples produced in the French West Indies only contribute to 25% of what is needed for local consumption. Accordingly, most of the groceries consumed at the islands are imported from France. This includes products like milk, potatoes, onions, tomatoes, beetroots, etc. Due to the higher costs of importing products into the island, the prices of basic commodities and food staples in Guadeloupe are much higher than in metropolitan France, while the average salary in Guadeloupe is lower than in mainland France, except for officials working for the French government who receive significantly higher salaries to offset the higher costs of living on the island. Unemployment and poverty rates are double those found in France. From 2006 to 2007, several riots protesting against high food prices have shaken the island. In 2009, the tensions cumulated in a social crisis addressing the unequal social and economic treatment of the mostly creole population compared to the citizens in mainland France. During this time an NGO with the Creole name “lyannai kont pwofisayn” (LKP) was founded to protest against this unequal condition of the residents of Guadeloupe. The word “lyannai”, used in the name of the NGO, means “conviviality”. Martinique writer Édouard Glissant (1928–2011), an important author of the French-speaking Caribbean and intellectual mentor to questions of post-colonial identity and cultural theory, had used the term “conviviality” as a synonym for creating joint forms of knowledge to overcome distance and separation from one’s own culture. The NGO used the codeword “conviviality” to mobilize feelings of social and cultural identity coupled with the narrative of the “creole garden” for a movement to fight post-colonial structures expressed amongst others through food dependencies from mainland France and social injustice.

Against this background, governmental support for an agro-ecological transition has emerged in the last decade. For example, a new legislative framework (Economic Development Scheme of Regional Communities) underlines the ambitions for a green economy, a shift away from the current monoculture to the production of crops and vegetables for local consumption and food sovereignty. Regional government started to support the agro-ecological transition away from the current monoculture (i.e., sugarcane (for rum production) and banana, mainly exported to the French market) to the production of crops and vegetables for local consumption. In 2020, Guadeloupe approved the Regional Strategic Plan for an Agroecological Land Transition based on three major work areas, i.e. providing support to economically viable agroecological systems; allowing agroecological systems access to land; ensuring dissemination, training and innovation to promote an agroecological transition which is supporting diversification towards multifunctional agriculture, focusing on small-scale family farming as a possible vector for agricultural development in light of the challenges of the 21st century. https://www.inrae.fr/en/news/microfarms-guadeloupe-agroecological-transition-has-begun

In addition, grass root initiatives promoting small-scale farming/urban gardening are currently spreading over the island. This could open up new, fairer opportunities for agricultural production and consumption for the Creole and non-Creole population in the French West Indies under the changes new climate regime dictating to seasonality, timing and volume of rainfall. Farmers (interviewed by Grit Martinez) expressed their visiona rooted in the socio-cultural identity of the so-called “creole garden” being a synonym for sovereign, self-sufficient and diverse agricultural production.

Against this background and under public pressure, regional government started to support the agro-ecological transition away from the current monoculture (i.e., sugarcane (for rum production) and banana, mainly exported to the French market) to the production of crops and vegetables for local consumption. In 2014, a framework agreement was signed with the Guadeloupe Region setting out the broad lines for agricultural research in Guadeloupe. Based on values and expressions offered during single interviews and alongside focus group meetings and workshops (undertaken by Grit Martinez) with key stakeholders such as regional authorities, farmers and NGO’s it became evident that a scalable, ergonomic and informative knowledge repository on the impact of climate change on agriculture processes to better characterize season disturbance and changes into plant life cycles in correlation with temperatures, rains and droughts variability would be a beneficial climate service for stakeholders in the agricultural sector.

INRAE, the French National Research Institute for agriculture, food and environment has being very much aware of the climate change impact on local common crops that is accompanied by a host of nuisances (pests, diseases, etc.). In 2017 the institute joined forces with the ERA-NET Consortium “European Research Area for Climate Services” (ERA4CS) project INNOVA (Innovation for Climate Service Provision) https://www.innovaclimate.org/ to develop a Data Knowledge Platform (DKP).

What kind of data / information / tools / service are delivered?

The framework which is called a geographic Data and Knowledge Platform for Supporting Climate Service Design (DKP) was developed between 2017 and 2020. It allows users to store, search and visualize various pieces of information and knowledge about the impact of climate change on agriculture processes in Guadeloupe. Data analytics can be conducted on key indicators that are defined and extracted from agricultural and climatic data in order to better characterize season disturbance and changes into plant life cycles in correlation with temperatures, rains and droughts variability. However, in its first version, the DKP particularly fits the case of the French West Indies (Guadeloupe and Martinique islands), a hub of the INNOVA project in which the development of services is studied to assess the risk of the impact of climate change on island agriculture.

