CHAPTER 18

Local representations of a changing climate

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Chapter Outline

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18.1 Introduction

Here, we share local representations of changing climate from five sites in four countries across Europe: Bergen (Norway); Brest, Kerourien (France); Dordrecht (Netherlands); Gulf of Morbihan (France), and the Jade Bay (Germany). These case studies represent opportunities for local consciousness-raising on climate-related questions, along with forthcoming implementation of climate services at local, regional, national, and international levels. We explore novel ways to transform climate science into action-oriented place-based climate services that engage, enable, and empower local communities, knowledge-brokers, and scientists to act locally and identify future information needs and the nature of the climate science needed to address the local communities' concerns, aspirations, and goals in light of climate variability and climate change. Our experiences working with these five sites also provide a glimpse into the diversity of climate contexts in Europe. This chapter is one of the outcomes from concluding a 4-year initiative codeveloping place-based climate services for action: CoCliServ; this chapter is a brief version of the WP4 project deliverables, available in full via cc-by-sa-nc doi:353039226 and doi:350386446.

18.2 Local conditions of a changing climate

18.2.1 Bergen, Norway

In Bergen, codeveloping place-based climate services, CoCliServ, is based on a municipal climate adaptation context and engaged in citizen science projects. Bergen is a harbor city in the fjords of western Norway. King Olav Kyrre founded the city in 1070, and its name *Bergen* means "the green meadow among the mountains." The historic center is on the flat land wrapped around the sheltered "Vågen" harbor, and surrounded by seven low mountains. The harbor itself is adjacent to a fjord – "Byfjorden" – which is sheltered from the North Sea by a chain of islands including the islands of Sotra and Askøy. Today Bergen is the administrative center of Hordaland County and comprises eight boroughs extending over an area of 465 square kilometers, with a population in 2016 of 278,121 inhabitants. Here, the CoCliServ study focused on the historic center of Bergen and the immediately surrounding suburbs that fall within the Bergenhus borough. Bergenhus contains most of the historic sites of the city and is the most densely urbanized, with shops, offices, apartments, and houses. Bergen has historically been an administrative and trading center. Once founded, it became the capital and administrative center for Norway until the late 13th Century when King Håkon V moved these functions to Oslo, though Bergen has remained an administrative center for western Norway. Bergen has always had a strong focus on trade through the harbor, historically tied to the trade of fish and dried cod in particular, which the city was granted a monopoly to trade in the 13th Century. By the

mid-14th Century, a commercial and defensive confederation of German merchant guilds—the Hanseatic League—established a "kontor" in Bryggen, alongside Vågen harbor. Bergen became one of the four most important Hanseatic trading centers up until the mid-18th Century when the Germans left the kontor to Norwegians. Over this time, Bergen was the center of trade in Norway, which also saw it become the largest city in Norway up until the 1830s when it was overtaken by Oslo. It has always been a prominent international city, with influences to its culture and language through trade ties to England, the Netherlands, Germany, and France.

18.2.2 Brest, Kerourien, France

In Kerourien, CoCliServ used climate change as a medium to connect the past, present, and future of social minorities in a collaborative effort with local artist groups. Kerourien is a neighborhood in the urbanized area of Brest, France, and is mostly structured around postwar housing projects. During World War II, the city of Brest was one of the worst damaged areas on France's west coast. From 1940 to 1944, it was the target of 165 bombings and 480 alerts, which resulted in 965 dead and 740 seriously wounded. The Kerourian farming area was also greatly impacted. The Kerourien reconstruction story begins January 8th, 1964. Albert Cortellari designed the site plan for the first Habitations à Loyer Modéré, (rent dwellings), HLM tower project in the western part of the city of Brest. The project included 500 apartments to be built on seven hectares of land the city purchased for 20 million francs using expropriation procedures that are recorded in the municipal archives. This housing project marked a clear turning point in the progressive transformation of Kerourien from a rural to a peri urban area. According to the 2013 census, Kerourien has 1200 inhabitants. It is a priority area within St. Pierre, as indicated in city policy statements starting in 2014. The most salient aspect of Kerourien is its diverse population. Rooted in a place with fragile economic conditions, residents face the challenge of unemployment. Thirty-two percent of residents between the ages of 15 and 64 are unemployed. For those between the ages of 15 and 24, the rate jumps to 46%. Thirty-two percent of women are unemployed. Only 35% of young adults ages 18−24 are enrolled in universities or other academic institutions. The most recent results from L'Hévéder's work in 2016 show the seasonal sea surface temperature (SST) of the ocean bordering the city using high-resolution satellite data. Coastal seas, well separated from offshore waters by intense frontal structures, show colder SST by 1°C−2°C in summer. A significant warming trend is observed in the autumn season. This positive trend is stronger offshore, with an annual mean SST increase of 0.32°C decade^{-1}, but weaker in coastal waters (0.23°C decade^{-1}), where strong vertical mixing induced by tides and winds acts to reduce surface warming. In the Iroise Sea the increase in annual mean SST in CMIP5 future scenario simulations ranges from 0.5°C (RCP2.6) to 2.5°C (RCP8.5) by year 2100, with a seasonal modulation leading to a more intense warming in summer than in winter. This increase in

SST may strongly affect marine biology, particularly phytoplankton phenology, macroalgae biomass and benthic fauna, including exploited shellfish. Governmental representations of climate converge mainly at the regional level and are summarized in the "Climate Plan: Energy & Territory 2014–2019" from the Regional Council of Brittany. This document establishes a framework rooted in the IPCC's efforts and identifies energy, transport, agriculture, fisheries, and infrastructure as the main sectors to focus on for improving sustainability through training, economics, planning, and environmental and international actions. The climate change representations embedded in Kerourien residents present a challenge, since they are manifested implicitly and explicitly, rooted in residents' past, present, and anticipated future life conditions. This opens the question: what can we learn from these embedded representations about the connections between knowledge and action?

