Deliverable 3.2

Evaluation of existing local climate service components

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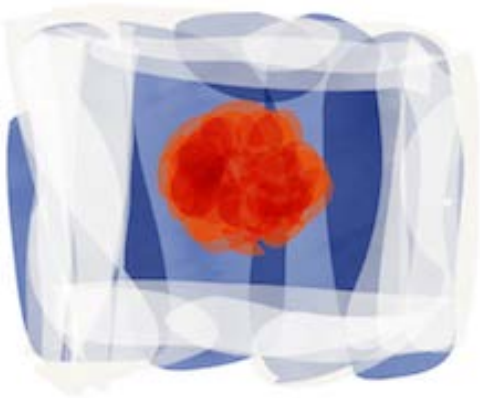

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Executive summary

In this report, local climate service components are evaluated. In CoCliServ, local climate service components are 1) local narratives (input from WP1) and 2) existing climate information and services (assessed in task 3.1.). For each case study site, local narratives of change are evaluated according to potential entry points for local contextualization of climate information. Based on these results, further steps for the evaluation of climate service components are derived and carried out for each case study site.

1 Goal/Purpose of the document

CoCliServ aims to connect climate science with local communities, using local narratives as an entry point (DOW; Vanderlinden et al. 2017, p. 1). Thus, the focus on narratives of change as a localisation device is a central local climate service component in CoCliServ (DOW; Vanderlinden et al. 2017, p. 2). It is assumed that narratives give meaning to facts and scientific calculations (DOW; Vanderlinden et al. 2017, p. 1,2,5). Based on the narratives suited frameworks are derived for each case study site in order to connect climate science with local communities.
The purpose of this deliverable is:

- to evaluate the local narratives from WP1 (narratives of change) according to possible entry points for WP3 as suggested in the CoCliServ DOW.
- to carry out evaluations of related existing climate information and services in the defined frameworks.

2 Relationship to the Description of Work (DOW)

According to the CoCliServ Description of Work (DOW; Vanderlinden et al. 2017, p. 4-5), narratives are essential to localize (climate) information, since they give meaning to simple facts and scientific calculations. They turn ‘matters of fact’ into ‘matters of

concern'. Place-based climate services should be rooted in intersecting histories in order to be effective and meaningful (DOW; Vanderlinden et al. 2017, p. 4); abstract concepts of scientific climate change would have to be filled with 'ordinary life' and 'ordinary affects', the 'structures of feeling', 'senses of place' and the sense of belonging (DOW; Vanderlinden et al. 2017, p. 4-5).

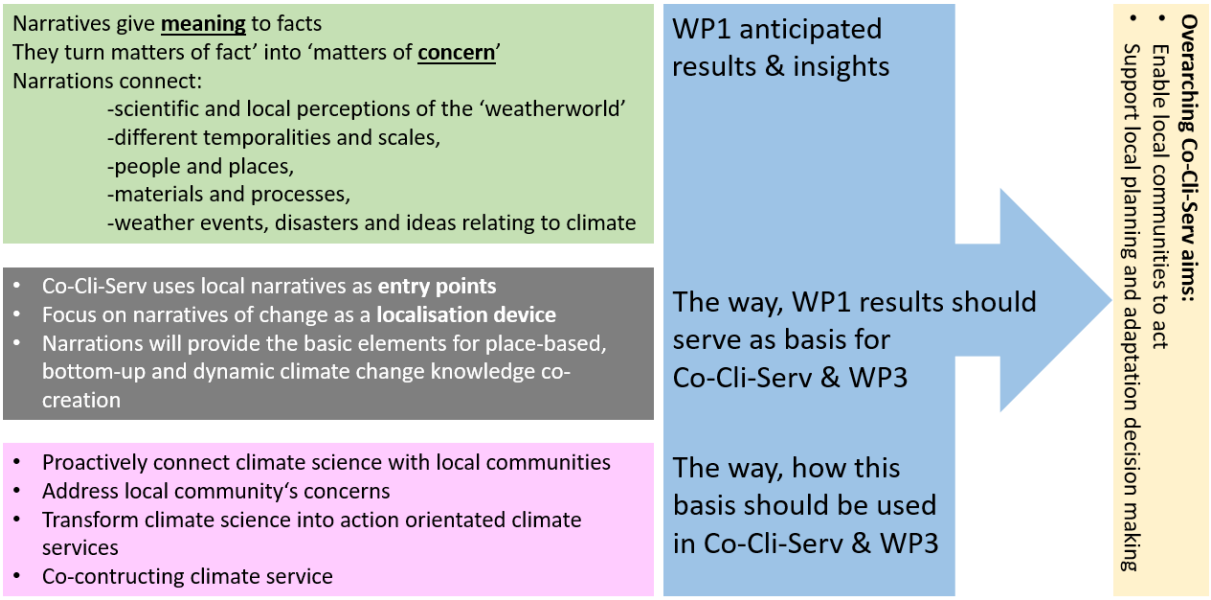

Figure 1 Concept and workflow according to the Co-Cli-Serv DOW (Vanderlinden et al. 2017)

According to the DOW, the narrations would connect different temporalities and scales, people and places, materials and processes, weather events, disasters and ideas relating to climate. This should provide the basic elements for place-based, bottom-up and dynamic climate change knowledge co-creation (Co-Cli-Serv DOW 2017, p. 5). CoCliServ aims to proactively connect climate science with local communities, using local narratives as an entry point.

In this report, the first part of each case study is focussing on the question, to what extend the CoCliServ concept, using narratives as entry point, as localization device and as basis for place based bottom up climate change co-creation, can be realized with the now available narratives. It is part of Co-Cli-Serv task 3.2. "evaluation centred on local climate service through user involvement". According to the DOW, the user involvement is the task of WP1 and WP2. In each case study site, the first part is focussing on WP1 (Narratives of change) in order to 1) assess if and how narratives

give meaning to facts and scientific calculation and to 2) localise potential entry points for connecting climate science with local communities. Based on this analyses a framework for the evaluation of existing climate information and services is derived for each case study site. Within these regional specific frameworks, the evaluations are carried out for each case study site, individually, since the diversity of the WP1 basis leads to different starting point, which required different strategies for evaluating the existing climate services. The report meets the requirements of Deliverable D3.2 Evaluation of existing local climate service components.

3 Evaluation of existing local climate service components

3.1 Narratives of change as potential entry points

In order to evaluate the narratives of WP1 according to potential entry points for local climate services, the approach is closely related to the DOW. The leading questions to find possible entry points are based on the described work plan in the DOW (Vanderlinden et al. 2017). In this approach, narratives give meaning to facts and scientific calculations. They turn 'matters of fact' into 'matters of concern' (Vanderlinden et al. 2017, p. 1, 2,3,5).

Matters of concerns are to be found in everyday conversations, in life stories, in eyewitness reports, legends and newspaper articles, as well as in archives, documents, plans, leaflets, tourist information and blogs (Vanderlinden et al. 2017, p. 5). In accordance with the work plan, we understand "matters of concern" as individual consequences of climate change, a person or a group is concerned about. While impacts are countable, measurable and related to the source, matters of concerns are defined as individual consequences of the perceived climate issue, a person or a group is concerned about. For example, if their everyday live is changed by climate change or if climate change makes people feel in danger or if accidents or losses of people are related to certain weather conditions or climate change, these are matters of concern. In combination with a particular local focus, they may serve as entry points.

In order to find potential entry points for local climate services, the WP1 reports are analysed according to these matters of concern, which are related to perceived weather parameters (see M3.2) and have a local focus. The structure of this analysis follows the respective aims of the tasks in WP 1 (see Figure 2). According to the CoCliServ approach, the results of this WP1 analyses should enable WP 3 to give meaning to facts and scientific calculations as 'matters of fact' are turned into 'matters of concern'. For each task, leading questions are defined in order to localize

potential entry points. In these questions, narrative based entry points as described in the DOW (see above) are connected with the respective task of WP1 (Figure 2)

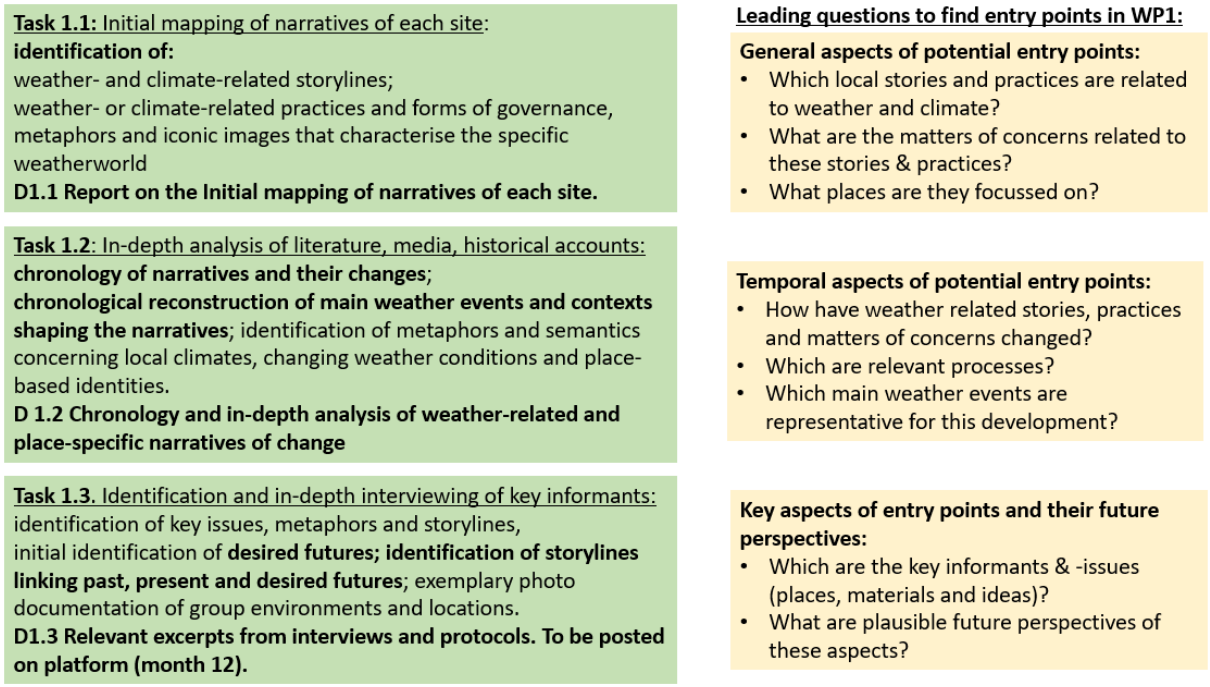

Figure 2 WP1 aims (left) and leading questions according potential entry points (right)

Task 1.1 aimed to identify weather- or climate-related practices and forms of governance, metaphors and iconic images that characterise the specific weather world (CoCliServ DOW 2017). Thus, the D1.1. report (Krauss et al. 2018 a) is analysed according to **general aspects** of using narratives as entry points for local climate services. This means in the first step, to identify local stories which are directly related to weather and climate change. The leading questions of the analyses are:

-Which local stories and practices are related to weather and climate?

-What are the matters of concerns related to these stories and practices?

-What places are they focussed on?

Based on task 1.1, the objective of task 1.2 was to elaborate a) a chronology of narratives and their changes as well as b) a chronological reconstruction of main weather events and contexts shaping the narratives. (Krauss et al. 2018 b). Thus, the D1.2 report is analysed according to **temporal aspects** of potential entry points for local climate services in WP3:

-How have weather related stories, practices and matters of concerns changed?

-Which are relevant processes?

-Which weather events are representative for this development?

Task 1.3 aimed to identify a) key informants and -issues as well as b) desired futures. Moreover, the objective was to derive storylines linking past, present and desired futures. This would be supported by an exemplary photo documentation of group environments and locations. (Co-Cli-Serv DOW 2017, p. 10). Thus, the leading questions for analysing report D1.3 address **key aspects** of entry points and their **future perspectives**:

-Which are the key informants & -issues (places, materials and ideas) and are, thus, relevant according to entry point?

-What are plausible future perspectives of these aspects?

3.2 Evaluation of related existing climate information and -services

While the first part of D3.2 focuses on localizing potential entry points for connecting climate science with local communities based on the narratives of WP1, the second part analyses and evaluates the adequacy of related climate services. The guiding questions for this analysis and evaluation are:

- Are climate information and climate service available, which are related to the matters of concerns / aspects / frameworks, derived in the WP1 analyses or to knowledge needs identified from scenario activities (WP2)?
- Are there additional information needs; are further services formats needed in order to enable climate related action?
- Can barriers or challenges be identified (such as knowledge gaps)?

The detection of barriers, challenges, and gaps from the evaluation could help understanding what is missing in order to reach the CoCliServ objective to enable climate related knowledge with regard to the needed action. Thus, this will be an important basis for the feasibility study D3.3. The second part of the evaluation is related to the analyses of user involvement based the WP1 interviews. WP2 workshops results are taken into account as far as they were available until December 2019. Not all WP2 workshop activities were finished until December 2019 but the results will be presented in Deliverable D2.2 including the hinge points. These hinge points represent an important basis for climate knowledge needs. They are linking WP2 to WP3, but cannot be fully analyzed here because of the jointly agreed postponed deadline for D2.2. Thus, the setting for D3.2 was adapted accordingly. Following the CoCliServ approach, hinge points are developments (from the stakeholders' point of view) along the potential pathways to the desired futures, that could lead to the area away from desired futures, and the points where these take place. Hinge points thus crystallize potential critical points and knowledge needs that WP3 could analyze to determine where and how climate information can play a role. Accordingly, the results of the scenario workshops were taken into account if they were provided before the submission of D2.2.

The basis for the evaluation (part 1 of this deliverable D3.2.) is a highly diverse among the individual case study sites in terms of the found climate related matters of concerns and their potential suitability as entry points for contextualizing climate information locally. Hence, the application of a standardized joint evaluation method or framework was questioning. Because of this case specifies we chose to rather use a targeted method selected based on the respective situation for each case study. This diversified approach is coherent and consistent with the diversity of the approaches in WP1 and WP2 among case studies.

Table 1 gives an overview of the different evaluation methods applied for each case study.

Table 1 Overview about different methods or approaches applied for to conduct the evaluation activity for each case study.

Methods to evaluate climate services	Dordrecht	Jade Bay	Bergen	Golf of Morbihan	Kerourien (Brest)
Analysis of discussions from a participatory workshop organized by WP3 with local actors		X			
Analysis of results from a WP2 co-development activity with local actors	X		X		
Interview with case study leaders				X	X
External expert evaluation (WP3)	X		X		
Analysis of discussions about climate-related topics in narratives and in the climate science community to localize divergence or convergence and deduce entry points for climate services			X		

The full details of each evaluation method are provided later in this report within the case study chapters where we describe how we implemented the method and present and discuss the associated results and conclusions. One key question that the findings will address is whether relevant aspects and matters of concerns (WP1) and other knowledge needs and demands (WP2) are entirely, partially, or not addressed at all with already existing climate services from the WP3 climate-information perspective.

4 Dordrecht

4.1 Analyses of narratives as potential entry points

(Insa Meinke)

4.1.1 Weather and climate related narratives (D1.1)

In the introduction, the authors firstly describe the case study site Dordrecht and its natural conditions as an island that is enclosed by rivers. Being surrounded by agricultural and nature areas, most of the Dordrecht case study site is about 1.5 m below sea level and thus protected by dikes (D1.1, p. 65). The authors state that:

> key climate related challenges include heavy precipitation events, drought and soil subsidence, flooding from the rivers, flooding from the nearby sea, and impacts from water management actions on the latter two issues both upstream and downstream.