The DKP is furthermore useful to simulate different agricultural scenarios and to trigger governmental action plans in combination with MOSAICA (a multi-scale bioeconomic model for the design and ex ante assessment of cropping system mosaics), an optimization system for Guadeloupe agricultural activities. MOSAICA is able to find the best combination of activities on each agricultural plot of the territory according to a given criterion to optimize, for instance the farmers income. MOSAICA takes into account climatic hazards and calculates the vulnerability index of each field and crop.

https://www.sciencedirect.com/science/article/abs/pii/S0308521X15300184?via%3Dihub

How are the data / information / knowledge delivered?

The Data Knowledge Platform (DKP) supports CS suppliers and users in their task by allowing to: (a) gather georeferenced information on a given local climate-change case study for further design of solutions towards mitigation and adaptation, (b) explore climate data and other categories of digital data into a geographic framework, and (c) act out climate-change scenarios related to a given activity.

The platform is functionally structured in three modules, each corresponding to a specific activity in the co-design process: (a) data-management, (b) geographic-data-staging, and (c) knowledge-discovery modules.

The discovered knowledge using the platform is of three kinds:

- a data-search module that allows users to search and filter the database via a search engine in order to identify any DKP resource matching a user query;
- a knowledge-extraction module that only focuses on climate data and is able to answer questions on the evolution of specific climatic conditions; and
- a text-mining module that allows users to conduct deep analysis of DKP textual resources associated either to a given hub or resulting from a more complicated query.

The DKP is intended to support climate-based decision making by enabling CS providers and end users who work in a co-design dynamic, to analyse local trends in numerical indicators and other available resources (images, videos, narratives, scientific publications), and assess the risk on the basis of visualizations and geographic representations. The DKP presents a technological climate service.

2. Valencia (Grit Martinez, ecologic)

Decision context (what is at stake, who is involved)?

In the metropolitan area of Valencia, the water use is intense, and the region suffers from frequent droughts due to climate conditions. Valencia is surrounded by an agricultural landscape with deep cultural significance and with a multi-sectoral structure in which irrigated agriculture plays an important role in the consumption of water. The Albufera Natural Park, less than 10 km south of Valencia, is a freshwater lagoon and its surroundings rice plots.

With around 800.000 inhabitants in the city and more than 1.5 million people living in the surrounding metropolitan area, Valencia is the third largest city in Spain. Founded as a Roman colony in 138 BC, Valencia is located on the east coast of Spain. The city of Valencia has a historical relationship with water, both marine and fresh, as the city spreads along the margins of the Turia River and by the Mediterranean Sea. Contemporary Valencia is a combination of architectural styles that originate from a rich history and cultural diversity, ranging from gothic to baroque and from Islamic to modernist buildings. More than 2 million tourists visited Valencia in 2017. The features that tourists mention more often about the city are the nice weather all year round, the local beaches, the Mediterranean gastronomy and the cultural heritage and regional traditions, such as the “Valencian Falles”. Climate change is a major concern for regional and local administration on the Valencian region. The main risks and vulnerabilities that climate change will bring to Valencia have already been profoundly studied, and nowadays the focus of research is shifting towards studying the best adaptation strategies available for the region.

The city of Valencia is surrounded by what is known as the “Valencian orchard” or “l’Horta”, an agricultural landscape with deep cultural significance. The main crops of the region are citrus, vegetables and rice. L'Horta as we know it today was developed during the medieval Islamic period. During that period irrigation ditches and small dams were constructed near the Turia and Jucar Rivers to irrigate crops. Many of these historical features still exist today and are still in use by farmers. The long tradition of water management in the area is also reflected in the existence of long-standing institutions like the Tribunal de las Aguas (Water Tribunal). This tribunal, a customary court, dates back its origins to Islamic or even Roman days. To this day, this court still settles irrigation disputes of farmers in nine irrigation communities around the city of Valencia.

The Albufera Natural Park, less than 11 km south of Valencia, is a freshwater lagoon and its surroundings rice plots. The lagoon is the main feature of the Valencian Albufera Natural Park, with a surface area of 21,120 hectares. The wetland and lagoon area has a high biodiversity sustained by its water ecosystem and the fields surrounding the lake, which are used for growing rice since the 18th century. Rice fields have great economic and environmental importance. Some of the species that live in the lake also use the surrounding rice crops, where sometimes water quality is better. This includes the grey heron, the great cormorant and the Hermann's tortoise.

The Climate Change Adaptation Plan for the City of Valencia 2050 describes three main climate change impacts on the city. These are extreme climate and weather events (like droughts and floods), increase of average temperature and the decrease in average rainfall. According to the Adaptation Plan, water is by far the most vulnerable resource (in terms of both availability and quality) for planning the city in the 2050 horizon. Water, as a scarce and valuable resource, is linked to effects on biodiversity of water dependent ecosystems (such as the Albufera), public health and agriculture.