18.2.3 Dordrecht, the Netherlands

In Dordrecht, CoCliServ joined municipal climate adaptation projects in addressing the needs of citizens and questions of social inequality. Dordrecht is located in the Rhine-Meuse-Scheldt Delta, one of the large European deltas. It is built on former peat swampland, and the soil consists mainly of peat, riverine clay, and to a lesser extent, sand. The presence of peat leads to ground compaction and consequently soil subsidence. The riverine clay, which is water impenetrable, reduces the uptake of water into the soil, and resulting in challenges with discharging rainwater. With receding water levels in the area, people built polders (drained land), with the first one dating back to 1603. From that date onward, the city developed significantly in size until the latest polder forms were built in 1926 around the Biesbosch on the island of Dordrecht. Whereas several severe floods happened before people started building the first polders in Dordrecht, much less is known about them, potentially due to their less severe effect on the already destroyed landscape around Dordrecht. Nienhuis (2008) refers to the big Allerheiligen Flood in 1570, which affected large parts of the North Sea coast due to a large storm that made landfall and was followed by several floods from rivers affecting the whole Delta region including Dordrecht. Accounts of this event on Dordrecht are not known in detail. Despite all the new dikes, after the St. Elisabeth's Flood (1421 AD), the city was completely surrounded by rivers and continues to be an "island on a river crossroad." The St. Elisabeth flood in 1421 had, by far, the most severe impact on the island, though many more floods occurred in the centuries to come. Interviews on the historical embeddedness of climate revealed, together with flood-stones in the city of Dordrecht, more recent historical floods in 1901, 1906, 1916, 1928, 1936, 1953, and 1954 (Marschütz et al., 2020). Recently, the municipality concluded that during flood events there will be too little time to evacuate its citizens, and that urban flood risk management will need to be rethought using concepts such as urban flood resilience and vertical evacuation. The municipality aims to actively collaborate with

citizens on climate adaptation and water management. Their work is backed by the National Water Plan, which states the need for adapting to climate change, specifically in relation to water. The province of South Holland has also considered the need to adapt to a changing climate and its effects, with this province being particularly at risk as large parts of South Holland are situated below sea level. Dordrecht in particular has been developing the concept of multilayer safety to bring flood resilience to a new level and incorporating sustainable urban planning as a primary defense to limit effects of flooding, as well as making the city and the island more self-reliable considering only 15% of the population can be evacuated. We have focused on the Reeland district of Dordrecht, with a specific interest in the Vogelbuurt neighborhood. The area has been affected by flooding through heavy precipitation events in recent years. The municipality and neighborhood are exploring on how to cope with weather-related issues and climate change through adaptation, with much local energy and with active local organizations. Furthermore, large-scale restructuring and maintenance (e.g., replacement of social housing estates), sewer replacements, and redesign of public green spaces and sporting facilities are planned. This provides a window of opportunity to explicitly take citizens' desires and climate change concerns into account when redesigning the area.

18.2.4 Gulf of Morbihan, France

In the Gulf of Morbihan, we worked together with nongovernmental organizations that have a strong focus on raising climate awareness. Located within the southern fringe of Brittany (at 47° 36′ North, 2° 48′ West), the Gulf is an attractive location for many reasons: geography and geology, history (and prehistory), environment and biodiversity, economy and tourism, and climate. These characteristics, in part antagonistic, justified the creation of the PNR in 2014. It works to protect and enhance the natural, cultural and human heritage of its territory by implementing an innovative policy of land use planning including mitigation and adaptation actions, and economic, social and cultural development, especially of a tourism respectful of the environment. The name "Gulf of Morbihan" is derived from two characteristics and one fallacy. It is a gulf of about 25 km in diameter (surrounded by a coastal trail of more than 400 km length, due to the numerous capes and bays), several tens of islands, from 6 km to a few hundred meters in length, and with a narrow entrance to the Atlantic Ocean (about 1 km wide). Morbihan, the name of the administrative department, means "little sea" in the Breton language. This little sea does not refer to the modern Gulf, but to the coastal sea which borders it to the west, limited by the "Pointe de Quiberon" to the northwest, the Belle Isle, Houat and Hoedic islands to the west and the "La Vilaine" river estuary to the south, a vast valley about 20 m deep, inundated after the end of the last deglaciation about 10−5 kyr ago. The Gulf itself was a small estuary joining two little rivers, which has been progressively inundated over these last 2000 years. The submersion derives from a