In this context, it is mentioned that the municipality of Dordrecht is actively working on climate change adaptation (D1.1, p. 65). This, however, is mainly related to flooding, whereas drought is not mentioned in the further document. The following section on the historical development of Dordrecht is mainly focusing on the interactions between flooding, measures against flooding, the natural conditions (in particular soil properties) and settlement. Among several past floods, the St. Elisabeth flood in 1421 is most famous since it changed the whole region substantially (D1.1 p. 69). This event was a combination of high tides from the sea and large discharge levels from the rivers (D1.1 p. 70). Since that event, the city is surrounded by rivers and continues to be an 'island on a river crossroad (D1.1 p. 73). Chapter 4.1.3, named "recent events in relation to weather and water", compares the St. Elisabeth flood from 1421 with more recent events. It states that the St. Elisabeth flood is the event with the far most severe impact on the island. Further comparisons between these storm surges according to their physical conditions or their impact are not conducted and certain weather conditions are not addressed in this chapter.
These two chapters on the past and recent historical development are followed by chapter 4.2 which is focusing on local adaptation, titled "Representations of climate

change: Local climate adaptation" (D1.1 p. 74). Several measures and concepts are mentioned on how to manage flooding in Dordrecht (flood risk management, concepts for urban flood resilience, vertical evacuation, concept of multi-layer safety for flood resilience). However, there is not any further representation or specification of climate change in this chapter.

> The National Water Plan (that) states the need for adapting to climate change, specifically in relation to water (D1.1 p. 74).

In the D1.1 Dordrecht chapter, it is unclear what the specific features of climate are, or if there are particular places, where they have major impacts and within which time horizon the changes might happen. Also, the specification "in relation to water" is rather general, since it is not differentiated according to its source, its impact, specific locations and temporal horizon. In another example, climate change is mentioned again in a quite general manner but in combination with local conditions:

> the province of south Holland equally states the need to adapt to a changing climate and its effects, with this province being particularly at risks as large parts of South Holland are situated below sea-level (D1.1 p. 74).

Several locations are mentioned to test measures and concepts (D1.1 p. 74) but it is unknown if these locations may serve as an entry point. It is not assigned in the D1.1 report if these measures and concepts are representing specific matters of concern related to climate change or if they were mentioned because of other reasons. One general matter of concern is mentioned, namely that

> … 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, through concepts such as urban flood resilience and vertical evacuation (D1.1 p. 74).

However, the link to climate change is unknown. It is not clear if this is a present situation caused by climate change, a plausible future development of Dordrecht or a situation, which is caused by past decisions or measures (dike building, drainage, low area). The missing link to climate change is also confirmed by the authors' description of a situation at the end of an interview meeting (D.1.1, p. 78):

> .. the initial interest in weather and water related issues over history in Dordrecht was fading once the conversation moved towards climate change and adaptation to it. This citizen voiced then his change in attitude and that he is not really sure what to believe in terms of climate change and that this citizen is doubting the severity of climate change and human effects on the climate system. (D.1.1, p. 78)

Summarizing, the results of the Dordrecht case study site according to the leading questions of D.1.1 are rather general. Which might be due to the fact that D1.1 was designed as an initial mapping of the narratives. The related weather parameters are precipitation and sea level (see Table 2.). The predominantly perceived issues of these weather related parameters are historical events and the present situation. Regarding future perspectives, some matters of concern are described. These are threats linked to flooding which are expected in future and how to encounter them, for example to prevent future flooding and how to evacuate 100.000 people in Dordrecht without experience (D.1. p. 80).

Table 2 WP1 analysis for Dordrecht, part D1.1

Weather parameter	Perceived issue	Perceived link to climate change	Scientific knowledge	Impact	Matter of concern	Particular local focus	Source
Precipitation	Past flooding from rivers	Not specified in D1.1		The St. Elisabeth flood 1421 was a compound event (flooding		Dordrecht	D1.1 p. 65
Sea level	Past flooding from the sea	Not specified in D1.1		from river and sea) changed the whole region substantially	during flood events, there will be too little time to evacuate its citizens	Dordrecht and large parts of south Holland	D1.1 p. 74

4.1.2 Chronology of narratives and their changes & reconstruction of main weather events (D1.2)

In D1.2 the analyses for Dordrecht keeps focussing on the challenge of living with water. In this context, the authors state that local narratives offer insight into how different local actors 'frame' the climate adaptation challenges (D1.2, p.34). It is

described that the city was heavily influenced by its interaction with water since its foundation (D.1.2, p.38):

> The country and the Dordrecht region are shaped by dedicated water management, which includes among others the drainage of areas and canalization of rivers. Drainage, however, leads to ongoing soil-subsidence and this is expected to continue in the future. Soil subsidence is expected to increase the risk of flooding, exacerbating climate change impacts on river discharge, precipitation, and sea level. Clay, which is badly penetrable by rainwater, can lead to local floods in case of strong rains.

It is stated that widespread flooding has been reported from 1287, 1288, 1374, 1376, 1394 and 1396, but again, the importance of the St. Elisabeth flood in 1421 is highlighted (D1.2 p. 43). More recent floods are mentioned as well as they were severe disasters and floods in the region around Dordrecht, namely in 1923 and 1953, which was the last flood affecting Dordrecht seriously. (D.1.2 p. 43). It is stated that Dordrecht's challenge of living with water can be linked with the present geosocial narrative of anthropogenic climate change. However, it is not mentioned which aspects of climate change are meant, in particular and which matters of concerns are linked to them. Thus, relevant processes of their changes are neither described. Instead, it is stated that:

> this includes discussions on impacts on water safety, freshwater supply & drought, precipitation & water nuisance, salinization, human health, nature, and recreation & tourism On longer timescales (centuries and beyond), sea level rise is particularly prominent in national water safety narratives (D1.2 p. 39).

According to sea level rise there is no further information on magnitude and time horizon of future increase. This is also confirmed by an interviewee, which perceives the following:

> "Dordrecht is not so big of course, it's a small island, as the people say we are living on an island. You are surrounded by water, and yeah, how long does it take until it goes not well anymore, I don't know. ... if people continue living like this and are causing problems with the poles, then it can be max. a few years (until this happens) ... but very fast." (D1.2 p.40/41)

While this interviewee expresses a matter of concern related to a diffuse perception of climate change, another interviewee is not at all concerned:

> "I feel pretty safe, unless (means: although) we are here around with rivers, we are some kind of island, Dordrecht, but I am not scared."

There is no further information in D1.2 about the interviewee's perception regarding climate change and which role it plays in this context.

Several river high waters and severe rainfall between 1990 and 2000 are mentioned as most relevant events. Similar to D 1.1, there is no link to climate change. Instead of climate change information, the events and their impact (fatalities, evacuation and damages) themselves caused action, e.g.:

> Interestingly, history is very present in many narrative accounts and is used especially by authorities to motivate actions.

and

> The relatively recent "Watersnoodramp" flood of 1953, which killed over 1800 people in the Netherlands as a whole, motivated authorities to safeguard the Dutch Delta with many measures, among which are several dikes and tidal barriers.

Chapter 4.2.5 -Narratives about seasons and their role- is mentioning the storm season as mainly perceived seasonal feature. It is accompanied by high spring tides, heavy western storms as well as high river discharges. Again, there is a link to the flood events in 1421 and 1953 and the caused damages (severe breaches in safety structures, D1.2 p. 44). There is no information on perceived changes and underlying processes and no link to climate change.

In the last chapter of D.1.2, 4.2.7 Biography / Lifetime and Weather, several perceived weather related changes are described. However, matters of concerns are almost not mentioned. Thus, neither any changes, relevant processes nor representative events can be found. Most of the provided quotes refer to increased rain during summer and during winter and more intense rain and drought periods:

> "I think there is like a general feeling of, that summers are wetter, and when there is rain there is more rain, and the periods of no rain are longer, ... so when it rains it rains more heavily, when it's dry it's for a longer period (D.1.2 p.47).

and:

> yeah definitely, I can see the difference. ... I like to predict a bit ... a real good example is, normally July was quite a good month, it was a dry month, it was a summer month ... the spring is getting dryer, the summer is getting wetter, and the winter is also getting wetter, so you see

> bit of a climate change. ... The periods are changing, when it's wet it's wetter, and when it's dry it's dryer." (D.1.2 p.47).
>
> yeah I think so. ... as a child during the summer holidays ... we always 6 weeks away, and now the summer time is more rain, more bad days, and I don't think it has any personal (effect) ... [it changes because] All the people are using things that change the environment! Hairspray, stuff [...]"

However, also some doubts are raised if these are real changes and if own feelings are reliable and to what extend the own perception is influenced by the media:

> about my childhood ... I remember hot days back then, and summers full of rain, the only thing I feel that changed, back in the day when I was a child, you could go ice skating every winter at least a week, and that's kind of gone now. I think people went ice skating this winter, but it's not every winter anymore, that's the whole point in that. So I think the winter isn't as cold anymore as it used to be. And maybe it rains more, but that's just my feeling that it rains more in the winter. ... you remember the terrible, terrible blizzard in November, and the terrible, terrible wind storm end of January, but what I think, I am not sure about it, and I think of my childhood and I remember terrible storms as well, and then, is it really worse and more, or is it just social media and the whole thing making more of it because exciting news sell ... also with the weather that all changed, "Oh tomorrow is code orange", and the whole country goes crazy ...(Citizen 9, 2018" (D1.2, p. 47)

Another quote is referring to water levels in Dordrecht:

> "I see that the water level (means now the one at the rivers/sea) becomes higher every year. The cay at the Merwede is flooding once a year, and this is a real problem.] B: Why do you think this is happening? C11: The world changes! (laughing) B: What do you mean? C11: Temperature! The temperature, it's now 29 degrees, warmer, and warmer and warmer. The North pole, down under, it's melting. The sea level is higher, higher, higher, also the rivers! B: How do you think this will affect you here in Dordrecht? C11: It gets worse here! (Citizen 11, 2018)" (D1.2, p.47)

Apart from the fact that the leading questions for D1.2 are not addressed, the chapter can be used for a further analysis on general aspects of weather related aspects in the narratives, one of the leading questions in D.1.1 (see above). Since the questions, which were posed to the interviewees are not available in the chapter, it is uncertain, whether the interviewees themselves perceived a link to climate change or if they had been explicitly asked regarding this link. Thus, if climate change is not mentioned in the quotes, the perceived link to climate change is classified as not assigned (see Table 3)

Table 3 WP1 analyses for Dordrecht; D1.1 (grey) and D1.2 (black) analyses for Dordrecht

Weather parameter	Perceived issue	Perceived link to climate change	Scientific knowledge	Impact	Matter of concern	Particular local focus	Source
Temperature	winter isn't as cold anymore as it used to be	Not specified in the chapter	True	Not specified in the chapter	you could go ice skating every winter at least a week, and that's kind of gone now	Not specified in the chapter	D1.2 p. 47
Precipitation	More rain in summer and winter	All the people are using things that change the environment! Hairspray, stuff	Summer: unclear, Winter: true (proof needed)	Not specified in the chapter	Not specified in the chapter	Not specified in the chapter	D1.2 p. 47
	extremes are more intense: when it rains it rains more heavily, when it's dry it's for a longer period	Not specified in the chapter		Not specified in the chapter	Not specified in the chapter	Not specified in the chapter	D1.2 p. 47
	Past flooding from rivers	Not specified in D1.1		The St. Elisabeth flood 1421 was a compound event (flooding		Dordrecht	D1.1 p. 65
Sea level	Past flooding from the sea	Not specified in D1.1		from river and sea) changed the whole region substantially	during flood events, there will be too little time to evacuate its citizens	Dordrecht and large parts of south Holland	D1.1 p. 74
	the **water level** (rivers/sea) becomes higher every year	The temperature, it's now 29 degrees, warmer, and warmer and warmer. The North pole, down under, it's melting			The cay at the Merwede is flooding once a year, and this is a real problem		D1.2 p. 47

4.1.3 Key issues and desired futures (D1.3)

The key issue in the Dordrecht case study site is the adaptation to water related exposures and risks, which are exacerbated by climate change (D1.3, p. 16). The authors' objective is to analyse the narratives in Dordrecht in order to get insights in developing a resilient and desirable future. In this context, the ongoing struggle of the city with water is mentioned again and is expected to be a significant stressor due to anthropogenic climate changes (D1.3, p. 17). A major aspect of this key issue is the strong link to possible events that occurred in the past, for example the threatening combination of a westerly storm and high discharge at the rivers (D1.3 p. 24). This link to past events, which has been experienced by the inhabitants of Dordrecht, enables awareness and is connected with detailed knowledge of possible impacts. Furthermore, the link to past events conveys and stresses the vulnerability of the city (D1.3, p.24). References to climate change information are made in very general manner, namely that the impact of past events and the present vulnerability is expected to be worsening in future perspectives (D1.3, p.24). This knowledge basis is used as entry point for adaptation strategies and future action.

The authorities are questioning whether the measures taken for coastal defence, so far, are sufficient for the future:

> "I've always been really hammering on go for something else, look into a different strategy. We are very good in these dikes but I don't think we should see it as the solution. In the future I doubt it is the solution (D.1.3, p.18)."

Similar to the authorities, the citizens as well doubt that existing measures of coastal protection are adequate for future development.

> … and we've to keep putting more infrastructure in the whole coastline to keep us safe […] I don't really think it will be durable to protect the whole Netherlands in the future … It's a worry. […] we have now the Deltaworks of course, but if those fail, all of South Holland, and part of Brabant and Zeeland, they are all at risk, and in my opinion the Deltaworks are […] getting old […] so I think one day […] it might fail. […] maybe all dikes will break loose and then the water is gonna be until Utrecht and then there is no Dordrecht left. I can't predict what the future will bring." (D1.3, p. 21)

A quote referring to risk governance indicates that in case of a flood the options for action are already limited under the present climate conditions:

> "[…] to focus more on rescuing than on evacuation. So that we have to face that in the case of the flood, maybe more than 100,000 people will be trapped in their houses or high buildings in Dordrecht, and that we have to prepare a way to bring them in safety […]"(D.1.3, p.19)

The options for actions perceived by the citizens are more diffuse, but need to act is clearly stated:

> The sea level is higher, higher, higher, also the rivers! […] and we need to do something about it. (D.1.3, p.18)"

Other cases are referring to the own direct filed of action, addressing mitigation:

> So I always think start with yourself. I don't eat a lot of meat, because that's really bad for the climate and for the air, so I cut my meat radically, one time a week, two times sometimes. So the small things I think, that's what I can do (D.1.3, p.18).

Further on, the authors' state:

> Occurring adaptive and mitigative activities by citizens: Some have pumps or collect water, others try to stop emitting CO2 and/or are vegan (D.1.3, p.23).

Climate information is referred to, in a very general manner. The main aspect is that the current situation is worsening:

> "Dordrecht will face very high level, water levels, in storm incidents, more frequently and more severely. So not every year, but once in so many years, we are quite sure that there will be westerly storm winds in which we have to close all the seaopenings, and then in the meanwhile there will be a lot of rain in Germany for example, where the rivers get very high and then you close for 2 days or so all the gates, and the city will drown." (D1.3, p. 20)

The interviewee is not stating to what extend the sea levels will rise, how much the frequency might increase, if the probability of compound events might increase in future, why this might happen (because of rain or of sea level) within which time horizon this might happen and which the possible impacts are.

4.1.4 Summary and discussion

According to the overarching Co-Cli-Serv objective, enabling local communities to act, the findings provide interesting insights. Although the perception of climate change are very coarse and general in terms of magnitude, time and local impact and

although no matters of concerns are directly related to climate change, the community is already acting in reference to climate change.

Because of its direct past, present and ongoing vulnerability to water, which is part of the inhabitants' identity, Dordrecht is acting *without* any further specific connection or localization of climate change information to the community.

Although the narratives do not highlight specific perception about climate change, interviewees seem to be aware of the water related risk and future threats. Thus, it seems that it is *not* climate change information, which is *predominantly* needed for action. Instead, it is the real existing personal impairment, the individual experience from past events combined with a diffuse perspective of increasing threats, which makes people to act.