The urban water demand of Valencia and its metropolitan area is shared between the Jucar and the Turia River. The qualitative and quantitative status of both rivers are critical factors to consider. Water for domestic purposes requires two water purification plants working 24 hours during the whole year in 19 treatment plants. EMIVASA, the company responsible of purifying the water for the city of Valencia and its metropolitan area was already conscious of the risk that climate change generates for their activity. EMIVASA is a public-private partnership with 80% owned by Global Omnium and 20% by the Municipality of Valencia.

The mandate for the ERA-NET Consortium “European Research Area for Climate Services” (ERA4CS) project INNOVA (Innovation for Climate Service Provision) was to assess the effect that climate change will have on the future raw (untreated) water available in the Valencia region in terms of both quality and quantity and to assist EMIVASA in finding the best strategies to treat and manage this resource as well as to calculate the costs of the adaptation strategies. Besides EMIVASA who was involved in the co-creation process of the climate service, Valencian municipality, EMSHI Metropolitan Area Authority for Water Supply and the Water authority of the basin were interested in the results.

What kind of data / information / tools / service are delivered?

Climate change is not only going to affect the amount of water available, but it also will have an impact on the water quality. One of the primary concerns are the rise of microorganism growth rates in water supply systems in Valencia caused by higher average temperatures. Changes in the abundance and the taxonomic composition of microorganisms can affect drinking water quality. The main goal of València’s water utility company is to guarantee the water quality and to improve the efficiency of the water supply network. For this reason, they have installed a new water treatment using active carbon to remove taste and odor produced by microorganism in raw water. Model simulations project a rise in microorganism growth and concentration due to the increasing temperatures in the near future and hence the importance of researching techniques to remove them.

The co-designed climate service developed by the INNOVA project team with the water utility company of Valencia led to three main results during the 3-year process of the collaboration. (1) Description of the effect of climate change on the water availability in different water reservoirs (water storage, monthly inflows, outflows and water shortages); (2) Impact of climate change on the quality of water storage in the reservoirs (e.g. temperature, chlorophyll, oxygen dissolved, organic nitrogen, ammonium, nitrates and phosporus); (3) Assessment of costs of adapting existing water treatment processes to the new climate scenarios.

How are the data / information / knowledge delivered?

The modelling framework couples water quantity and quality and their interaction in a chain of models. The analytical framework has three distinct elements: (1) a combination of climate projections; (2) hydrological and water resource management model of the river basin system; (3) reservoir management and water quality model. Two concentration pathways were considered in two timeframes for the analysis (the short term (2020–2040) and the medium term (2041–2069). The results show a significant reduction in water availability combined with an increased frequency and intensity of phytoplankton blooms and anoxia episodes. (Rubio-Martin et al.) Through the involvement of water utility operators in the co-creation process of this climate service it was possible to combine models on different scales targeted to the needs the water utility operators which is to reduce the system's vulnerability to climate change.

Ecosystem of actors

Water utilities are often more interested in management issues that develop over time, rather than in particular technical issues with a definite end-point. In the Valencia case, the interaction with the INNOVA team during the project raised additional interests of the water utility company regarding operational issues that have motivated continuing the partnership and the coproduction relationship towards new goals after the conclusion of the INNOVA project.

3. Northern Germany (Werner Krauß, UBremen)

The goal of this case study from the North German coastline is to follow the process how climate policies are implemented, to find out what kind of information, data and knowledge are delivered by whom, and what kind of interactions are put into play by the various actors. My special focus is on science-based climate services, on so-called municipal climate (protection) managers, and on a citizens' climate initiative. For more detail, please see Krauß (2023).

Decision context

The North Sea coastline and the surrounding districts are among the hot spots of climate change. Sea-level rise threatens the low lands behind the dikes; parts of the land are below sea level. It is until deep into the inland a constructed landscape, partly reclaimed from the land and shaped by ditches and drainage to put the water out of the land. It is a post-apocalyptical landscape, due to the horrendous storm floods between the Middle Age and the 18th century, and it has centuries-old infrastructures of water management to keep it inhabitable. Increased extreme weather events in combination with land use and historically extraction of soils makes it more and more difficult to drain the land.

In the past decades, farming became more and more industrialized, with severe changes in land use and ownership: there is intensive cattle production for the nearby slaughterhouses, large scale monocultures (corn) for the production of biogas and for feed, former grazing pastures are increasingly used for dumping manure from the intensive cattle breeding, and there is increased use of land for wind energy. Big companies invest in land cultivation, while the number of farmers is reduced dramatically. These factors have changed the landscape profoundly, raising greenhouse gas emissions and consequences for adaptation.

Like in many parts in Germany, the public is 'climate sensitive', and until recently, Fridays for Future was highly popular. Currently, climate is a point of contention raised by right-wing politics.