large-scale tilt of Southwestern Brittany and its associated continental shelf, along the fault following the western boundary of the Hercynian western mountains (submersion speed of about 1 mm per year) confirmed by 14C dating of submerged oak roots and megalithic menhirs of about 5000−7000 years BP, and Gallo-roman houses and roads. Climatically, the Gulf of Morbihan is within the general zone of conflicting influence between the mid-latitude Atlantic Ocean system and its ocean atmosphere interactions (with seasonal and interannual oscillations of the dry Açores tropical anticyclone system, and, at its north, the chain of temperate depressions and associated rain and westerly winds). Furthermore, seasonally the winter climate involves expansions of the continental polar anticyclone systems, together with cold north-easterly winds and the summer experiences expansion of the warm subtropical continental anticyclone. Local people are sensitive to climate change, with the winter rains more frequent, and dryer summers. Hay and wheat harvests are typically one month earlier nowadays than 50 years ago.

18.2.5 Jade Bay, Germany

The Jade Bay (Jadebusen) area is part of the UNESCO World heritage site Lower Saxony Wadden Sea, and it is situated between the river Ems and the river Weser. This North Sea bight reaches far into inland, and is the result of many centuries of interaction between humans and the sea. Especially between the 15^{th} and the 19^{th} centuries, devastating storm floods had extended the sea far inland. Since the end of the 19th century, a dike line of 55 km almost fully encircles the Bay and ensures the maintenance of the deep-water trenches, the so-called inner and outer Jade (named after the river Jade), which form Germany's only deep-water port in Wilhelmshaven. The Jade bight resembles a giant bathtub, surrounded by dikes and with a neck to the North Sea, which serves as the entry and exit of tidal waters. The bathtub is filled twice a day with water; with each tide, 450 million m^3 water from the sea floods an area of 164 km^2, while during low tide, only 44 km^2 are covered with water. The Jade Bay is surrounded by two districts, Wesermarsch in the east (the Butjadingen marshlands, between Weser Delta and Jade Bay) and Friesland in the west, with its main towns Jever and Varel. Water remains the crucial threat and challenge in this area: from the seaside, storm floods threaten the land, and on the land, highly complex drainage and pump systems keep the rainfall water out of this low-lying landscape and pump it into the sea. The marshlands, moors and the *Geest* (land formed by alluvial sediments from the ice age) are mostly used for pastures, cattle, and energy production, such as crop for bio-gas tanks and wind turbines. As a result, climate change in the Jade Bay area is mostly addressed by the fields of coastal climate adaptation, land use and energy transition.

18.3 Art and science local representation processes by site and related challenges

While the diversity of each local site determined the local representation processes, each local representation process aimed at three main representation forms: art and science integration, metadata, and geo-referencing. While the art and science components have their roots in each site, the metadata and geo-referencing aspects have been connected throughout the representation processes in ongoing discussions and explorations. However, they are less salient in the stabilized final representation forms. We discuss this further in the section dedicated to lessons learned.

18.3.1 Bergen, Norway

On three different occasions, Bergen's partners introduced groups of children and adults to the historic Norwegian calendar and invited them to create their own primstav (ancient Norwegian stick) for their own lives, and through this engaged them in thinking and conversation about the rhythms of their year, seasonal adaptation, climate adaptation, and climate change.

Around 150 primstavs were made through this approach. While one might argue that the representations made through this exercise are seasonal clichés, the main objective of the exercise was to spark reflections on (1) how we do different things at different parts of the year, (2) that this has been different at different times in history, for example, the time of the historic primstav and now, and (3), that this might change again in the future, for instance, due to climate change. Based on the conversations we had with the children and adults during the exercise and the primstavs they created, we think the exercise worked well. We find the primstav to be a powerful image, a concrete object articulating what living with seasonal rhythms can be, suggestive in the context of climate change and climate adaptation; an object "good to think with" (Levi-Strauss, 1964). The adults and children were fascinated by the primstavs and excited about the task of making one for their own life, and they found the suggested connection of this to climate change and climate adaptation to be interesting.

We found that, as the exercise is currently designed, children younger than seven have some trouble responding to it, though they also seemed to enjoy the drawing. On the other hand, we found that most adults enjoyed it and responded very well to the primstav and climate adaptation analogy, and to the drawing and woodwork.

18.3.2 Brest, Kerourien, France

For the Kerourien, Brest, France partners, the coproduction work focused on collecting narratives in an ad hoc process that evolved along the way. The initial step of our

coproduction process allowed us to anchor our actions in local stories and relate directly to our partner community and its values. This allowed us to free the coproduction team from dominant (and technocratic) climate change and adaptation discourses. Rather than adopting the pervading culture represented in the climate literature available to the community, we adopted coproduction work with narratives associated with everyday life, hardships, the joys and pain of migration, and engagement for greater justice.