In summary, the overarching Co-Cli-Serv aim to enable local communities to act seems already be reached in Dordrecht. However, although this situation is, compared to the other case study sites, rather advanced in terms of climate change related action, the authors of D1.3 state that one deficiency of the current communication strategy is the missing long-term perspective.

> Authorities currently communicate with citizens where direct needs emerge and are perceived, which runs the risk of being rather ad-hoc. More strategic, systematic communication and interaction with citizens could be beneficial. (D1.3, p. 30)

From citizens' perspective this is linked to uncertainty about the extend and urgency of future climate change related impacts.

> "It's also a job for the local government, "how serious are we taking that problem", because in the end it's you're talking about the lives and the way people are living in Dordrecht .... you can't take it lightly that's what I mean. [...] That's the whole questions, "how serious is it?", I think it's quite serious, and I think the local government is a bit like "yeah it is serious, but yeah it's also really expensive to do something (D1.3., p.19)"

In order to support local planning and adaptation decision making (2. CoCliServ aim) the WP 1 narratives for Dordrecht provides the following framework to connect climate information with local communities:

- (Strengthen the) linkage between actual perceived water related risks with climate change
- Quantification (magnitude, time and local impacts) of relevant climate change information to set priorities to needed climate change related action.

The evaluation of the existing information and existing climate service formats would give insight if this information does already exist, which format it has and how it might be implemented in existing structures.

4.2 Knowledge Needs in the Dordrecht case study – deduced from the WP2 scenario workshop

(Contribution from Arjan Wardekker and team)

In the Dordrecht case study, a workshop was organized to develop future visions, scenarios, and hinge points for the Vogelbuurt neighborhood, in a collaboration between residents, policymakers, and researchers (Wardekker et al., 2019, 2020). The hinge points were also used to elicit information needs. Participants noted that much information on climate change in the Netherlands is available (e.g. Van Minnen et al., 2013; KNMI, 2014, 2019a,b; Klimaateffectatlas, 2019). However, additional needs for knowledge and climate services became apparent in the exercise. These range from classic climate information (but often in a different format than currently available) to more detailed information on impacts and vulnerability, the potential positive and negative effects of local adaptation options, and non-climate information that impacts decision-making on climate change, such as policy developments (local to EU level), economic and pricing information, and social and technical trends.

Classic climate information

A group of needs deals with information that helps the Municipality and neighborhood prepare for disasters and surprises. For example, probability and risk estimates of flood events and related scenarios (e.g. failure of the Maeslant storm flood barrier in Rotterdam, which impacts Dordrecht). Similarly, more information is

needed on the potential impacts of certain types of disasters, disruptions, and incidents on the neighborhood and city scales. For example, specific local vulnerabilities and vulnerable locations in a neighborhood. Insight into the impact of options would also be needed. It is also important to have information on 'small disasters' available. Relatively small disruptive events can be a window of opportunity to discuss the future situation and potential options. In that case, information on how such events will change in the future (frequencies, probabilities, impacts) and what might be done to what effect, is important. Moreover, such information should be readily available in a format that is accessible to citizens, so that it can be used in information and communication efforts following disturbances.

Local impacts & vulnerabilities

Important questions for the residents and policymakers were: how sensitive is the Vogelbuurt to water-related issues (now and in the future)? What do people find acceptable and what not (info on acceptation and perception of risks (but also of options))? E.g. how long should streets be allowed to remain flooded? Local wishes, desires, and acceptation of specific risks and options are an important information need. These can also change strongly over time, and also depend on whether people know how to deal with such impacts (e.g. if people know what to do in case of flooding, flood risk acceptation may be higher). For the 'Close-knit Island Community' vision, residents indicated a need to have visualizations of the neighborhood that showed climate change impacts and make these more tangible to local residents. Visuals of situations where no action is taken help. Future price estimates of impacts of hot summers, invasive species and dike breaches could also be useful to discuss the usefulness of measures to counter specific climate impacts.

Adaptation option effects

Images of typical streets in the Vogelbuurt neighborhood with and without trees would be useful to display the impact of trees on local temperatures (in relation to urban heat islands, heat waves). Information on invasive species (plants, animals) is

useful for people planning what to plant in their gardens. Gardens and other green spaces are promoted to reduce the impacts of heat waves and intense rainfall, but these could have negative impacts as well, both climate and non-climate related. For instance, local climate is getting more suitable for some South-European plants (e.g. ambrosia (ragweed), olive trees) which are also highly allergenic. Similarly, some pests (e.g. oak processionary caterpillar) are increasingly prevalent. Which garden options worsen the situation and are better avoided, and which improve local biodiversity?

Non-climate information

Information on future energy prices is important to show the impact of sustainability measures and the cost of not improving energy efficiency. According to participants, this could highlight that the future energy bill might be higher than the rent.

For the 'Innovative Connections' vision, participants indicated that a very important information need is on political trends, social trends, and legal issues. Examples were given on changes regarding energy, water, privacy, and technology (sensors, data analysis, smart applications, artificial intelligence). How might these broader legal-political changes impact our plans for adaptation? Information on the (potential) political and social sensitivity of options is also important.

4.3 Evaluation of related existing climate information & services

(Brigit Gerkensmeier)

4.3.1 Compiling findings from WP1 and WP2 for the evaluation of available climate services

The outcome of the WP2 workshop provide a much more detailed description of knowledge needs than it was possible to in the matter of concern analysis based on the deliverables of WP1.

The increased look into the future (which is a given and required aspect in a vision activity) confirms that the demand for quantification (magnitude, time and local

impacts) of relevant climate change information really exists in the community. The results from WP1 had only allowed this to be assumed on possible starting points for enhanced climate services. The report from WP2 makes it clear that climate change (adaptation and mitigation) is a topic that moves the municipality and the residents of Vogelbuurt neighbourhood. This stays in contrast to the results of the matter of concern analysis that way hardly able to highlight the argumentative relationship to the topic of climate change. It rather led to the assumption that the pressure to act seems not due to the perception and awareness of climate change, but rather due to the perceptible threats today (see above). The WP2 results address and deepen the aspects of (ongoing) vulnerability to water-related threats, which were highlighted in the matter of concern analysis. In the matter of concern analysis already highlighted the long-lasting experience and the ongoing discussion about the situation of being surrounded by water and dealing with flooding from the sea and the hinterland (rainfall).

The topic of changes in the seasons was less discussed in the WP2 activities. In WP1 activity, references were found with regard to observations and personal experiences highlighting changes in the seasons recognized through change in the parameters such as temperature ("winter isn't as cold anymore as it used to be") and precipitation ("more rain in summer and winter").

It could also be pointed out from the WP1 discussion that one deficiency of the current communication strategy is the missing long-term perspective. The WP2 activities address this aspect by highlighting some difficulties and challenges that currently still hinder the development of such a long-term perspective. On the one hand, a lack of imagination becomes clear in the WP2 activities: To overcome this, the participants asked for climate services in the form of visualizations of various adaptation measures on a local (street) scale. In addition, the demand for more detailed information on impacts and vulnerability on a very local level makes clear what information is needed to promote the development of a long-term perspective.

In this context, the WP2 findings also highlight the demands for information about potential positive and negative effects of local adaptation options. These aspects seem to be are in most cases associated with a multi-use function such improving resilience against climate change as well as improving the quality of life or strengthening of the solidarity in the neighbourhood. Whether these different aspects are already discussed in the available climate services will be an important aspect in the WP3 evaluation activity.

In addition, the WP2 results highlight some aspects with regard to knowledge needs and demands that are indirectly related to climate change. These aspects include information about the potential positive and negative effects of non-climate information that affects decision-making on climate change, such as policy developments (local to EU level), economic and pricing information, and social and technical trends. The extent to which these indirectly related issues related to climate change are addressed through the available climate service types and formats is also examined in the following evaluation activity.

4.3.2 Comparison with existing climate services

The existing climate services are evaluated regarding the narratives (WP1) and knowledge needs (WP2). In cases in which findings from the narrative analysis and the results from WP2 complement each other or address a similar topic, they are summarized under a joint heading and available climate service are examined accordingly. In cases where climate issues are only addressed by the matters of concern analysis, we also analyzed the available climate services accordingly. Aspects that resulted from the WP2 analysis and are currently not covered by the classic, available climate services are also thematically clustered and discussed.

The evaluation may serve as a first step in classifying the available climate services and possible rooms for improvement or enhanced services; and does not preclude any further assessment of the current climate services by local actors and stakeholders, for example in the last WP2 stakeholder workshop.

Table 4 Comparison of perceived issues and(WP1) and knowledge needs (WP2) for the topic 'seasons / changes in the seasons' for the Dordrecht case study

Seasons / changes in the seasons Perceived issue (WP1): changes in the seasons recognized through change in the parameters Includes the parameter temperature; concern: "winter isn't as cold anymore as it used to be"; Precipitation: "more rain in summer and winter" Knowledge needs (WP2): --	
Climate Services available (mainly based on D3.1 assessment)	**Appraisal from WP3 perspective about the service's fit of function to address the matter of concern**
Climate Impact Atlas (Klimaateffectatlas): *Web tool, provided by CAS (The Foundation Climate Adaptation Service)*	*What does the climate service provide and is of importance for this matter of concern:* • provides an initial impression of the (future) threats of drought • Parameters: Diverse impact variables (potential maximum precipitation deficit, precipitation summer quarter, annual reference evaporation) and affected sectors; both can be combined with exposed infrastructure, population etc. • Scale: The zoom function allows you to zoom in on municipality level *If and to what extend does the climate service address the matter of concern:* As the name suggests, the atlas focuses on the impact - particularly relevant to this concern: Drought stress and heat stress and related variables. However, a distinction between the seasons is only possible where the variables have been explicitly divided (and presented) for summer or winter (that is rarely the case).
Story Maps *part of the Climate Impact Atlas, provide an explanation (text) for certain maps in the Climate Impact Atlas*	*What does the climate service provide and is of importance for this matter of concern:* • Explanation for certain maps in the Climate Impact Atlas: what do I see on the map, why is this aspect significant, and how can I use this data for my area? In addition, the Story Maps provide tools for potential solutions and strategies • Story maps are focused on the translation and make the information of the climate impact atlas usable in practice – there is a specific story map for drought and one for heat *If and to what extend does the climate service address the matter of concern:* The story maps are a good complement to the contents of the atlas (increased understanding). The texts, due to the format, are descriptive of the phenomenon; but are not location-specific. Therefore, this Climate Service provides good background information, but it cannot provide any site-specific knowledge in a prepared form (in this case text form).
KNMI Data Centre (KDC)	*What does the climate service provide and is of importance for this matter of concern:* • Web platform; • Data catalogue (for experts); the KDC provides access to weather, and climate datasets of KNMI • Scale of the data depends on the dataset *If and to what extend does the climate service address the matter of concern:* The data portal is a helpful tool for experts who are trained in dealing with datasets. For the general public access and gaining information without this knowledge is difficult or even impossible to achieve. However, it must also be emphasized here that the tool is explicitly designed for communication or exchange with experts or knowledgeable users.
KNMI Climate Data Explorer	*What does the climate service provide and is of importance for this matter of concern:* • The KNMI Climate Explorer is a web application to analysis climate data statistically. Data tool (for experts): it provide climate data and analysis tools; • The Service provide: Observation data, reanalysis and hindcasts (seasonal and decadal), Scenarios (mainly CMIP3+ & CMIP 5; CORDEX) *If and to what extend does the climate service address the matter of concern:*

	The data portal is a helpful tool for experts who are trained in dealing with datasets. However, it must also be emphasized here that the tool is explicitly designed for communication or exchange with experts or knowledgeable users. Local contextualisation seems not to play role here; in particular, since there is no call for local or regional data and analysis

Table 5 Comparison of perceived issues and(WP1) and knowledge needs (WP2) for the topic 'weather / climate extremes' for the Dordrecht case study

Weather / climate extremes Perceived issue (WP1): Mainly parameter precipitation: "extremes are more intense: when it rains is rains more heavily, when it's dry it's for a longer period" Knowledge need (WP2): Future price of impacts of hot summer; information about (local) impact of green spaces & gardens to reduce heat and flooding	
Climate Services available (mainly based on D3.1 assessment)	**Appraisal from WP3 perspective about the service's fit of function to address the matter of concern**
Climate Impact Atlas (Klimaateffectatlas): *Web tool, provided by CAS (The Foundation Climate Adaptation Service)*	*What does the climate service provide and is of importance for this matter of concern:* • provides an initial impression of the (future) threats of drought and heat • Parameters: Diverse impact variables (e.g. Risk of drought stress, potential maximum precipitation deficit, precipitation summer quarter, annual reference evaporation) and affected sectors; both can be combined with exposed infrastructure, population etc. • Scale: the zoom function allows you to zoom in on municipality level *If and to what extend does the climate service address the matter of concern:* As the name suggests, the atlas focuses on the impact - particularly relevant to this concern: Drought and related variables. However, a distinction between the seasons is only possible where the variables have been explicitly divided (and presented) for summer or winter (that is rarely the case). With regard to impacts the atlas provides insights on climate indices such as number of tropical days, number of summer days etc. as well as it provides some sensitivity functions and spatial characteristics: mainly of interest here are urban heat island effect, green per neighbourhood and percentage of paving per neighbourhood. However, the impact of these aspects is not further quantified.
Story Maps *part of the Climate Impact Atlas, provide an explanation (text) for certain maps in the Climate Impact Atlas*	*What does the climate service provide and is of importance for this matter of concern:* • Explanation for certain maps in the Climate Impact Atlas: what do I see on the map, why is this aspect significant, and how can I use this data for my area? In addition, the Story Maps provide tools for potential solutions and strategies • Story maps are focused on the translation and make the information of the climate impact atlas usable in practice – there is a specific story map for drought and one for heat • Impacts are discussed in terms of soil subsidence and drought stress (drought story maps), warming of surface water, heat stress (mainly in the nights affecting people's health) and the amount of greenery and pavement per neighbourhood (heat story map). *If and to what extend does the climate service address the matter of concern:* The story maps are a good complement to the contents of the atlas (increased understanding). The texts, due to the format, are descriptive of the phenomenon; but are not location-specific. According to the narratives, the matter of concern is defined primarily by the parameter precipitation. At this point no separate consideration of the parameter is available (such

	as time series at a specific location, records etc.); it is rather integrated in the description of the extreme event Drought and Heat. With regard to the aspect of information of impacts (WP2 demand), the tool discusses selected issues such as the neighbourhood typology, which are related to potential damages and impacts. However, a quantification (or information about the amount of damage /price) of impacts is not possible with this tool.
KNMI Data Centre (KDC)	*What does the climate service provide and is of importance for this matter of concern:* • Web platform; • Data catalogue (for experts); the KDC provides access to weather, and climate datasets of KNMI • Scale of the data depends on the dataset *If and to what extend does the climate service address the matter of concern:* The data portal is a helpful tool for experts who are trained in dealing with datasets. For the general public access and gaining information without this knowledge is difficult or even impossible to achieve. However, it must also be emphasized here that the tool is explicitly designed for communication or exchange with experts or knowledgeable users.
KNMI Data Centre (KDC)	*What does the climate service provide and is of importance for this matter of concern:* • Web platform; • Data catalogue (for experts); the KDC provides access to weather, and climate datasets of KNMI • Scale of the data depends on the dataset *If and to what extend does the climate service address the matter of concern:* The data portal is a helpful tool for experts who are trained in dealing with datasets. For the general public access and gaining information without this knowledge is difficult or even impossible to achieve. However, it must also be emphasized here that the tool is explicitly designed for communication or exchange with experts or knowledgeable users. This data portal is less suitable for analysis or information about impacts. The focus is on the physical data on weather and climate parameters and events.
KNMI Climate Data Explorer	*What does the climate service provide and is of importance for this matter of concern:* • The KNMI Climate Explorer is a web application to analysis climate data statistically. Data tool (for experts): it provide climate data and analysis tools; • The Service provide: Observation data, reanalysis and hindcasts (seasonal and decadal), Scenarios (mainly CMIP3+ & CMIP 5; CORDEX) *If and to what extend does the climate service address the matter of concern:* The data portal is a helpful tool for experts who are trained in dealing with datasets. However, it must also be emphasized here that the tool is explicitly designed for communication or exchange with experts or knowledgeable users. Local contextualisation seems not to play role here; in particular, since there is no call for local or regional data and analysis. This data portal is less suitable for analysis or information about impacts.
NAS adaptation tool Provided via the Knowledge Portal Spatial Adaptation	*What does the climate service provide and is of importance for this matter of concern:* • includes the effects of climate change on four climate trends in four bulb schemes; of importance for this matter of concern: (more) precipitation, drought, • Sources: current scientific research findings provide the basis and are supplemented in a work session with knowledge and experience from practice • Users can compile a selection of climate trends, sectors, impact and nature *If and to what extend does the climate service address the matter of concern:* *This tool is suitable for creating an overview of the risk situation with various participants in a discussion about impacts of changes, mainly with regard to more extremes in more precipitation and increased droughts for different sectors. The content can be customized, i.e. selected for each individual example. However, they cannot take special local conditions into account.*