Due to the national endeavor to reach the climate goals, climate is supposed to become a decisive factor for decision-making in sectors like housing, mobility, health, construction, energy, water management, dike maintenance or land use. In my case study, which started during the ERA4CS project CoCliServ (2017-2021) and is still ongoing, I focused on the implementation of climate policies on three levels: 1) Public science-based climate service; 2) the implementation of municipal climate managers and 3) a citizens' initiative, *Klimamarkt Ammerland* (climate market Ammerland). My interest is in the respective narratives of change, practices and contestations. Who counts as a provider, who as a user, what is the agency of the respective ways of climate service?

Data – types of information and knowledge

There is a great offer of **science-based climate information**, provided by designated climate services or those delivered from public administration and as a result of research projects. Among them are the German Weather Service (Deutscher Wetterdienst), the German Climate Center (GERICS), the North German Coastal and Climate Office and others. Climate data are available on the Internet or presented in public presentations (North German Coastal and Climate Office, for example). GERICS, for example, provides for every district in Germany basic climate information (with long descriptions of uncertainty concerning the presented data). Users are the public, businesses, schools, media or selected stakeholders.

In public administrations like water management or dike associations, **empirical data** are permanently monitored, like temperature, extreme weather events etc. Specific trends are compared to scientific data presented by available science-based services.

Lower Saxony and the districts in this coastal area are subject to the German Climate Initiative, originated by the German government. One of the features of this Initiative is to finance climate managers for districts, municipalities and parishes for at least two years. They deliver **data about**

territorial GHG emissions in the individual sectors like mobility, housing, industry etc., based on standardized (BISKO standard) energy planers.

One of the results of the co-development of climate services for action, CoCliServ, was a **local citizens initiative**, the Klimamarkt Ammerland (climate market Ammerland), which is still active. It is a networking initiative which brings together various initiatives, private and public, in order to promote a **climate friendly way of life**, like alternative forms of mobility, education, food etc., based on **local knowledge** and on a long alternative (sub)culture. They also protest against a planned Autobahn, which crosses the moors of the Ammerland, against monocultures, and promote the rewetting of moores etc.

The management of this constructed landscape and the maintenance of its infrastructure is deeply ingrained in public administration. It is also ingrained in public life; inhabitants have to pay regularly for the maintenance of the water management system; the landscape is shaped by the ditches, with the marshes, moors and the *Geest* (sandy remnants from the Ice Age, main land) as its features. Climate is **institutionalized knowledge** (water management, coastal protection etc), **local knowledge** (the memory of past storm floods and weather extremes) and **tacit knowledge** (farmers are used to work in irregular weather conditions); there are **customary practices** in this rural area (historically related to dike maintenance and water protection), and there is permanent change.

Data Delivery

The official climate services deliver data on the **internet**, in form of **publications** like the North German Climate Atlas, or in **public presentations**. During my fieldwork, I worked together with the North German Coastal and Climate Office. They are specialized on delivering regional climate data for diverse publics in Northern Germany, such as in schools, for organizations, public administration, media etc. Mostly, the presentation of data and politics are clearly separated; on the other hand, climate change is used as a moral asset to promote climate science.

The climate managers in the districts and municipalities present **standardized climate protection plans (Klimaschutzplan)**, with detailed lists of emissions in the various sectors. From these data, they derive suggestions how to reduce emissions in the respective sectors – proposals which have to be approved by local politics. They include **public participation**, via focus groups and public presentations, and they bring together stakeholders to discuss the possibilities of emission reduction. The data they deliver are standardized and as such they are comparable in Germany and beyond.

The citizens' initiative, Klimamarkt Ammerland, organizes **public climate markets**, where they invite local initiatives which promote alternative and climate friendly infrastructures. The Klimamarkt also organizes public discussions with political candidates before election, they organize webinars and other activities. The goal is to bring different initiatives together and climate issues into the public sphere.

Ecosystem of actors

The implementation of climate policies happens on various levels and through different actors, each with an agenda of their own. The provision of climate services seeks to address a broad range of diverse target groups, the public, public administrations, and private businesses. Many of the public administrations have access to a wide range of precise climate data from different sources such as the IPCC, regional projects etc., and many of them are conducting research, too. Water management and dike associations have access to the general information, but their practice is mostly based on tacit knowledge, on experience and local knowledge. The *Klimamarkt* as local initiative in turn addresses drivers of climate change in private, public and economic life. All of these 'climate services' work on different levels, and tell different narratives of change.

We can expect that the demand for CS is growing over the next years, partly mirroring trends in recent climate governance: Climate change becomes part and parcel of all policy fields and sectors (housing, construction, energy, health, water management, mobility, nutrition etc), the adoption of national and local climate related goals (adaptation, mitigation, Net Zero targets). Currently and due to the energy and emission balances and national politics, the implementation of climate friendly thermal energy will be a priority of local politics.

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