Paying attention to local stories and the role of weather and climate within these stories led us to the realization that locally place-based climate service coproduction may actually entail working with multiple locations and associated issues. Coproduction challenged our routines. It pushed us to reconceptualize "place" as extending beyond the circumscribed location where our coproduction partners were living at the time. In the course of our work, place became a relational concept, the definition of which belonged to the members of the coproducing community—what mattered was their sense of place (see Stedman, 2003). Sense of place is an integrative concept (Saarinen et al., 1982), and it carries the characteristics of the physical environment and of the individual or group perceiving it. Sense of place plays an important role in place attachment, and others have shown, as we also observed, how memory is critical for migrant populations' relationships to places (Rishbeth & Powell, 2013). By adopting this extended concept of place, we recognized knowledge transcends national boundaries, and that time scales may relate to individual trajectories of past, present, and hoped-for futures. In their work analyzing the interplay of occupation, place, and identity, Huot and Rudman (2010) propose that individuals perform their identity in relation to place and occupation. This resonates with our results and the dynamic nature of the judgment individuals expressed of the place where they live and of the (now imagined) place that they once left, and to which many long to return. The status of an individual's perception of place shifts through time, as a manifestation of changes in their context, occupation and identity. Place-based coproduced climate services in such situations need to be reinvented to offer information that is dynamic, reconfigurable, and multilayered. This is another central challenge for the climate service coproduction research agenda.

Through the lens of priority setting, climate service coproduction has much to learn from participatory research and participatory planning. For instance, one aspect we did not address explicitly in this experiment in coproduction was that of gender. In the realm of participatory research there are many analyses showing that one should be explicit about gender and other identity dynamics at play—the "Whose voices? Whose choices?" questions that need to be answered (Cornwall, 2003). In the case of climate service coproduction, the dominant discourse may totally blind coproducers with its technocratic, pseudo-neutral, scientific stance; it seems too often to consider gender, race, class, and other social categories as not necessarily part of what deserves attention. Within the realm of climate change, our results point to "the importance of (re)politicizing co-production by

allowing for pluralism and for the contestation of knowledge" (Turnhout et al., 2020). As Krauss (2020) writes, "a focus on narratives shifts the attention from the impact of climate on society to the myriad of entanglements between human and non-human actors in a changing climate." This shift in focus would allow us to ground further steps of climate service coproduction in the priorities of those most vulnerable to the vagaries of the world.

18.3.3 Dordrecht, the Netherlands

The Dutch partners worked with "knowledge directors" and creatives, such as graphical designers, applying their skills to climate change and adaptation to codevelop a visual workshop to help participants develop their vision and scenario design. Designing future visions and scenarios for timescales up to 30 years from the present can be very challenging, for experts and nonexperts. A clear advantage of this approach is that it helped facilitate the research process and local design of climate adaptation visions, options, and scenarios. It helped bridge the disparate worlds of different scientific disciplines and different stakeholder groups, including policymakers, residents, and researchers. This type of art approach also involved a very tactile, physical mediation, which stimulated active discussion and creative work during the workshops and put all participants on an even playing field. The latter is particularly important, for instance if there are tensions, or perceived barriers or differences in expertise between participants. The use of line art and uncluttered white space enticed people to add their own contributions. Visualizations of hypothetical neighborhood streets, with elements connected to the scenarios, and a timeline were printed on large cardboard wall posters, which allowed multiple participants to work on them. The collaboration between the research team and the graphic designers in developing the artwork also went very smoothly. One might speculate that graphic designers are used to working with a wide range of clients for purpose-driven assignments, compared to more art-driven processes such as painting or theater. Of course, the specific situation in the case study and the Dutch team also helped: the Dutch research team and project leader are very interdisciplinary, and Studio Lakmoes is specialized in knowledge visualization. Overall, this led to a very useful and productive process.

We encountered several challenges and limitations as well. Graphic designs and line art worked well to represent physical elements that are easily visualized into recognizable objects, such as houses, people, clouds, etc. However, the narratives also involved more nebulous notions such as identity, history, sense of community, and emotions such as hope and fear. Combining the visual art with narrative handouts (short descriptions with quotes per vision) worked well to bridge this potential gap. It may also be useful to combine this approach with other art forms. The approach was successful in combining the natural science and social science dimensions of adaptation, but in line with the previous point, it may be challenging to integrate with humanities-related aspects unless combined with other

forms. Regarding the human dimensions of graphic design in art-science collaboration, while this approach worked very well, one could also argue that it is fairly goal-directed and instrumental. It helped elicit the "insider perspective" of the local communities. Other art forms might be better at providing an "outsider perspective"; for example, an artist observing the proceedings and providing their own unique perspective on it.

18.3.4 Gulf of Morbihan, France

For Morbihan's partners the aim was to engage local stakeholders through several forms and approaches, always aiming to achieve greater collective construction. This brought its challenges and pleasant surprises. The main outputs are: a collaboration with a designer to produce creative tools to help facilitate workshops; a long-term exhibition; and a small traveling exhibition with climate data panels and a comprehensive storytelling exercise connecting them to the metadata and dynamic mapping tool. The artistic process is embedded in extracts of interviews, led by the social sciences research team, and in the results of the workshop. All the information shared during the workshop was seeded by the presentation of local climate data and services.

In the Morbihan case, five artists came together to work on the projects along with a designer and the scientific team, resulting in some misunderstandings and possible frustrations. After a strong beginning, thanks to coordination work done by the designer and the local partner, Clim'action, it became clear with time that the will and expectations of some individuals in the group had given contradictory information on the possibilities of the project. Realigning everyone to share a common understanding of the project's objective and constraints took time but once the long-term objective was clarified, it became a strong foundation to build on.