Table 6 Comparison of perceived issues and(WP1) and knowledge needs (WP2) for the topic 'being surrounded by water' for the Dordrecht case study

Being surrounded by water Perceived issue (WP1): (Past) flooding from rivers, (past) flooding from the sea, rising water level Knowledge need (WP2): information about impacts on local scale, information about smaller disasters, probabilities and risk estimates of flood events, Sensitivity of Vogelbuurt neighbourhood to water-related risks	
Climate Services available (mainly based on D3.1 assessment)	**Appraisal from WP3 perspective about the service's fit of function to address the matter of concern**
Climate Impact Atlas (Klimaateffectatlas): *Web tool, provided by CAS (The Foundation Climate Adaptation Service)*	*What does the climate service provide and is of importance for this matter of concern:* • provides an initial impression of the (future) threats of flooding and urban flooding • Parameters: Diverse impact variables (e.g. site-specific flood probability 2050) give an overview about primary and regional flood defence facilities and affected areas; • Scale: The zoom function allows you to zoom in on municipality level *If and to what extend does the climate service address the matter of concern:* The climate service provides a good insight into the spatial distribution of the areas affected; the high resolution also allows a strong local view. However, it does not name and quantify impacts in different sectors or for different buildings. Moreover, individual (past) flood events, and the explicitly mentioned parameter (rising) sea level are not included in the tool. Above all, we see the strength and usefulness of this tool to address the matter of concern in the visualization and localization of affected areas (today and in the future).
Story Maps *part of the Climate Impact Atlas, provide an explanation (text) for certain maps in the Climate Impact Atlas*	*What does the climate service provide and is of importance for this matter of concern:* • Explanation for certain maps in the Climate Impact Atlas: what do I see on the map, why is this aspect significant, and how can I use this data for my area? In addition, the Story Maps provide tools for potential solutions and strategies • Story maps are focused on the translation and make the information of the climate impact atlas usable in practice – there is a specific story map for flooding and for urban flooding • Includes information about neighbourhood typology which is helpful for local adaption activities *If and to what extend does the climate service address the matter of concern:* The story maps are a good complement to the contents of the atlas (increased understanding). The texts, due to the format, are descriptive with regard to the phenomenon; but are not location-specific. For the matter of concern "flooding", the peculiarity is that the narrative increasingly refers to past events; the atlas and the story maps show above all the present and the future state (since this is an adaptation tool). Thus, from this climate service background information can be obtained for the matter of concern, but specific consideration and classification of past events is not possible. With regard to the aspect of information of impacts, the tool discusses selected issues such as the neighbourhood typology, which are related to potential damages and impacts. However, a quantification (or information about the amount of damage /price) of impacts is not possible with this tool.
Delta Viewer *interactive presentation,*	*What does the climate service provide and is of importance for this matter of concern:* • *Information on past events, explaining the situation of the Netherlands* • *The Delta Viewer explicitly address the children, the exploratory story uses picture etc.*

visualises how the Netherlands has battled water in the past, present and will do so in the future	• *Aim of the Delta Viewer is to raise awareness for water-related problems, Delta programs solutions, measures implemented* *If and to what extend does the climate service address the matter of concern:* Above all, the Delta Viewer addresses the past flood events as essential elements; which are also highlighted by the matters of concern. This Climate Service is one of the few that makes a historical classification; In addition, the importance of dealing with flood events within the Dutch culture and history is discussed and emphasized (which are also repeatedly address the narratives of the Dordrecht case study)
NAS adaptation tool Provided via the Knowledge Portal Spatial Adaptation	*What does the climate service provide and is of importance for this matter of concern:* • includes the effects of climate change on four climate trends in four bulb schemes: heat, (more) precipitation, drought, sea level rise • Sources: current scientific research findings provide the basis and are supplemented in a work session with knowledge and experience from practice • Users can compile a selection of climate trends, sectors, impact and nature *If and to what extend does the climate service address the matter of concern:* This tool is suitable for creating an overview of the risk situation with various participants in a discussion about impacts of sea level rise for different sectors. The content can be customized, i.e. selected for each individual example. However, they cannot take special local conditions into account.

Table 7 Comparison of perceived issues and(WP1) and knowledge needs (WP2) for the topic 'political and social sensitivity analysis' for the Dordrecht case study

Political and social sensitivity analysis Perceived issue (WP1): -- Knowledge need (WP2): include with regard to this aspect information about risk perception and risk awareness, information about the level of peoples acceptance of certain risk and measures, local wishes and desires; information about political trends, social trends, legal issues (EU, national and local level)	
Climate Services available (mainly based on D3.1 assessment)	**Appraisal from WP3 perspective**
	The knowledge needs from WP2 address the need for information on sensitivity studies, studies on risk perception and risk tolerance in different contexts. These aspects form a cluster that has hardly been addressed by available climate services (which have been incorporated in this analysis). At least some of these aspects represent much-discussed topics in the scientific community. These discussions include, for example, studies on climate change perceptions, studies on the risk tolerance of various actors or studies that analyse different preferences for adaptation and mitigation measures. What is not immediately apparent to us at this point is the question of whether and to what extent communication and transfer of this knowledge from the scientific community to practice (in the form of climate services) takes place. And whether the currently available studies also cover those areas and the scales that are specifically requested for Dordrecht here. From our WP3 perspective, it can be stated that the scientific community, especially social climate science research, has a broad portfolio of methodological approaches to address these question raised in the WP2 activity in Dordrecht. Transferring these methods to a climate service that is constantly running and being constantly updated presents a challenge but also an opportunity to establish a new climate service. To our

	knowledge, such a kind of service does not yet exist in this form for the Dordrecht region (or comparable in other regions).

4.4 Discussion and Outlook

The available climate services offer a wide range of information on both different climate parameters and climate change adaptation information. They establish a link between actual perceived risks with climate change, with regard to water related issues as well as to climate aspects, amongst others with regard to drought and heat. Quantification of relevant climate change information are partly available at national and regional level, but require further processing on the local scale. However, most information needs from WP2 ask for these specific, local scales (neighbourhood or street scale). In particular, the demand for quantification of impacts of disasters (large as well as small disasters) are not yet provided to an extend corresponding to the demand of local actors. Therefore, there seems to be a real need at this point to scale existing data sets or impact analysis even further down to a local level.

What was not as specific in WP1 as later in WP2 is the desire for visualization of climate impacts and their cost estimation if adaptation measures are not taken. Both demands have to be taken into account for the further and new development of climate services, as none of the available formats can currently adequately meet these needs.

Knowledge needs with regard to non-climate aspects (that impacts decision-making on climate change, (such as policy developments, economic and pricing information, and social and technical trends) have not been addressed by classic climate services so far. However, with regard to the question whether we should think of climate services in a much broader sense (beyond the information on climate parameter and events) these aspects might be included under such a broader definition.

The importance of personal impairment, which has been highlighted in the narratives already, is also underlined in the workshop discussions of the WP2 scenario activities. The demands for information and the developed actions are often associated with a multi-functional aspect: adaptation measures and actions that focus in most cases not on climate change adaptation, but also on an improvement in the quality of life, strengthening of the solidarity in the neighbourhoods together with a reduced vulnerability to changing weather and climatic conditions. These multi-functional aspects distinguish the expressed needs and demands from the stakeholder workshops from the available climate services analysed here. The latter, for sure in line with the original intention of climate services, focus on the goal of improved adaptation to changing climatic conditions and increasing the resilience to climate change. In this case, the available climate services thus meet only a partial aspect of the requirements and need expressed in the case of the local case study in Dordrecht. The conclusions for the development of local climate services for adaptation therefore include the consideration of these different aspects in climate services.

5 Jade Bay

(Insa Meinke)

5.1 Analyses of narratives as potential entry points

5.1.1 Weather and climate related narratives (D1.1)

In the Jade Bay, there are two main temporal frames in the D1.1 report, one at present time, the other in the past. For the present, there are two chapters with direct relations to regional weather and / or climate change. These are chapter 3.6 Nature conservation and chapter 3.9 Field work in the weather world. Chapter 3.2 and 3.5 refer to the past weather, focussing storm surges.

In D1.1, chapter 3.6, warming, seasonal changes, and sea level rise are mentioned in the context of ecosystem changes. It is described that:

> ...the director of the Dangast house clearly confirms that climate change already left its traces in the Jade Bay; temperature and sea level are rising; new species arrive and older ones disappear; patterns of bird migration change, as does the arrival of the seasons. (Krauss et al. 2018 a, p. 58)

Another aspect in this chapter is related to the challenge of climate change education. It is described that ...

> ... climate change is didactically difficult to teach; mostly, in seminars and workshops, ecology prevails over climate change. Climate change is mostly invisible and untouchable, while ecology is close at hand; narratives about climate change cannot compete with those of ecology, whose subjects are visible and touchable. (Krauss et al. 2018 a, p. 58)

In D.1.1, chapter 3.9, the described aspects are mainly focussed on unusual weather features of the latest seasons (summer 2017, winter 2017/2018). The author describes that

> ... an already unusual rainy summer, as my informants told me, was followed by an extremely wet winter." (Krauss et al. 2018 a, p. 62)

The major part of this chapter is focussing on the winter 2017/2018. This corresponds to the period where the interviews and fieldwork were conducted. The rain is perceived as something unusual and is subject of general complains. Climate change

is assumed as reason for this unusual precipitation amount and old weather proverbs are not any longer perceived as reliable. The author describes:

> Everybody complained about the rain, and many of my informants blamed climate change for it. As a farmer explained to me: only freezing temperatures provide clear and sunny skies in the winter, while rising temperatures and rainfall keep the skies full of clouds. Old weather proverbs are no longer valid, he said. No one remembered such a wet winter. (Krauss et al. 2018 a, p. 62)

In addition to the precipitation, it is mentioned that one interviewee stated that the wind and extreme weather in general are subject of long term changes (D1.2, chapter 3).

> ...extreme and stormy weather, with intensive rainfall and strong winds, becomes more frequent, as one of the heads of the dike organization explained to me. (Krauss et al. 2018 a, p. 62)

Besides the generally perceived "bad" weather, the author summarises briefly some consequences of winter 2017 / 2018 in chapter 3.9., which are related to agriculture:

> "... the fields and meadows were drowned in water and became inaccessible, farmers could not get rid of the manure any more feet of humans and animals deeply sank into the black earth of the fields. (Krauss et al. 2018 a, p. 62)

Coastal geomorphology and coastal protection:

> ... One of the storms broke large pieces out of the dunes of the island of Wangerooge;
> ... Maintenance and climate adaptation work at the dikes along the Jade Bay are critically covered, and climate change lingers through many of these stories (Krauss et al. 2018 a, p. 63)

Shipping:

> ... a tanker ship stranded before the island, and during high water (Krauss et al. 2018 a, p. 63)

Losses of life:

> ... one tourist who slept in his car close to the sea was surprised by storm flooding and drowned. (Krauss et al. 2018 a, p. 63)

It is assumed that some individuals and groups are concerned because of the above mentioned consequences. However, this is not further indicated or described in WP1.

Some parts of the chapters 3.2 “Geo political narratives” and 3.5 “Storm flood memory as cultural heritage” are focussing on direct weather relations in the past. Sea levels and in particular storm floods are main aspects in this context. Chapter 3.2 is focussing on geological time scales and describes the geomorphological history of the Jade Bay, which is mainly impacted by storm surges. Chapter 3.5 describes how past events are memorized and, thus, how they linked to the present time. Monuments and landmarks remind of past storm floods and the damage they had done. Past storm floods are measured in relation to the current height of the dikes as warning and affirmation that current dikes are high enough (Krauss et al. 2018 a). On the occasion of an anniversary, an exhibition of the Christmas flood of 1717 has been shown. During this storm approximately 9000 people had died. At the opening ceremony of the exhibition the audience has been reminded of the horror of the cold death which storm flood brings (Krauss et al. 2018 a).

Based on the above analysis, Table 8 shows the perceived weather parameters extracted from WP1 (see Milestone M3.2.), complemented with the related perceived impacts, matters of concern and local foci. The table is completed by the analysis of the other reports in WP 1 (D1.2 and D1.3), if possible.

Table 8 : WP 1 analyses for the Jade Bay

Weather parameter	Perceived issue	Perceived link to climate change	Scientific knowledge	Impact / story / practice	Matter of concern	Particular local focus	Source
Temperature	Rise in general	Yes: : warming is mentioned as trace left by climate change	Consistent: Compared to the reference period 1961-1990 the Jade Bay region has warmed about 0.9°C (Meinke et al. 2015) Until the end of the 21.century warming could continue up to 5°C (Rosenhagen 2011, Meinke et al. 2015 and 2018)	new species arrive, former ones disappear; patterns of bird migration change	Not assigned in WP 1	Jade Bay wadden sea	D1.1 p. 58
	Rise in Winter	Not assigned	Consistent: Compared to the reference period 1961-1990 winter temperature in the Jade Bay region has increased about 1.1°C (Meinke et al. 2015)	less ice cover on parts of the waterways and the wet pastures	in former times, skating was possible in every winter for several weeks; nowadays, this is hardly possible.	Not assigned	D1.1 p. 63
Precipitation	Unusual high amount in Winter 2017/18	Yes: many of the informants blamed climate change for the rain	Consistent: precipitation amount in winter 2017 / 2018 was about 30% above the average value of the reference period 1961-1990 (DWD 2019). Winter precipitation has increased since then and is expected to further increase in future decades (Meinke et al. 2015 and Meinke et al. 2009)	fields and meadows were drowned in water	Fields became inaccessible, farmers could not get rid of the manure	Not assigned	D1.1 p. 62
	Unusual rainy summer 2017	Not assigned	Consistent: Precipitation amount in summer 2017 was above the average	Not assigned	Not assigned	Not assigned	D1.1 p. 62

Weather parameter	Perceived issue	Perceived link to climate change	Scientific knowledge	Impact / story / practice	Matter of concern	Particular local focus	Source
			precipitation amount of the reference period 1961-1990. (DWD 2019 & Meinke et al 2015) There is no significant trend in summer precipitation, so far (Meinke et al. 2015) and future change of precipitation amount is unclear (Meinke et al. 2009)				
	Drought in summer 2018	Yes	Inconsistency There is no significant trend for summer precipitation, so far. (Meinke et al. 2009)	Fields and meadows turned brown, and farmers missed one or even two hay harvests and had to buy additional fodder.	Prices were raised due to the Enormous demand, and many farmers had to sell cattle prematurely	Not assigned	D1.3 p. 55
Wind	Storm activity winter 2017/18	Not assigned	Unknown, no scientific source available focussing 2017/18	Land loss, tanker ship stranded	Not assigned	Island of Wangerooge	D1.1 p. 63
	Stormy weather, with intensive rainfall becomes more frequent	Yes: long term trend perceived	False for the last century, True for the past decades, uncertain for the future (Rosenhagen et al. 2011 and Meinke et al. 2018)	Not assigned	Not assigned	Not assigned	D1.1 p. 62
Sea levels / storm floods	Land sea interaction in the past Today: sea level rise and intensification of storm floods	Yes: Sea level rise is mentioned as trace left by climate change	True: Mean sea level has risen at the German North Sea coast by 10-20 cm during the last century. Storm surge frequency and storm surge heights have increased mainly due to sea level rise. Until	In the past: Flooding Damage Loss of people, Today: danger on	Past: Horror of cold and death Today: concern about	Jade Bay coast	D1.1 p. 56-57

Weather parameter	Perceived issue	Perceived link to climate change	Scientific knowledge	Impact / story / practice	Matter of concern	Particular local focus	Source
			the end of the 21. Century storm surge height may increase up to 1,1 m (Weisse et al. 2016)	the seaward side of the dike	adequate dike height, danger of accident		

5.1.2 Chronology of narratives and their changes & reconstruction of main weather events (D1.2)

For the Jade Bay, the report D1.2 is mainly focused on sea level, its interaction with coastal areas and the related coastal protection activities in order to enable settlement and development in this region (chapters 4.1.2 coastal mentality, 4.1.3 coastal protection, 4.1.4 dike inspection, 4.1.5 Dangast tidal gates). Some weather- and season-related perceptions are described in the chapters 4.1.6 Art chronotope and 4.1.7 narratives about the seasons.

In report D1.2, one chronology can be found for the Jade Bay, focusing on the interaction of sea levels, coasts and their settlement. As described in chapter 4.1.3, due to sea-level rise along the Jade Bay coast, human settlement was accompanied by dike building. For a long time, it was perceived as the fight of the Friesians against the sea. It is mentioned that the previous generation still had flood experience and was afraid of it. However, due to improved coastal protection and ongoing dike maintenance (chapter 4.1.4) some WP1 interviewees were not afraid of storm floods any more, since 'they' take care of it (Krauss 2018 b, p.31).

Nowadays, dikes are under the pressure of climate change and of nature conservation. Coastal protection would need to be adapted to stronger storm floods and rising sea level as effects of climate change (Krauss 2018 b, p.22).

There is no reconstruction or chronology of relevant sea levels or other weather events in the D1.2 report. Instead, the six stones in Dangast are mentioned, which are reminding of historic storm floods of the years 1717, 1825, 1855, 1906, 1962 and of

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2006. In the report only two of them are further mentioned, the storm surge in 2006 and in 1962:

> The most recent stone remembers of the All Saints flood of 2006, which had reached the highest peak, with 5,31 meters, higher than the flood of 1962, which is the obligatory reference point along this coast, (Kraus et al 2018 b, p.27).

A WP1 interviewee was surprised about this height. He took a picture of the driftwood, which was above the six stones of Dangast, marking the high storm surges. Although this storm surge was obviously higher, it was almost not mentioned in the media:

> …he had a framed colour photograph of the flood stones at his wall: it shows a line of debris right over the irregular line of flood stones – the highest peak ever reached. He took the photo the day after the All Saints flood of 2006, and he was totally stunned when he saw the debris above the landmarks. There were almost no reports in the media; he said (Krauss et al. 2018 b, p 27-28).

For the Jade Bay region, D1.2 does not include any further chronologies of narratives and reconstructions of main weather events. The remaining chapters on weather- and season-related perception refer to the same parameters as D1.1 but there are no further insights according to the matters of concern, particular places, their changes and underlying processes. Only one weather event, the snow catastrophe from 1978 is mentioned, since according to the author it seemed to be the most remembered weather event of the WP1 interviews:

> The most remembered weather event in my interviews was the 'snow catastrophe' of 1978, when snowstorms isolated the North of Germany for days (Krauss et al 2018 b, p.31).

This event and others have not been reconstructed as described in the DOW, task 1.2 (Vanderlinden et al. 2017).

Summarizing the above analyses, not all leading questions, raised at the beginning of this section, could be answered. From the narratives that were detected in D1.1, only one (sea level) was addressed in D1.2 according to the chronology of narratives and their changes. A reconstruction of related main weather events and their impact on people's perception is missing and there is only very little information on places,

people, materials and ideas related to weather events and climate change in the report.

Thus, an information on temporal changes in weather related matters of concerns are rare. However, one important exception was found by analysing chapter 4.1.3 and 4.1.4: According the storm surges a matter of concern was described for the previous generation, which still had flood experience and was (therefore) afraid of it. However, due to improved coastal protection and ongoing dike maintenance (chapter 4.1.4) it is stated in WP 1 that interviewees were not afraid of storm floods any more. This means that the storm surge related matter of concern has disappeared with time due to adaptation (coastal protection) and missing experiences. The visible dikes and their security promise seem to be much stronger than the rising sea level and increasing number of storm surges caused by climate change. Although existing and measurable, this happens behind the dikes where it keeps invisible and unperceived.

5.1.3 Key issues and desired futures (D1.3)

For the Jade Bay region, the D1.3 report is addressing different sectors. According to the headlines it is expected that mainly future perspectives were addressed (future water management (4.5.3), future coastal protection (4.5.4), energy futures (4.5.5), future of National Park and World heritage (4.5.6), environment and Planning (4.5.7), future of tourism (4.5.8) and future climate politics (4.5.9)).

Agriculture is described as a net greenhouse gas emitter and as a sector impacted by climate change. According to the author, unusual seasonal weather in winter and summer was linked to climate change. But the economic restrictions imposed by the European Union were perceived as more important. About the future, the possibility of inheriting a viable farm to the next generation is the only mentioned aspect. In this context weather is only one component of the vagaries, which need to be calculated, others are the market, politics and technological developments. In the chapter on the future water management, general aspects of marshland drainage are described.

According to the author, the main challenge for coastal protection is sea level rise (D.1.2, section 4.5.4); the mudflats and salt meadows cannot grow accordingly due to the existence of the dikes. This aspect is also subject of chapter 4.5.6 on the future of National Park and World heritage, where it would lead to a loss of biodiversity and endanger the success of nature protection from the last decades. Two general ideas of possible future coastal protection measures are described (living with water and second dike line, D.1.2, section 4.5.4). These ideas, raised by coastal researchers, were seen critically by the discussants in WP1 since it would be beyond imagination that the dikes might be opened. According to the National Park, it is suggested to declare the Wadden region as an UNESCO biosphere reservation. The other chapters do not have any direct link to certain weather parameters. Summarizing, four of the nine sections of the Jade Bay chapter have a link to weather parameters. However, plausible future development is described in a very coarse manner and there are only very few and general aspects for the future.

5.1.4 Discussion and conclusion

Several matters of concerns are presented in the WP 1 reports for the Jade Bay. Some of the narratives include directly weather related matters of concern, as suggested in the CoCliServ DOW (Fig.2). Not in all cases, it was assigned if a link to climate change has been perceived (see Table 8). Few general aspects of weather related stories, practices or matters of concerns have a clear link to climate change according to the WP1 reports (see Table 8). The localized weather parameters are temperature, precipitation, wind and sea levels / storm surges (Table 8, see milestone M3.2). The perception of these parameters is mainly related to the actual or recent season. The warming, the unusual winter precipitation amount and (partly) the sea level rise have been linked to climate change. This is in accordance to scientific knowledge (see milestone M 3.2).

The narratives, which are connected with weather parameters, are strongly related to the actual weather conditions during the time period, when the interviews were conducted. Thus, narratives on the weather conditions of winter 2017/18 are predominant. In turn, this could mean, that other aspects that were not perceptible during that period, might not have been detected. Referring to the in WP 3 aspired local contextualization of climate information to the described narratives in WP 1 this might lead to an incomplete picture of local climate change. Furthermore, it cannot be excluded that stronger, perhaps even contradicting matters do exist. For example, according to the warming in winter the described matter of concern is that in winter, skating is nowadays hardly possible (see Table 8). The impairment of the interviewee and further conditions, which makes this a matter of concern are unknown. It is unknown if this is just an observation, which is not highly relevant or if an important traditional custom has disappeared. Furthermore, it is unknown if the majority is concerned about winter warming or if other perhaps contrary matters (e.g. reduction of heating costs, less cold infections) are perceived. Referring to the WP 3 aim to locally contextualize climate information to the described narratives in WP 1 this could lead to a randomly composed extract of local climate change issues which fails to address central societal concerns and challenges of climate change.

Moreover, a fragmented ensemble of few and quite diverse matters of concern would not lead to a contextualization of scientific results with public validity. For example, the concern about fields which were not accessible because of high winter precipitation (Table 8), matters only to a small part of the society (e.g. farmers), whereas it does not matter to the majority. Thus, the added meaning, which may result from the contextualization of scientific knowledge with regard to this matter of concern, could be perceived only by a very small societal group.

On the other hand, the few climate change related narratives are too broadly scattered across different climate change impacted groups. Thus, a contextualization of climate information along this ensemble of narratives cannot be used to tailor climate information for a certain stakeholder group or sector. The range of

concerning aspects was not systematically collected and covered with regard to a particular group. Thus, the ensemble of climate change related aspects is fragmentary from the perspective of particular groups. For example, according to the sector of agriculture, the WP 1 reports describe few impacts of climate change, which may matter to this sector. They are about the inaccessibility of fields and about unusual weather characteristics of the actual or recent season. Form the scientific perspective of climate change impact research there are other matters like late frost events, hail, increased pest infestation and salt-water intrusion, which may reduce productivity significantly and thus could lead to much stronger concerns (von Storch et al 2018). It is unclear if these concerns do not exist among the farmers in the Jade Bay region or if the matters of concerns did not occur due to methodical matters (selection of interview partners, impact of the interview period and its occurred / not occurred weather conditions). However, relating climate change to only these few aspects would not help to contextualize and tailor climate information, since it neglects mayor aspects of climate impacts for this sector.

In general, there is no further information available on where, for whom and to what extend the described issue is a matter of concern. For example, the described general narrative, that new species arrive, former ones disappear, and that patterns of bird migration change, does not give any insight about the cultural meaning or economic significance of certain species, key persons and particular places are not mentioned. However, without this knowledge, it is not possible to contextualize climate information in order to turn matters of facts into matters of concern.

To conclude, the identified personal climate change related matters of concern, described in WP1 for the Jade Bay, are not appropriate as direct entry points to contextualize climate information, as suggested in the Co-Cli-Serv DOW. For this purpose, they are too fragmented, not focussed and too general. A contextualization of scientific results along these entry points might lead to an incomplete picture of local climate change with a questionable priorization of aspects. The CoCliServ aim to

add meaning to scientific facts by using narratives for contextualization can be reached neither for the public nor for particular stakeholder groups. Beside this content based deficiency, there are also practical barriers which hinder a contextualization of scientific results according to the narratives. Entry points, which allow a place based individual contextualization of climate information through the WP 1 narratives, cannot be derived since the further context of the narratives as suggested in the DOW (Fig 1) is not provided in the WP1 reports. Localization devices cannot be derived since the narratives are not allocated to specific places in the Jade Bay region. A basis for bottom up co-creation is not given since the key persons are not mentioned in the WP 1 reports.

Thus, instead using the WP1 Jade Bay climate related matters of concern 1:1 as entry points, general aspects of local relevance are derived. These aspects of relevance are related to the WP1 narratives but allow for a coverage of all aspects, which may have impact on society in the Jade Bay. For the Jade Bay region these are:

- Climate change and seasonality in the Jade Bay: Perceived weather / climate related aspects are mainly referring to “unusual” phenomenon of the actual or most recent season.
- The interaction with water (precipitation and sea levels in the North Sea): Interaction with water (precipitation, run off, water levels) is the prevailing issue within the perceived aspects in the WP 1 Jade Bay reports.

5.2 Evaluation of related existing climate information & services

Related to general aspects derived in the previous section, a workshop on “climate change in the Jade Bay region” has been organized and conducted in Dangast. About 30 regional stakeholders participated. The participants covered a broad spectrum of different stakeholder groups from governmental agencies, science, politics, civil society organizations, education, citizens and economy. The intention of inviting a

broad variety of stakeholders from different stakeholder groups was to enable regional stakeholders from different societal groups in the region to exchange views, ideas and questions with respect to climate change in their region based on existing climate information and -services. Initiated by a scientific impulse talk on regional climate change in the Jade Bay, provided by a regional climate service provider (Insa Meinke), it was supposed that the subsequent dialogue/discussion might provide insights in further options for improving or enhancing the local climate in the Jade Bay region. The workshop was recorded and transcribed.

5.2.1 Impulse talk

An overview about the current state of climate research on global, regional and local scales in the Jade Bay was provided. The structure of the talk "climate change in the Jade Bay region" was referring to the above-derived general aspects, seasonality and interaction with water with a regional focus on the Jade Bay region. At the beginning, existing regional and local climate service products from the Northern German Coastal and Climate office were introduced. Some of them, in particular the web tools, were further explained within the talk since they served as basis for the presented information. Moreover, general concepts of climate change were explained. In particular, the difference between climate and weather was clarified, in order to elucidate the meaning of climate change with respect to the applied statistical methods. Furthermore, the greenhouse effect was explained and sources for anthropogenic greenhouse gas emissions were described. Moreover, the scenario technic underlying future climate projection was introduced. The first part of the talk focussed on climate change and climate variability during the last century and during the recent decades whereas the second part of the talk gave an outlook to possible future climate changes until the end of this century (2100). In both parts, global climate change was addressed, first. Regional climate, regional climate change and variability were addressed, subsequently in more detail. The focussed region included the whole Jade Bay region. In order to localize climate change information as far as possible, the nearest suitable weather station and tide gauge were chosen to describe

recent local climate change & variability. The regional and local climate change information was structured according to the seasons with particular regard to water (precipitation, sea level and storm surges). Recent extreme seasons like the warm and dry summer in 2018 and the rainy winter 2017/18 were related to the reference period 1961-1990 and to possible future scenarios. The talk was followed by a lively long discussion. In the following section, this discussion is analysed in order to find additional aspects to support a place based climate service for action. It was assumed that these aspects might refer to additional information needs, important local features, specific groups with particular information needs and missing formats. However, no leading questions were predefined at the beginning of the discussion, since the objective was to find out which association this diverse group of different stakeholders has according to the given impulse on local climate change in their region. All impulses came from the auditory.

5.2.2 Dialogue

The discussion after the talk included mainly two parts. In the first part, the participants articulated questions with direct link to the talk. In the second part, the auditorium exchanged personal views, perceptions and experiences according to climate change. In accordance with these two parts and their different foci, the role of the regional climate service provider changed. In the first part, she was a partner within a science-stakeholder dialogue, acting as knowledge broker by answering the raised questions. In the second part, her role was less central, since the participants exchanged views and thoughts among each other.

Questions

All raised questions of the participants were referring to aspects, which were mentioned in the talk, before. They can be classified coarsely in two groups. One is referring to methodical aspects of research in climate change; the other is focussing on certain aspects of climate change on global and regional scales.
According to the methods, questions mainly addressed the conceptual basis of future

climate scenarios. One important aspect in this context were tipping points and to what extend they are taken into account in the existing scenarios. Particular interest was articulated according to the effect of melting permafrost areas with regard to possible Methane emissions, changing radiative properties of melting sea ice and the possible weakening of the Gulf Stream due to increased fresh water intrusion from melting inland ice. The context of this interest was the inherent uncertainty of using climate models, which are limited to the state of the art. Beside this, uncertainty by using climate models is due to the fact, that numerical models reduce complexity. The question related to this uncertainty was related to the expected worst case, in particular, if the available future climate scenarios include all plausible future climate related processes or if future climate change might even get worse:

> "Does this mean that the calculations are based on today's state of knowledge, but it could also get worse?"