The main objective was to develop artistic work on the basis of material collected through the interviews and workshop. In the process, we noticed the weak presence of some high-stake topics such as the loss of biodiversity, acidification of oceans, and changes in the rain regimes. This led to debate about the mission of the art and science project: (1) to only illustrate the concerns raised by the interviewed stakeholders, considering those will be the main ones of interest for the population of Vannes; and/or (2) to inject topics identified as key by the scientific and artistic teams to extend the horizons of the visitors.

Developing artistic work has been found to be an effective way to convey future narratives. We used maps and creative tools to help workshop participants engaged in the discussion with other approaches. The development of the Cataravane (the term used for one of the art forms is a neologism combining the words for "caravan" and "catamaran") and the storytelling exercise led to discussions among the artistic team and created the possibility to discuss our visions for the future. In order to push those exchanges beyond the boundaries of the team, multiple

animation activities were planned to accompany the art and science process. The objective was to organize animation at the end of the exhibition, seizing the potential benefits from the immersive experience to further discuss spectators' perception of climate change and will to act or take decisions. Unfortunately, the difficulties of setting up the exhibition both administrative (due to COVID) and human did not allow us to carry out these animations.

The coastal path turned out to have a fundamental role as an apt location for the artistic exhibition. Propositions such as the "Pathway of possibles" allow us to argue that artistic work can also become chronotopes. Here, chronotopes refers to points in the geography of a community where time and space intersect and fuse. Time takes on flesh and becomes visible for human contemplation; likewise, space becomes charged and responsive to the movements of time and history and the enduring character of a people (. . .) Thus chronotopes stand as monuments to the community itself, as symbols of it, as forces operation to shape its members' images of themselves (Bakhtin, 1981).

Such works would result from interpretations of collectively built narratives of past, present, and future change converted into physical elements to allow people to follow ongoing changes in the territory. Scientific researchers and artists would analyze scientific information collectively to capture the spatial and temporal dimensions of current transformations, which would then be communicated through artworks acting as markers, for instance, of expected sea level rise or estimated coastal erosion in the future. This "sneak-peak" into the future, as well as the ability to observe the speed of these changes through these new chronotopes, could inspire community-led transformative practices.

The team confronted various difficulties in conducting a collective process on the artistic aspect of the project. Artistic media is the result of a complex combination of its creator's perception, personal artistic interpretation, and the message the artist wants to convey. Most of the artists engaged in the Morbihan project produce in situ creations. The uncertainty of the location for the long-term and short-term exhibitions was perceived as a difficulty for the artists, and perhaps originated from a misunderstanding or mismatch between the expectations of the project's research team and the creative processes of the artists. We also encountered the difficulty of creating a horizontal management dynamic with individuals from different backgrounds and sensitivities. It was not always clear who was in charge of the final decisions and how should those decisions should be taken. This was only exacerbated by the constraints created through the COVID-19 context of only being able to meet virtually. We speculate that the group dynamic would have taken another turn if we could have met in person.

The COVID-19 situation prevented in-person meetings on-site and between the artists. The horizontal management that was implemented was constrained by the budget discussion, which was in the hands of the scientific team or under the responsibility of the local partner. These two elements would usually be easily discussed in person through formal and

informal conversations. The distance created by the virtual meetings emphasized difficulties of the inclusive process. Moreover, the artistic process mobilized individuals with different sensitivities and expectations for the project and its development. At various moments, the artists felt excluded from the process; we believe in-person meetings would have helped to avoid such situations.

The project benefited from the contacts and existing networks of artists at the site, involved in climate/environmental awareness art performance. However, it is important to note that in parallel to the official communication within the artistic committee, alternative communication and dynamics within the preexisting network were creating other narratives about the project and its aims.

18.3.5 Jade Bay, Germany

The initial intention of the art and science cooperation was to document ethnographic work in the coastal village of Dangast, the most prominent tourist location and one of the oldest sea bathing areas in this section of North Sea coast. The environmental photographer Werner Rudhart was invited, as was done for previous works on the Swiss Alps (Krauß, 2019), for two stays in Dangast; unfortunately, the second stay had to be canceled due to Covid-19 (Krauß, 2021a). The results of the first stay—in total several hundreds of photos were taken—served to be useful for documenting the coastal landscape. Many of the photos have been used in articles and presentations at conferences, and an e-book coauthored by Werner Krauß and Werner Rudhart about climate change in this coastal area is in preparation, with the working title "Blind spots – climate change in a coastal area." The e-book serves to demonstrate that climate and its changes are not abstract phenomena calculated by scientists, but visible in the work and maintenance of the dikes and the land.

The artist working for Jade Bay lives and works in rhythms which are different from those of their academic counterparts. "Hiring" an artist for a project involves complicated time- and financial-management. Furthermore, it is impossible to predict in advance if the collaboration will be successful. Art is a process dependent upon intuition and serendipity, as is ethnography to a certain degree. In practice, the photo documentation of the ethnographic fieldwork was an interdisciplinary and continuous dialog between the photographer, the human and nonhuman motifs, and the anthropologist. A documentary is not just a depiction of something that already exists; rather, it is an active process producing something new. Photography did not simply add something to the body of ethnographic work that already existed; instead, it turned into a collaborative activity with its own dynamic and new insights.