Another aspect was referring to the generation of future greenhouse gas emission scenarios and their inherent uncertainties. It was questioned if the future development of society, and society's ongoing aspiring towards industrialization has been accounted, in particular against the backdrop that China, India and Africa are not (completely) industrialized, yet.

Summarizing, both methodical aspects were linked to the method inherent uncertainty. However, unlike to previous expectations, which were often articulated in the context of adaptation to climate change, that the uncertainty range needs to be reduced to a single value (Meinke 2017), here both aspects were referring to plausible enlargement of the uncertainty range to even stronger climate changes in order to estimate the worst-case scenario of future climate change.

Linked to both, the underlying method of climate research as well as to the general aspect of anthropogenic climate change, two contrary perspectives of the anthropogenic contribution were elucidated: One was referring to the climate deniers, arguing that the observed global warming is within the range of natural

variability. It was assumed that their analyses is based on the same data. Thus, it was questioned why they come to different results:

> "On the one hand it is said that we are making a significant contribution to climate change, but on the other hand there are also scientists who say that this is increasing, but that is all natural, we are now living in an interim warning period. We are 10,000 years from the last ice age. They have the same data or not?"

The other perspective articulated in this regard was the contrary assumption that there is and will be no extreme season or weather which is not impacted by anthropogenic greenhouse gas emissions.

> "I wanted to ask about the question of whether this was now climate change or not, a particularly hot summer for example. This is called man-made climate change. There is actually no competition for man-made climate change, because the climate is man-made. In the future, our weather will always be made with people, no matter what"

Other questions were linked to certain aspects of climate change in global scales. One aspect was related to present anthropogenic greenhouse gas sources, in particular the moors as greenhouse gas sources due to drainage:

> "I have a very different little question, which is about the moor. Moors, only 3% of the earth's surface is covered by moors, which, I believe, store more than 30% of CO2. We always have this graph, which says that CO2 is emitted by industry and agriculture and the like. Where are the moors, because they emit a considerable amount of CO2?"

Moreover, the different contributors of global sea level rise were asked for, since sea level rise would mainly be associated to melting ice sheets in Polar Regions. Some of the presented issues of regional and local climate change and their impacts were also addressed as reference for questions and associations how these issues may develop on global scales or in other regions of the world. Here, it was referred to a map illustrating the coastal protection need in the Jade Bay region, now and possibly in a future climate. This local condition was accounted to reflect on developments at the global level.

> "I mean, dikes are a typical thing for coastal areas in our country. However, they don't even exist in many places, but there are many metropolises that were originally built just because of their location close to the sea. I spontaneously think of New York or something. So there are tens of millions of people living there, but they don't have protection like we do."

Linked to this aspect another visitor raised a strong matter of concern in the Pacific Ocean

> Tuvalu and Kiribati will certainly not survive this, they are with half a meter up to one meter above sea level, thus they are quasi exposed to ruin.

A similar mechanism (using local conditions to associate matters of concerns in remote regions) was linked to high summer temperatures. A visitor was referring to the hot summer 2018. In the talk, this summer has been analysed for the Jade Bay region and was related to the reference period 1961-1990 and to future regional climate scenarios in the Jade Bay region.

> "You showed somewhere this map with the increasing summer maximum temperatures. The weather was hardly bearable for the people in many places, here. I just think about what this means for mankind globally, if this temperature increase not only happens here in the northern hemisphere in the higher latitudes, but when a corresponding increase would also occur in equatorial regions. What is happening there? Then surely large areas of the earth will become virtually uninhabitable? Is that correct?"

Another aspect referring to climate change on regional scales was the question if changing global atmospheric processes are leading to increased atmospheric dynamics, more variability and less predictability. In particular, it was requested if the possible weakening of the Jet-Stream is the reason for opposed extreme characters of a specific season, like the wet summer 2017 and the hot and dry summer 2018.

The perceived increased unpredictability of the seasons, in particular summer precipitation, was also addressed by another visitor who raised a matter of concern with respect to planning of his livestock farming.

> "How do I divide my food if I get such a dry summer now? Am I harvesting this or what is expected now …, what will come out this year anyway? This means that I have always the feeling that we are just using up the very last bale and getting our sheep and lambs just so far that we can get them all into the slaughterhouse."

Another visitor argued that for industrial livestock farming this is *not* a matter of concern:

> I just wanted to say a few words related. Fortunately, our industrial livestock farming is independent of such concerns, because the feed comes from somewhere else, so we do not need to worry about it.

Regardless of the correctness of this perspective, it shows, that even within one sector, here livestock farming, the perceived matters of concerns may differ depending on specific decisions and the chosen strategy of a particular stakeholder. Even if uncertainty of future planning would be reduced by improved seasonal forecasts this does not reduce or prioritize possible actions or decisions, like in this case deciding for a small farm or for industrial livestock farming. There is no single correct option for action, and it is not up to science to decide between a right or wrong strategy. Thus, a place based climate service for action implies that the role of science needs to be kept neutral. Rather than supporting a particular favoured action, science can support decision-making processes by analysing how certain decisions, compared to others, may initiate specific changes and impact developments.

Moreover, the depth and the sustainability of concerns may substantially vary, which was discussed in the context of the extension of vegetation period. In the talk, it was shown based on temperature measurements and some examples in the regional nature that the duration of the vegetation period has increased. It was asked if, thus, crop yields may increase. Another visitor was referring to this question:

> "It is actually a false conclusion to say: Oh well, the vegetation starts earlier and we can perhaps harvest earlier. In fact, in nature, everything is coordinated and interacting, the insects develop within a certain period of time, the birds need the grass if it is not yet so high. And if the environment change so quickly, nature sometimes has no way of adapting, so I guess that's just too fast for many (species). We don't know what the consequences could be for the species we need."

This shows another feature of diverging matters of concern within the same area, here nature. It can be de described as visible, short-term impact (here harvest) versus invisible slow process (here ecosystem interaction).

An important aspect, which was perceived as obstacle in dealing with climate change impacts is the increased isolation of different living environments, which do not show any crosslinking among each other. Missing links and missing participation to each other's living circumstances prevents communities to co-develop strategies or define joint actions regarding how to deal with climate change.

> "These are, of course, life backgrounds and experiences which, I say, Donald Trump, of course, doesn't have for example - which of course doesn't interest him either, of course. Yes, and I think that by splitting into these different life scenarios or life perspectives, we won't be able to cross-link any more, I think that's one of the biggest problems we have at all."

Discussion

The second part of the dialogue was introduced by questions referring to the presenter's personal perception of social circumstances. These questions served as a hanger for articulating own perceptions and initiated discussion among the participants. One question was related to the perceived role of climate change deniers, since the visitor was concerned about their influence in politics and on society:

> "As a scientist, you present all this relatively factually, but how do you personally feel when you observe that somehow this climate change deniers, in times of fake news, are not only somehow present worldwide, but are also still active in the places of political power. It scares me personally."

Another visitor was asking about the presenter's personal reception of the discrepancy between political climate targets and political decisions.

> " ...how do you experience the reception in politics? Well, I see a huge discrepancy. On the one hand, there is a Juso boss who says that he would like to socialize large companies. Everything is screaming, for heaven's sake, we cannot do that. On the other hand, hundreds of villages, i.e. thousands of people, are simply expropriated in order to make a brown coal open-cast possible. On the one hand it is said that we have to save CO2, but a highway is being planned, a forest is being cleared ..., in other words there is a huge discrepancy in policy between what is proposed in terms of climate targets and what is actually being done, which is exactly the opposite. How do you experience this reception in politics or are there few intersections?

It was perceived that economic interests of a minority have priority although they are contradicting the political climate targets. Big companies are protected and supported, however these decisions directly harm a majority of citizens and are in addition contributing to climate change.

Another discrepancy was described regarding the mitigating impact of implementing technical innovation and its potential and actual development. It was perceived that

knowledge and innovation does not evoke mitigating action, although it would be technically possible. Increased technical innovation and efficiency does not lead to more environmentally friendly behaviour. Instead, increased economic and technical power has been observed.

> "I was able to hear the story, i.e. the statistical recording (of climate change), for the first time in a similar and probably much larger form in Al Gore's film. And I have to say that nothing has really happened since then concerning human steps to stop this development. If measures were implemented which show a qualitative improvement, then on the other hand, a quantitative counter-movement has prevailed this improvement. Cars, for example, have become more and more environmentally friendly, but the fact that there are now many more cars means that this technological step has been practically nullified … . How do you feel about that personally?

Marketing of the big companies was seen as major reason for this development.

> The possibilities to change something, to flip the switch: The technical possibilities, the energy cooperations, they all exist, we all already have them, but they are not applied. And that is the problem, that we are also slowing down the application of hydrogen technology. We don't have to develop SUV cars, the SUV cars have certainly not been developed by the consumers, but by some people who can market them, and they are simply these wrong switches that weren't flipped, but that's possible.

While here the consumer is seen more in passive role, influenced by powerful marketing strategies, another visitor described the gap between existing knowledge and missing personal action as consequence of the knowledge

> As I have often said …, we do not have a lack of knowledge, but we do have a lack of action. From my personal observation I expect that it will remain like this …. I was just thinking that it would be really exciting to have a psychologist at such an event. Where he tries to explain whether there is perhaps a point somewhere, that suffering pressure is so great that a global swarm intelligence develops - because it doesn't exist. The Russians don't care and the millions of Trump voters don't care either. There are always these projects like this: City cycling, Earth Hour, last year, I said that I wouldn't go along with that, because we don't have to set any more signs. Everybody knows it, but nobody wants to do without some certain things in their small private cosmos and I count myself among them, I don't make myself holy at all, I'm the same."

Like in the previous examples, it is clearly stated that the reason for missing adequate personal climate related action (here mitigation) is not due to a lack of knowledge. Quite the contrary, everybody is well informed and aware about climate change. However, most people do not want to do without anything in their everyday life. It was assumed, that there might be a collective psychologic conspicuousness, which

could only be counteracted by an increased suffering pressure, which is leading to a global swarm intelligence. The aspect of the missing swarm intelligence as a consequence of increased suffering pressure was adopted by several other visitors:

> "that can't be done by now calling a politician names but by all of us ourselves. And there the swarm, as you have just said, must develop a swarm intelligence or develop an affinity or even a distress, threatening the very existence, so that the basic instinct in every living being takes effect, so that they begin to change."

Like in the previous example, it is assumed that individual action of single persons would only begin to change as consequence of a strong personal impairment. This was also supported by another participant pointing out that society is in a huge learning process where a challenge -is among others- the invisibility of climate change, which is hard to be translated by a simple campaign:

> "I would just like to briefly turn back to this swarm intelligence: I mean, we are all challenged there. ... I find that so interesting when it comes to the death of insects, because two or three years ago, when you said, "Oh, there's an insect," "Ighh," and insects, and now I find that totally interesting. In the county there was a campaign, now seeds were given free of charge in order to promote the insects. It's not always ideal, but I'm totally amazed who everywhere starts to do something for insects at once, then I think "Yes!", there's quite a lot going on. And well, climate. -Insects can be grasped, but climate, it's a topic, it's very abstract, but we're all in this process. Maybe it has to hurt, first"

The aspect that climate change needs to hurt before action is changed was also mentioned in the context of suited policies:

> But you do something, we all do something about it, and at some point it will also be a politically attractive topic. It is clear that if someone stands there, ..., he will not demand something of which he knows there will be no resonance among the population. But I hope that at some point we will have such an enlightened population that they will say: of course! -we need it now. Now, perhaps, it will have to hurt before we move in a different direction. So, I think we are in a process of development, we are in a huge learning process.

The issue of public acceptance of needed policies was also addressed by another participant. The missing acceptance, he assumed, is also a main reason for the discrepancy between the set political climate targets and the missing political decisions to implement suited measures:

> "Yes okay, so there's always a lot of grumbling about politics, it would not react enough. Of course, it is unacceptable to enliven the climate conference in Paris and then nothing happens.

> But fighting with great passion to get an agreement (in Paris) is the simple part of the fight. But then you get the receipt on national level as soon as you start making unpleasant decisions. We see this very strongly in France, where a very smart president was elected with great sympathy and then suddenly he took completely unsmart decisions, which basically made a lot of sense from an ecological point of view, as far as I know. But in no time at all, anger was caused on the streets. In other words, we need broad acceptance among the population that they are willing to go along with the decisions and are willing to support them."

It was further amplified, that this acceptance can only be achieved if it is managed to maintain the prosperity of the population in spite of the necessary measures:

> "Politics is always also a promise of prosperity, which means that I have to be able to combine both, in other words that we become ecologically better, but nevertheless, at least in the short term, I cannot do it to people that they have less. Then they will withdraw their trust in me.

Moreover, the articulated assumption of a self-learning society was relativized by this participant, as we still experience little climate impact compared to other regions. Thus, other problems are more pressing:

> "And if we are honest, if we experience the talk now, it feels like "Oh my God". But when we return to everyday life, we first have other problems, and perhaps we are just in the water with our feet, but it really doesn't stand us up to our necks. Nor can we say that we are threatened the day after tomorrow, these are completely other regions."

However, the argument that other remote regions are much more threatened was seen as a concern, since this would initiate migration and thus additional people expecting property. This would make the reduction of CO2 emissions even more difficult:

> I believe that Europe will be a favoured location for a long, long time, just like America, they can do a lot for quite a long time. But what happens to people who are unable to prevent themselves? They will be on their way and they also have an expectation of prosperity. Because they will also see how other people are doing, and that becomes more and more acute. And now it would be important to know how to develop, prosperity that at least remains stable - and with population growth it even has to rise - and still a decreasing CO2 curve.

These perspectives were summarized by specifying the challenges to combine rising prosperity with decreasing CO2 emissions:

> We must show that this is our task, and that this is possible. We do not have to believe ... that we can save the world the day after tomorrow through our own behaviour. But we must show other countries in the world that this is possible, that prosperity is rising steadily, but that we are

> nevertheless doing something in a way that is compatible with the environment. That, in my view, is the great challenge.

5.2.3 Reaction on direct requests for additional information needs

At the end of the discussion, described above, the moderator raised explicitly the question regarding additional information needs. In particular, it was asked if there is knowledge need regarding people's everyday practices, which has not been addressed in the talk of the regional climate service provider. Two of the three raised issues were related to human greenhouse gas emissions. In both cases, the need for transparency was claimed:

> You asked where is the need for knowledge? There are no indicators yet of how urban development failures will affect climate change, and there is no research on this yet. But that's an interdisciplinary story, it's very challenging. … If I then say, dear community, this single urban development mistake has now emitted so much CO2 for the next five generations, then we would find that, "oh", all our climate protection efforts have just vanished into thin air, simply because a local council once said that the single-family house area, that's what we want there, and that's exactly how we want it. It would be interesting to simply make this transparent for once.

And:

> I think this graphic is very nice (sources of human greenhouse gas emissions). It's certainly important to see where most greenhouse gases come from. However, I think it's also important to see what has changed in recent years? Because I know, for example, from the transport sector, which is perhaps my area of expertise, that nothing has changed at all, while the other energy suppliers and especially the industry are making an effort or are also noticing that something is going down there, but not at all in transport. In other words, we could try to take up this development, which already exists, and work on the points where there is still the most increase.

Both aspects show that there is a knowledge need regarding the magnitude of greenhouse gas emission of specific decisions and within certain sectors. In both cases, it is hoped that this will raise awareness and that reasonable action will follow, in order to mitigate greenhouse gas emission.

The third and last issue raised here was like several aspects before linked to the missing personal impairment of climate change:

> I'm still interested in these effects on people themselves. ... So of course I have a connection, but how could something like that be brought even more to people? Because I recently went to the dentist, for example, and was quite amazed at how climate change was in all the booklets. Well, all people are really informed, so as you said, it's not that, but it's about how do I get it to me? And there, I am still missing a bit the impact.