The art-and-anthropology collaboration is different from the collaboration with science. Climate science is exclusively about the production and exchange of data and information. From the anthropologist's perspective, there was a strong feeling of uneasiness about

reducing complex field experiences and long conversations or interactions into "data" or "information," or to figure out whether local perceptions of climate change were "right" or "wrong." The photographer shared this feeling of unease from the beginning: what kind of data was he expected to produce? What kind of product was he expected to deliver? It is difficult to get rid of this kind of thinking, which is common in interdisciplinary projects. In our art-and-anthropology collaboration, we discussed this kind of pressure from the beginning and started to reset the default position. We both had already worked in different settings about landscapes, and we compared our methods: how do we engage with a landscape, what does it take to understand, to see and to feel the specific atmosphere of a territory, understood as an amalgam of the physical, the geological, the social and political atmospheres? Is it possible to "see" climate change, and what does it mean to live in the Anthropocene? Our explorations were focused on the blind spots; our goals were: (1) to visualize climate change; and (2) to show "the phantoms of the Anthropocene," as Tsing et al. (2017) put it, in a specific combination of words and pictures.

Dangast as a field site turned out to be instructive. The work of the famous painter Franz Radziwill, who spent most of his life in Dangast, served as important inspiration. In his paintings in the style of magic realism, he links different elements of reality in new ways and integrates the horrors of the World Wars, the lifeworld of modernity and environmental degradation (Krauß, 2021b). Most of all, he was fascinated by the permanently changing light in this coastal area. Photography is about light, too, and light is linked to weather and time. The light of the North Sea coast is one of the reasons people love to spend their time in this area, and it is integral part of the photos of Werner Rudhart.

In a first step, we absorbed local climate information in many ways: as daily weather, in talks about the weather, by deciphering historical landmarks or in interviews. People were curious about our work and easily understood our intention to depict climate change beyond statistics and numbers. Our project served as an entry point for debating what it means to live in a coastal landscape with a changing climate.

In a second step, we focused on the dikes that surround the Jade Bay. Our working hypothesis was that climate change sits in the dikes, and that the dikes are the result of work, maintenance, construction, and planning (Krauß, 2020). In documenting the work that it takes to protect the land, traces of climate change become visible.

Finally, the simultaneous existence of the UNESCO world heritage site Lower Saxony Wadden Sea and the highly industrialized landscape with Wilhemshaven on the horizon, invited us to document the phantoms of the Anthropocene. Unfortunately, Covid-19 prevented our finalizing the last step of the project, the portrayal of the main interviewees of the anthropological research as inhabitants of the Anthropocene. There is only a small group of portraits; Werner Rudhart arranged for each inhabitant to be photographed in specific settings where the anthropogenic landscape merged with the professions of the interviewees.

The art-and-anthropology cooperation turned out to be successful despite the interruption of the pandemic, and the results open up a new way to engage with climate change as a practice, as a place-based coastal phenomenon. The photos display dike maintenance, scenes of constructed land- and sea-scapes, moments of regional Fridays for Future demonstrations as much as the interaction of humans and nonhumans in unusual arrangements. Focusing on the blind spots in climate communication thus enables new forms of collaboration and place-based climate action.

18.4 Metadata and dynamic mapping perspectives for local representations

Constructing and using a metadata model (metadata refers to a set of data that describes and gives information about other data) and a metadata tool is a complex undertaking. The time-consuming aspects of preliminary tasks may mask the hypothetical future benefits. For example, encoding metadata for the whole corpus of narratives was too tedious a task for most partners, whether via the Excel spreadsheets provided or directly into the QGis-based tool we developed, even with templates to simplify the task. The future advantages that would potentially result from such efforts remained too unclear—and were indeed not demonstrated—to convince project partners to dive into this effort. Timing was also a challenge, since narrative collection and the metadata scheme proceeded and matured in parallel. Site leaders had already started to use their traditional methods of analysis when the possibilities that the metadata offered in this respect became clearer. However, the prospective of visual representations of results was an incentive.

In many respects, we opted for a resolutely open metadata model:

- no field was mandatory;
- new options could be added to drop-down menus;
- new metadata fields could be proposed;
- numerous fields accepted free text.

The obvious advantages of such a model are its flexibility, the freedom allowed to the person entering the metadata, and the high degree of nuance that can be expressed. This approach also has strong drawbacks. The fact that the scheme expands as time goes by and more options or fields are added hinders the comparison of narratives for which metadata were recorded at different stages of its evolution. Empty fields may result in discarding a narrative from statistical studies. Free text cannot be automatically read and makes comparison between narratives arduous. To guarantee sensible information content, easy analysis and at least minimal comparability, a balance between flexibility and rigor must be achieved. Flexibility may be preferred as long as the scheme is under development but at some point, the model must be frozen in order to be usable.

Data of a subjective nature are essentially different from the data used in the physical sciences for which metadata schemes have been established for a long time. Even more crucially, the subjectivity of the researcher who documents a narrative influences the metadata content, which is less likely to be the case for metadata pertaining to physical measurements. Whether a number lies under a given threshold, for example, will not depend on the metadata provider, whereas an element of a narrative may be interpreted by one researcher as an allusion to a potential climate-related point, and not by one of their colleagues. In this sense, users must be aware of the relative nature of narrative metadata.