Again, it was assumed that the personal impairment by climate change would change peoples' personal way of thinking about climate change and respective behaviour.

5.2.4 Reaction to missing aspects, which should be accounted

At the end of the workshop, the moderator asked for aspects that had not been noticed but are important to mention in this group. Here, a local aspect was raised, namely the venue of the workshop. It was seen as a huge mistake of urban planning with regard to climate change. It was built against the will of the majority of the citizens. The decision that the building could be built, although it is vulnerable to be flooded by storm surges, was based on a scientific information:

> So I was thinking all the time: we are here in this room, which is actually the monument of a misguided local political development in the sense of what we have discussed today. There was a spa centre, which sold by the town to an investor, including a 6-hectare spa park around it, back there was all the beauty, and he built this building against the declared will of large parts of the population ... in a place where the building is not insurable, where the dike that protects does not meet the standards that a main dike must have.

The decision that the building was built, although it is vulnerable to be flooded by storm surges, was based on a scientific information:

> And to the local politicians, the engineering firm that raised this dike told them that the building is now in an area, or will be in an area, where it is likely that only a single storm surge in the next 70 years will be high enough to endanger the building. Local politicians have interpreted these statements as follows: At the earliest in 70 years a storm surge will occur, and there upon they were of the opinion that there is no problem that the building is build there and that it invests cunningly. And that is why I see this building, and we from the citizens' initiative, with very, very mixed feelings since then, and we only hope that what we think will never happen to this building with regard to climate change. Because we have also paid for it, and not just us.

This indicates that scientific information is used and interpreted to legitimize favoured decisions and actions. The same information can serve as basis for very different and contradicting decisions. Although the information could have been used to support climate change adaptive action, it was used for legitimizing a new

building, which is quite vulnerable to climate change. Again, this shows that scientific information does not necessarily evoke climate adaptive or mitigating action. Instead, decisions follow a particular interest while scientific knowledge is used to legitimise this behaviour influenced by personal interest.

5.2.5 Summary and conclusion

The workshop clearly showed that the reason for missing climate change related action is not due to a gap of knowledge on climate change or missing place based climate information.

According to needed climate related action, discrepancies within several societal areas were discussed. In particular, huge discrepancies were seen between political climate targets and actual political decisions. Reducing these discrepancies would require a broad acceptance for the needed decisions and measures within society. It was assumed that this could only be achieved by meeting the challenge to combine rising prosperity with decreasing CO2 emissions.

Moreover, discrepancies were seen between the potential mitigating impact of technical innovation and their actual use that follows the laws of the free market economy. Powerful marketing strategies of the respective companies were seen as source for this discrepancy.

Furthermore, the significant gap between existing personal knowledge on climate change and personal action as consequence of this knowledge was discussed. There was agreement among the participants that changes would only be expected as a consequence of a strong personal impairment and increased suffering pressure.

As the discussion showed, the participants do not perceive, that climate change is impacting their personal every day live, so far. Moderate local climate change impacts (heat) and efficient local adaptation measures (coastal protection) were referred to in order to associate strong matters of concerns in remote regions of the globe. Whereas the matters of concerns raised according the own life appeared to be limited to single perspectives and seemed to vary or contradict within one sector (e.g.

agriculture). In this context, the increased isolation of different living environments was mentioned as obstacle to co-develop strategies or define joint actions regarding how to deal with climate change. Possibly, also due to presently missing personal impairment, uncertainty of future climate change scenarios was mainly related to the worst possible future climate change.

There was no additional fundamental information need beyond the existing status addressed to physical climate research. Most of the articulated additional information needs could be complied with already existing climate information. According to the method of climate research and questions related to global climate change, the IPCC reports served as most important basis. For the regional and local climate information needs the existing information of the regional climate service provider served as adequate basis. Additional information needs were mainly articulated according to source of anthropogenic greenhouse gas emissions and the direct personal impairment of climate change. The venue of the workshop, the "Weltnaturerbeportal" in Dangast, turned out to be an important local feature in order to analyse the role of scientific knowledge on climate change in decision processes. The agricultural sector could be identified as a group with particular information needs. Seasonal forecast and ecosystem service were found as important research fields, here, as matters of concerns were related to them. There was no discussion according to specific missing formats. However, since isolation was raised as one of the main obstacles, it is plausible to suggest formats allowing participation in order to share life backgrounds and experiences with regard to climate change.

6 Bergen

(Birgit Gerkensmeier)

6.1 Analyses of narratives as potential entry points

The case study of Bergen provided, according to WP1's conceptual framework, a comprehensive work, by highlighting in D1.1 where and how climate change occurs in public narratives; D1.2 added the dimension of time to the spatial representation of weather-and-climate-related narratives in specific places. D1.3 finally, takes a closer look at future visions for Bergen in the context of climate change.

The stakeholder workshop, held in Bergen in November 2018, provided insights with regard to needs and demands of local actors and stakeholders in order to deal with changing climate conditions in Bergen in the next decades. In addition to the findings from the analysis of entry points, discussed in the next chapter, these insights from the stakeholder workshop provide a basis for the evaluation activity in the Bergen case study.

6.1.1 Weather and climate related narratives (D1.1)

The Bergen case study team presented the analysis of public narratives about Bergen as starting point for the CoCliServ analysis to deduce narratives of changes. Following the case study team, public narrative provide, in its form of often co-produced stories across the private and public sphere, a starting point to analyse how local people relate to the climate and how climate is framed and act as a place-making device (D1.1, p. 29-30). These narratives provide a good first orientation for WP3, which topics are relevant in the case study.

Climate and weather are essential parts of many public narratives in / about Bergen. Rainfall is a central element in this context, which can be found in the public narrative about the outsider perspective on Bergen as well as in the Bergen municipality policy narrative. The narrative about the outsider perspective on Bergen, presented in the chapter 'Information for Bergen for outsiders' (chapter 2.2.1) strongly emphasis the

climate of Bergen positively as mild and full of 'plentiful rain' (D1.1, p. 30/31). Moreover, it highlights the close connections Bergeners have with the natural environment, emphasizing rainfall as a daily business they are (creatively) dealing with (D1.1, p.31). The Bergen municipality policy as an additional public narrative (D1.1, subsection 2.2.2) underline 'rain' as a central element stating that

> Bergen is depicted as the 'Rain City', both as the city's 'trademark' and as a possible 'contribution to city life.' (D1.1, p. 32)

In addition, the municipality's vision statement (Bergen Kommune 2010), highlighted that beside dealing with rainfall air quality is an ongoing issue

> One on-going issue in Bergen, often related to the local climate, is air quality in the city. (D1.1, p. 32)

Since public narratives are also conveyed and shaped by the media, D1.1 for Bergen consulted an existing media study: the study mentioned was conducted by Elisabeth Meze-Hausken (2007) who "reviewed the coverage and contextualisation of weather and climate as front-page news stories in Bergen's local daily paper, Bergens Tidene, from 1994 – 2003." (D1.1, p. 33). Major points that Meze-Hausken (2007) highlighted about climate and weather shaping the public discourse includes:

i) perceptions and tensions in climate and weather articles (for the time period selected) are mostly related to different seasons (seasonal issues receive most coverage in the sample);

ii) impacts of extreme events are also often addressed (receive second most attention)

> "reporting mainly on avalanches, floods, and storms. Drought, fires, thunderstorms and heatwaves – both locally and abroad – also receive attention" (D1.1 p.34, referring to Meze-Hausken 2007).

iii) Bad weather conditions (third most discussed in Meze-Hauskens' sample) are often linked with extreme events but also with impacts on individual (unpleasant) living conditions (and weather-based depression). However they are also linked to

positive stories giving "the impression that the challenge to live in this hard climate is met with pleasure" (D1.1, p. 34 referring to Meze-Hausken, p. 10).

Chapter 2.2.4. 'Observations in the city and at key sites: museums' highlighted weather and climate related place-making devices, which "all appeal to the 'Rain City' identity attached to Bergen" (D1.1, p. 36). Chapter 2.2.5 'Locally histories, in local bookshops' underlined the long lasting and multifaceted connection inhabitants of Bergen made with regard to weather, mostly rainfall. In addition to the public narratives for Bergen provides insights answering the question "to what extent has the threat of global climate change coloured the way Bergen's people discuss the climate in Bergen, and the cities future?" (D1.1, p. 42). Chapter 2.3.1. 'Climate change narratives inside Bergen climate governance networks' underlines the rapidly growing climate science community in Bergen in the last decade; for both national and regional climate science as well as for global climate science. A quote from climate scientist Erik Kolstad (Uni Rsearch Climate) on a 'Klimathon' in Bergen, 8-9 January 2018, provides a kind of summarized insight about the major issue for Bergen related to climate change, which will also be addressed in the forthcoming activities of WP1 in Bergen:

> "He noted predictions for wetter weather along the northwest of Norway, with implications for the city's surface water management. He also noted a shifting in the timing of the seasons and the weather contained in each season, would affect activities like farming; "Now that spring comes earlier, it will also rain, and as a result it will be difficult to use heavy machinery on the fields. (D1.1, p. 43).

Meanwhile, many local governmental and municipal activities and networks have evolved around this scientific expertise:

> The municipality has a whole network of relevant policy instruments and vision statements, including (i) Water and the life of the city'; (ii) Cities of the Future; (iii) Bergen Smart City Energy Efficiency; and (iv) 'Green Strategy; Climate and Energy Action Plan for Bergen. (D1.1, p. 43)

A statement from a municipality representative at the BTO, Bergen 13 June 2017, provides insight about impacts of combined increased rainfall and sea-level rise and

concerns about limits of the capacity of existing water surface and sewer systems that are included and conveyed in these public (municipality) narrative(s):

> "The city has a long tradition is surface water management. The city has managed this rather well so far, but existing water systems are about to reach the limits of their capacity and many systems will have problems in the future due to climate change: (i) increasing amount of precipitation (especially in autumn and winter); (ii) increasing intensity of the rainfall (summer rain); (iii) problems with flooding (Nesttun watercourse, Damsgård and more). We also face sea level rise, which will (i) increase overflow from the sewer systems; and (ii) Bryggen will be flooded more often".(D1.1, p. 44)

These individual statements (scientists and governmental representatives) give first indications of different perspectives and concerns regarding climate change in Bergen, which are discussed and shaped in the respective communities. Through the in depth insights of local and individual narrative in the following deliverables WP3 hopes to explore Whether or not these concerns also exist in the population or amongst the affected groups (farmers community for example) and therefore provide an entry point for WP3 CoCliServ activities.

Chapter 2.3.2. 'Climate change narratives in the broader public sphere' highlights concerns about impacts of future climate change. The Wikipedia page, analysed here as a source representing a broader public perspective, highlights heavy rains caused floods and several landslides, including some indications are that due to climate change, storms causing landslides and floods will become more severe:

> "In recent years, precipitation and winds have increased in the city. In late 2005, heavy rains caused floods and several landslides, the worst of which killed three people on 14 September. Some indications are that, due to climate change, storms causing landslides and floods will become more severe in the area and in the surrounding counties. […] [There were] over 480 landslides in Hordaland county from the spring of 2006 to the summer of 2007. Most of the slides hit roads, without causing damage to cars, buildings, or people, until October 2007 when a large dislodged rock killed a motorist" (Wikipedia 2018). (D1.1, p. 45)

In the context of 'climate change narratives in the broader public' the media analysis of Meze-Hausken (2007) D1.1 already referred to earlier, had been cited by the authors of D1.1 underlining the fact that climate change also appears quite regularly

in the local newspapers. Meze-Hausken (2007) discussed the linkage between the connection between local climate scientists and highlights that

> "[…] The possibility of being confronted with even greater amounts of precipitation captures journalists' attention" (D1.1, p. 46 referring to Meze-Hausken 2007, p. 13)".

To sum up, D1.1 for Bergen presented several major issues and initial insights from general, public narratives that helps us to get an idea of the debates and discourses about weather and climate change in Bergen. Precipitation is a central element, in the past and for today. Seasons are a mentioned as central element in the public discourse about weather and climate in D1.1; however only in a broad sense. Further specification how this might serve as an entry point is expected from D1.2. Related discussions and potential concerns about precipitation and seasons include individual (unpleasant) living conditions (and weather-based depression) based on bad (and rainy) weather conditions as well as concerns about increasing challenges for surface water management (also in combination with sea level rise) caused by an increasing amount of precipitation.

Beside precipitation and seasons, D1.1 highlighted extreme events as an important issue; heavy rainfall events and resulting landslides appears to be one of the most perceived events in this context. Building on these insights we expected D1.2 and D1.3 to further substantiate and underpin these insights from interviews and addition al activities according to temporal aspects of potential entry points and (their) future perspectives.

6.1.2 Chronology of narratives and their changes & reconstruction of main weather events (D1.2)

The analysis in D1.2 draws on the public and private narratives identified in D1.1, and on a series of 18 'narrative interviews' with diverse Bergen residents in May/June 2018. (cf. D1.2; p.52).

> It "starts by sketching a unified, synthetic narrative of the emergence of climate change in Bergen, before breaking down this story into its constituent parts relative to the different times evoked" (D1.2; p. 52).

Activities in D1.2 focused on deducing the emergence of climate change in Bergen. "Interviewees were asked to think about weather events that stood out for them, were important to them, and this elicited a corpus of private stories" (D1.2 p. 64).

D1.2 distinguished and analysed narratives in Bergen according to timescale and chronotopes (D1.2, p. 52). The chapter on 'emergence of climate change in Bergen' and 'climate change as an emerging concern in Bergen' (D1.2, p. 52-56) underpinned the strong link between Bergens identity and climate and weather elements (cf. D1.2, p. 53). From 2003/2005 onwards, the authors highlighted that

> "we see Bergensers' perspective on local weather shift in character, 'looking out' with a regard for global climate change, before refocusing on Bergen and discussing what climate change might mean for Bergen" (D1.2, p.54).

This shift in perspectives is attributed on the one hand to an increase in competencies and amount of climate-science conducted in Bergen, which includes the creation of the prestigious Bjerknes Centre of Excellence in 2003 and the "increasing solicitation of advice from Bjerknes scientists to support decision-making by various actors" (D1.2, p. 55). On the other hand, the authors highlighted two triggers from the physical system:

1. sustained torrential rains:

The authors shed light on the sustained torrential rains that caused a massive landslide in the Hatlestad residential suburb of Bergen in September 2015 as an important event. For these events, the perceived link to climate change has been highlighted in the interviews:

> "For many (see Interviews 6, 7, 9, 11, 16 and 17) these landslides sparked the public, and perhaps more importantly the political, awareness of local climate change and its terrible impacts. Many considered that landslides of this magnitude in residential areas were beyond anything Bergensers had experienced before, and foreshadowed a new era of weather." (D1.2, p. 55)

Interviews also highlight perceived increase in vulnerability to these sudden events:

> "Landslides continue to occur, and draw public attention to climate change. A landslide in November 2017 on nearby Osterøy Island, crashed into the bedroom of a house and killed the mother sleeping there, while the father and children were in the kitchen. This has triggered a drastic review of all areas potentially vulnerable to slipping on the island." (D1.2, *p. 55)*

2. outstanding / exceptional winters and summers

> "Outstanding seasons since 2003 are also evoked as a sign of Bergen's new climate, and seem to signal that some Bergensers see this as a new epoch for the city." (D1.2; p. 56)

Perceived outstanding seasons include exceptional cold winters and exceptional summer seasons:

> "Or interviewees own accounts of snowy winters that are tailing off, both in peoples' memories and statistically (e.g. Interviewees 7 and 17)." (D1.2, p. 56)

> "some interviewees (see e.g. Interviews 14 and 16) wanted to talk about the exceptionally sunny, warm and dry spell of weather over much of May 2018' (D1.2 p. 56)

Beside the perceived link to climate change and outstanding seasons, the authors also highlighted perceptions and concerns about impacts of these kind of exceptional seasons – positive and negative ones:

For exceptional winter seasons:

> "Many interviewees (3, 5, 7, 9, 14, and 17) spoke of the exceptionally cold, clear and snowy winters experienced in 2010/2011 and in 2017/2018, and the wonderful experiences they brought; from playing in the snow with a young child, to skiing through the night in Bergen's mountains." D1.2; p. 56.