Due in part to the novelty of the approach and in part to the different styles of practice, concepts and vocabulary of the researchers in their respective fields, developing a metadata scheme for narratives involved substantial communication and lasted for the duration of the project. The scheme that was progressively completed to meet the partners' expectations was only tested on some examples, not numerous enough to conclude if the concept was adequate, even less to document all the collected narratives and serve as an analysis or dissemination tool. Yet, we hope the outcome of this pioneering exercise will be a starting point for future projects.

GIS (Geographic Information System) brings together various more- or less-sophisticated techniques, of which cartography is probably the best known. Cartography produces rich and relatively easy-to-understand graphics to enlighten a discourse. It also lays the groundwork for certain analyses by allowing the spatial dimension of studied problems to be taken into account. Geographers start by mapping a phenomenon and then use this spatialization to look for correlations with other aspects or other mapped phenomena. By attempting a hybridization between humanities, social, and natural sciences, the CoCliServ project explored various paths, including GIS.

The ambition of CoCliServ in relation to mapping was more than just to produce beautiful illustrative maps to brighten up reports or to support meeting discussions with local communities. That said, we did also make and use maps for these purposes, as maps are a common tool in scientific discussions about environmental issues, and are presented in other deliverables. Beyond this, we intended to explore the feasibility of producing a tool to dynamically share field observations from many types of sources and ensure a maximum preservation of the collected information. In the social sciences, not all information can be saved and standardized; there is always a limit, as a written text will fall short of capturing and conveying the depth and intensity of personal feelings or lived experience. The intention here was to develop a database model to push the limits of data compilation and digitization from informal social science sources. Our first step was to create a metadata scheme with the field investigators, the second was to produce a database model and the third was to make a user-friendly interface for different types of users, dealing with different types of information. These three theoretical steps were explored simultaneously with lots of back and forth during the project. "Whether such a dream may really be a nightmare is another topic" (Peuquet & Marble, 1990). We aimed

to compose an IT tool for users who are not familiar with such technology in their usual activities (e.g., Caquard, 2013; Vivant et al., 2014). This proved a never-ending task, since the needs were always too specific and a versatile solution would require high computer literacy, as it would need to remain very abstract. The challenge is to find the right balance between solutions that are simple to grasp but unable to account for the nuances of human reality, and very sophisticated solutions that can accommodate such nuances but are too complicated to learn and use.

We have come to the conclusion that mixing these opposite constraints might be feasible if:

- users are ready to learn;
- there are a few users responsible for more difficult tasks;
- someone is there to manage the system on a technical level.

18.5 Lessons learned and final conclusions

Three papers directly linked with the sites' efforts were published in the past year (Baztan et al., 2020; da Cunha et al., 2020; Krauß & Bremer, 2020). These papers are the first arts and sciences papers published in the dedicated journal, "Climate Risk Management." These publications illustrate the first key point for our consortium and the broader research community: it is important to validate experimental local approaches with mainstream dynamics through peer-review publication.

The second lesson from our CoCliServ experiences is the room for improvement revealed through the peer-review validation process. This room for improvement expands in three main directions: the art and science processes and their methodologies; making social transformation intentions explicit; and linking local challenges with national and European Framework Directives related to climate services.

The third key lesson is to understand the power of using art forms to represent local climate information. Now we know how local stakeholders engage in the process and how important they are for engaging with local and regional actors on climate change; from here, we need to link arts and sciences with other modes of representation. Art-based intervention has been proposed in the context of climate change for quite some time (Lippard, 2007; Volpe, 2018). This is not without pitfalls such as instrumentalizing art and reproducing dominant categories and codes through art (Miles, 2010). To counter these risks, experiments have shown that through public participation and activism, art may be empowering, and may shift attention to issues that question dominant paradigms (Sommer & Klöckner, 2019).

Several dimensions have been identified for collaborations between art and science: new understandings and capacities within and across the arts and sciences involved (Gabrys & Yusoff, 2012); catalyzing explorations of the scientific context and critical re-imaginations

of research practices (Rödder, 2017); helping to engage multiple senses and emphasizing social interaction within research practices; aiding participating researchers in thinking creatively (Jacobson et al., 2016); redesigning social relations to natural systems (Armstrong & Leimbach, 2019); rearticulating politics and knowledge (Latour, 2011); offering more effective approaches to engaging multiple publics in climate-compatible behavior change; and engaging explicitly with the underresearched issue of the role of place attachment and local, situated knowledge in mediating the influence of climate change communication (Burke et al., 2018).

Drawing from these observations, we developed the working hypothesis that iterative art and science approaches have the potential for instigating and sustaining community dialog through efforts to coproduce climate services. We see art as essential for making the concept of climate services more meaningful in a specific place, and our approach focused on narratives as an entry point for coconstruction.

Developing strong connections between art and science enables the re-articulation of the scientific description of the world (Latour, 2011). The teams at each CoCliServ site, in their diversity, explored polysemic concepts such as climate change and associated "services" through their own local arts and sciences approaches. Our investigation entailed examining the potential of art "gestures" (Citton, 2012) and the "practices of everyday life" (de Certeau, 1990) to facilitate cultural translation between different fields of knowledge and the associated diversity of priorities in bringing them to action. While the five sites each have their own particularities to their approaches, here we synthesize the main lessons learned from the sites along with the common points in the sites' processes, and the final conclusion.

18.5.1 Conclusions on local representations for codeveloping climate services

For the purpose of this research, we used Vaughan and Dessai's (2014) definition of climate services: "The aim of climate services is to provide people and organizations with timely, tailored climate-related knowledge and information that they can use to reduce climate-related losses and enhance benefits, including the protection of lives, livelihoods, and property." When considering this definition, we focused on providing people with climate tailored knowledge, "people" understood to be the members of local communities. The central challenge we wished to address was that of "tailoring" climate knowledge and information for communities at the margins, or at the core, who may or may not be aware of climate issues. Such tailoring of climate knowledge is closely associated with the ability to establish iteration (Dilling & Lemos, 2011) and dialog between scientists and nonscientists in the course of knowledge production and use. Climate knowledge coproduction, the "deliberate collaboration of different people to achieve a common goal" (Bremer & Meisch, 2017) has been proposed for quite some time (e.g., Lemos & Morehouse, 2005) to address challenges of initiating and maintaining such reiterations and

dialogs. But what if this dialog needs to be established on grounds other than those of climate change?

Bremer and Meisch (2017) conducted an extensive mapping of the literature on climate change research coproduction. They identify a series of eight "conceptual lenses" and call for a "self-reflexive transparency when using coproduction concepts" to address the concepts' polysemy. Within their framework, CoCliServ work lies at the juncture of several objectives associated with these various lenses: we wanted to integrate nonscientists as coinvestigators (extended lens); we aimed to sustain interactions between climate science providers and users (iterative interaction lens); we pursued a goal of empowering local experience, and thus of local knowledge (empowerment lens); we recognized the need to facilitate social learning about climate issues (social learning lens); and we were embedded in a culturally rooted goal to improve public service through the joint engagement of government agencies and citizens in the production of new knowledge (public services lens).

All these objectives are associated with acknowledging the current uneven distribution of access to, and benefits from, climate services development. For instance, Harjanne (2017) surveyed institutions related to climate services to identify how they justify the need for climate services (as a departure from climate science), and identified the following: global and widespread nature of the climate challenge; specific industry needs; socio-economic value; technological potential; and deficient supply and demand. We envisioned the coproduction of climate services, not because we perceived coproduction as a "value in itself" (Voorberg et al., 2015), but because we understood coproduction as a means to create and nurture sustained interaction with communities while contributing to their empowerment. We aimed to explore means for correcting the inequitable distribution of climate change knowledge for action.

We hypothesized that part of this uneven distribution may reflect that not all communities are equal and some are facing such immediate challenges that climate change may be invisible to them. This hypothesis called for working to shift awareness to the actual or potential, current or future, connections between everyday nonclimate concerns and climate issues. Such a shift called for a practical intervention, centered on local culture. We chose to work hand-in-hand with artists to conduct such an intervention, as art is well identified as an approach to make visible the "invisible or almost-visible" phenomenon of climate change (Knebusch, 2008). Art is also identified as facilitating access to narratives in general, and climate narratives in particular (Roosen et al., 2018).

18.5.2 Final conclusions

Representations and their associated modes were at the very core of what the five sites were working toward: turning "matters of fact" into "matters of concern," and using narratives to

transcend oppositions in representations of scientific and local knowledge, nature-culture, global-local, in order to coproduce climate services. The complexity of the starting point and the exigence of the learning process brought the partners through three key stages that we consider major contributions for the climate services community:

1. Climate services do not necessarily appear in the top priorities of the population. Our efforts demonstrate that the modes of representation and their associated processes contain the priorities of society as a whole. Standardizing across the five sites resulted in protocols to connect the populations' priorities with climate services, and from there climate services with the most pertinent and integrative local modes of representation.
2. In order to have access to and represent the complexity related to climate services and its connection with society as a whole, we found a way to create an integrative context for the three modes of representation: metadata, dynamic mapping, and art. In this we learned to be explicit in the related processes at play in the emergence of new forms of representation that link and integrate what was previously separate for reasons of disciplinary inertia.
3. Local particularities and constraints clearly appear in our efforts. Universal concepts related to climate services can be applied locally with long-term perspectives only if they are concordant with local values and "acceptable" processes.

The formal context for "modes of representation" enabled us to recognize the importance of making social transformation intentions that are explicitly linked with local challenges and values to connect with national and European Framework Directives related to climate services. We reiterate the importance of having local stakeholders engage in the climate services process in order to forge common commitments and incorporate value perspectives, even those that may be polarized, throughout society as a whole.

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CHAPTER 19

Agricultural water pollution

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Chapter Outline

19.1 Introduction and background

19.1.1 Water consumption and contamination tied to agriculture

When considering global water use, Hoekstra and Chapagain (Hoekstra & Chapagain, 2007) suggest volume of water consumed is related to wealth, level of meat consumption, climatic conditions and agricultural efficiency. We know that global water use has increased sixfold over the previous 100 years and will continue to increase at roughly 1% each year forward (UN World Water Development Report, 2018).

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