> "But in evoking these winters, some (see e.g. Interviewees 7 and 17) lament the exceptionality of snowy winters in this new epoch, and fear that we will eventually lose the magical Norwegian white winters that used to be the rule, rather than the exception." (D1.2; p. 56)

Due to the geological situation of Bergen, the local conditions from time to time lead to an occurrence of inversions causing bad air quality. A direct link to meteorological conditions in winter and its negative impacts on health is perceived– but a direct link to climate change is not mentioned.

> Interviewee 6, at Bergen Kommune, recounted the winter of 2013, after Christmas, when pollution was so bad that asthma sufferers were hospitalised and a French newspaper labelled Bergen as having the worst air quality in Europe. (D1.2, p.58)

For exceptional summer seasons D1.2 highlights the positive aspects of an exceptional season (summer);

> "some interviewees (see e.g. Interviews 14 and 16) wanted to talk about the exceptionally sunny, warm and dry spell of weather over much of May 2018. Here again, this was seen as an exceptional and wonderful period, though both interviewees tempered this enthusiasm by noting its abnormality and attributing it to the more sinister cause of climate change; "This is one aspect of climate change that we can say 'welcome' to"." (D1.2 p. 56)

The chapter on geo-social narratives and historical narratives underlined Bergensers' relationship to the local climate and rainy weather conditions and draws the attention to the emergence of this relationship in the form of historical events, traditions, and outdoor activities. Insights from the interviews and analysis of historic source shows that the close and long-lasting connection between identity and climatic aspects is, above all, a positive and practical way of dealing with and adapting to the conditions:

> "A Bergen pamphlet notes how the challenges of living with rainfall have built expertise in water and sewage management, noting 'The water works in Bergen are the oldest in Norway, and Bergen has a total of 1900 km of water and sewage pipes' (Bergen Kommune 2018, pg. 9)." (D1.2, p. 44)

In the context of the close link between Bergen's identity and weather and climate elements, D1.2 takes a closer look at the role of seasons for this relationship. The authors highlights that 'seasons' represent an important aspects that provides access for the Bergensers to the topic of climate and climate change.

Seasons as cognitive scripts for social, cultural and agricultural activities:

> "Seasons create a setting of expected natural conditions that are used to plan for social activities and routines; they act as cognitive scripts." (D1.2, p. 60)
>
> "The farming community around Bergen are guided by planting and harvesting seasons (despite large sections of agriculture moving indoors), informed both by forecasts but also traditional proverbs and calendars (e.g. 'all potatoes should be planted before the national day – the 17th of May') (Interview 2)." (D1.2, p. 46)
>
> Seasons are the basis for cultural events in Bergen, outdoor activities (summer and winter) and distinguish the social life into highly busy and holiday seasons (D1.2, cf. p.60/61).

Perceived changes in the seasons could also be found; the authors refer to a statement of a leading climate scientist, given at a public speech at the 'Klimathon' 2018 highlighting already observed warmer winters with less snow, as well as several individual statements highlighting perceived changes in seasons due to changes in colouring of the leafs:

> "Seasonal change was also raised in the interviews. Many perceived Bergen's winter as becoming warmer with less snow than before, including two climate scientists who say they have experienced this and also seen it in the statistics (Interviews 7 and 17)." (D1.2, p. 63)
>
> "Interviewee 13 lamented the loss of autumn colours. Her birthday is in October, and she remembers her mother used to say that she could mark the approach of her birthday by the autumnal reds and yellows; colours she says are duller today." (D1.2, p. 63)

Changes in seasons are also partly addressed: in terms of (already today) experienced negative impact for health in the case of long lasting dark winters

> "some stories (Interview 9 and 12) talked about the challenges of lasting the long dark months of winter One interviewee (9) recounted how after one particularly nasty, wet winter he read in a newspaper that there had only been four hours of sunshine between January and May, and realised, 'no wonder Ive been so depressed'. (D1.2, p. 65)
>
> "Many interviewees (among them interviewees 7, 8, 9 and 12) discussed the depression that arrives with the darkness and departs in the spring." (D1.2, p. 61)

In addition, changes in seasons are discussed in terms of perceived (future) impacts the loss of snow and related limited skiing activities is suspected:

> "The loss of white winters is lamented as the loss of the winter sports and snow-play that marked interviewees' childhoods and family stories." (D1.2, p. 63)
>
> In addition to seasonal long-term changes WP1 in Bergen also shed light and on particular weather events and their impacts (chapter 4.3.6 'The weather events that mark Bergensers lives'), and distinguish these short-term events from the long- term climate change.
>
> *As noted above we can arguably distinguish a meta-narrative of climatic change in Bergen; a new epoch of interpreting the weather events that have punctuated normality over the past 15 years. This is seen in the shared shock around the landslide at Hatlestad Terrace, the week of air pollution after Christmas 2013 that triggered widespread bouts of asthma, the near-dead whale full of plastic wasjed up on Sotra island, the bitter-sweet enjoyment of the last snowy winters of 2010 and 2017/2018, or the overshadowed enjoyment of the exceptionally sunny and warm spring in 2018 for instance. Other public narratives occupy the festivals days that punctuate the year (Meze-Hausken 2007); like the snowy 17th of May in 1959 (Interviewee 1). (D1.2, p. 64)*

One common theme in the interviews relates to torrential downpours and landslides and the resulting flooding (D1.2, p.64); especially with regard to the local event in the Hatlestad residential suburb of Bergen that caused causalities.

The quotes and excerpts presented in D1.2 pretty clearly underline the perceived link to climate change in terms of a change in intensity of precipitation events, the

resultant impacts in the form of landslide events, and an increased vulnerability to these events:

> Another change is experienced in the intensity of weather events, especially torrential downpours of rain in summer and autumn, 'When the streets flow like rivers' (Interview 3)." (D1.2, p. 63)

> "For many (see Interviews 6, 7, 9, 11, 16 and 17) these landslides sparked the public, and perhaps more importantly the political, awareness of local climate change and its terrible impacts. Many considered that landslides of this magnitude in residential areas were beyond anything Bergensers had experienced before, and foreshadowed a new era of weather." (D1.2, p. 55)

"Another central theme are stories that relate the strong winds of storms and the aftermath (Interviews 2, 5, 9, 11 & 14)" (D1.2, p. 64).

> Interviewees recount sitting inside and watching trees battered and tiles ripped from roofs. One interviewee (11), was out running with his dog when a tree blew over in front of them. Picking through the windfall is an impact that marks interviewee memories, with one (9) noting that he is still cutting up the trees blown over on his land by the Nina storm four years ago." (D1.2, p. 64)

To sum up, through the presentation of the insights from interviews conducted in Bergen D1.2 underpins and substantiates insights on already elaborated weather related entry points from the public narratives described above. In addition to further insights highlighting the essential role of seasons as cognitive scripts for social, cultural and agricultural activities, matters of concerns are highlighted in D1.2 in terms of perceived changes in seasons (changes in colouring of the leafs) and experienced, negative impact for health (depressed mood) in the case of long lasting dark winters. Insights on exceptional winters and summers shows positive 'concerns' for both (sunny summer, pleasure of white winters). However, exceptional winters also come along with concerns about eventually losing the magical Norwegian white winters if these cold and snowy winters used to be the rule, rather than the exception. D1.2 highlight perceptions and concerns about sudden weather events; insights on concerns about landslides are substantiated. The presented interviews / quotes unravel a perceived link to climate change in terms of a change in intensity of precipitation events and an increase in the magnitude of resultant landslide events

resulting in an increased vulnerability to these events. Major events in 2005 and 2017 with major negative consequences (including casualties) are of particular importance in this context.

With regard to air quality, a direct link to meteorological conditions in winter and its negative impacts on health are deduced, but a direct link to climate change is not mentioned.

Therewith D1.2 offers valuable insights if and how Bergensers perceive the existence and impacts of (local) climate change in Bergen; insights help to unravel relevant forms of social practices and cultural sense-giving that Bergensers give to and connect with climate change and these aspects shed light on the existing sense-making, awareness and potential concerns of Bergensers about climate change.

6.1.3 Key issues and desired futures (D1.3)

Building on the basis of D1.2, D1.3 offers more detailed insights about future visions for Bergen in the context of climate change. The basis were led by the interview questions: "At the beginning of our interviews with Bergensers, we asked them, "How would you describe Bergen to someone who had never been here?", and their answers often found resonance in their answers to the last question of the interview: "What is your vision for Bergen in the future?""(D1.3, p.28). While the first part of D1.3 for Bergen (4.2.1: 'Bergen as place, Bergen as identity: Key characteristics of Bergen today') mainly focuses on the aspect of identity, the second part (4.2.2: 'Visions for Bergen under a new climate') highlights several additional insights for connecting points to WP3 on climate and weather, with regard to future visions. Within this chapter, existing topics are underpinned in particular with regard to dealing with these issues in the future. The third part of D1.3 provides insights on leading formal vision for Bergen, shaped by public policy documents.

The first part of D1.3 focussing on the aspect of identity further underpins Bergen's natural and geographical setting, the interplay between the weather and the seven mountains surrounding the city, as essential element forming the identity of

Bergensers. Additional decisive aspects include the characteristics of Bergen as a medium sized, compact and cosy city, its openness to the world and the characteristics of Bergensers. In addition to the public narratives in D1.1 and the temporal aspect sin D1.2, also D1.3 further underpin the importance of weather, in particular the parameter of rainfall, as essential element shaping the identity, today and in future – regardless how this parameter will change in future:

> "Bergen's identity, impacted by its climate, also shapes visions for the future of the city. If climate change is to bring more rain, this can only further conform to an already strong identity of 'living under the rain'. If it brings less rain, then the locals will be glad of the respite." (d1.3, p.35)

Within the chapter 'Visions for Bergen under a new future' (4.2.2) the case study team deduced several hints from the interviews stressing the huge uncertainties, and related factors that are beyond our control, about what Bergen and the local climate will look like.

> "Yeah, I don't know. I believe that it is so incredibly uncertain. There are so many contradictory things that can play a role [in shaping the city]" (Int. 3). Or as someone in Interview 11 said, "I don't know. How will Bergen look, what will people do in 100 years?" (D1.3; p. 37).

However, beyond these general uncertainties, the Bergen case study team was able to deduce and distinguish different aspects to future visions. The latter relate to a broad range of topics ("some relate to democratic, scientific and policy processes and capacities we need to have in place; others focused on the physical structure of the city; others on social practices; and still others on the industries the city can attract and develop" (D1.3, p.37)).

For the weather- and climate-related entry points WP3 is looking for, the chapter in 'visions for Bergen under a new climate' highlight several key aspects / key ideas. Optimism is acknowledge due to Bergen's institutions and Bergensers capacity to deal with climate variability, being and staying resilient in the light of changing climate, mainly with regard to potential increase in future precipitation. (cf. 4.2.2.2). Chapter 4.2.2.6 'Living under the rain' provides a link to discussions on Bergensers 'in-built resilience', in terms of "some (4) respondents Bergen's residents will just

need to learn to live with a changing climate, like they live with the rainfall today" (D1.3, p. 41) underpinning that adaptation is essential:

> "residents will just need to learn to live with a changing climate, like they live with the rainfall today; "I think here in Bergen there is a very active consciousness about living with the weather conditions, and living with the natural environment" (Int. 10)." (D1.3, p. 41)
>
> "It is beautiful with water, and green spaces are very good for keeping water and drain water and avoiding flooding" (Int. 6)."(D1-3, p. 42)

Trust in Bergensers capacity to be able (and willing) to adapt to a changing climate is underpinned by concrete practical starting points for actions mentioned by the interviewees. These ideas include ideas about physically designing the city to better live with increased amount of rainfall and sea water (sea level rise and flooding) and ideas about attracting new industries for Bergen, making use out of Bergen's advantage having a lot of water available in the future (Cf. D1.3, p. 42). However, several interviewees highlight room for improvement with regard to building political will amongst politicians and residents for making 'wise' (in terms of climate-wise) decisions (D1.3, p. 38/39). Furthermore, room for (future) improvement is mentioned with regard to increasing Bergen's resilience by better developing local climate science and policy. In this context, a local governmental planner raised concern that currently needed decisions are not made because of missing climate information and service:

> "how can you rig the system so that these decisions [to mitigate and adapt to climate change] are made today? […] If the research environment could provide visualisation and secure information, and get it out there, so that it's impossible to not get to those decisions, that would be awesome! If we could provide guidelines and checklists to the municipalities to do this, that would be really helpful for the administration in the municipalities, because what they need is hard facts and secure projections on how things will be if we don't do this and that" (Int. 2) (D1.3, p. 38)

The future vision about Bergen as a safe place (to grow up) (chapter 4.2.2.3) provides a climate-related link in terms of an interviewee raising his key concern (which are not further elaborated) to keep the city's high safety standards also in the future when adapting to changed climate parameters:

> ""I think the biggest priority would be to adapt for safety, so that if sea levels are rising and we have more rain and more wind, Bergen is still a safe place to live" (Int. 4). " (D1.3, p.39)

At this point sea level rise as an additional parameter of climate-related concern is mentioned for the first time. Additional insights due to concerns and future aspects of the parameter sea level rise is provided also in the following subchapter discussing the aspect of public transport (chapter 4.2.2.4 'a car-less city'): it provides an, somewhat indirect link. The context was set by a discussion about more emphasis on public transport, cycle-ways, and walkways; the latter also included those by the sea. Within this statement, the interviewee raised his concern about a potential massive sea level rise, affecting Bergen in the next 100 years – which tempted the interviewee to compare Bergen to a future, northern Vencie.

> In this context "another respondent echoed this sentiment, somewhat playfully, "I think in 100 years that Bergen will be the north's Venice, with canals and gondolers and so on, to get around after we've experienced massive sea-level rise" (Int. 11)." (D1.3, p.40)

The last part of D1.3 focus on key aspects from two local climate policy plans (The Hordaland Climate Plan and the Green Strategy), since both address (at least partly) aspects of a future vision for Bergen. For both of them, the focus is mainly (The Hordaland Climate Plan) and clearly (Green Strategy) on climate mitigation. Adaptation is discussed much less explicitly (D1.3, p.42-45).

> "By comparison, adaptation is left quite open, and treated largely as a knowledge deficit problem; if we can precisely predict how the climate will change, we can better adapt." (D1.3, p.43)

For potential starting point for deducing needs for new / improved climate services, estimation of the authors is important, which emphasize that narratives deduced from the personal interviews show a much wider threshold for acting within the realms of uncertainty and more openness to adaptation than local policy plans actually do.

> "Interviewees gave a much wider threshold for acting within the realms of uncertainty, compared to the policy document which advocates for precise predictions, offering a very narrow space for manoeuvre." (D1.3; p.43/44)

As a result of analysing D1.1, 1.2 and 1.3 according to the leading questions for WP3, the following table for Bergen (Table 9) provides a summary of relevant parameters, perceived issues and related concerns.

Table 9 Result of the analysis of narratives related to climate and weather for Bergen

Weather parameter	Perceived issue	Perceived link to climate change	Scientific Knowledge	Impact	Matter of concern	Particular local focus	Source
Precipitation	Wetter winter (less snowfall; warmer) Shift in seasons	Yes:	Shift in seasons is underpinned by observation data and model projections in the past and for the future; Increase of precipitation in winter and spring, summer unclear, potential increase in autumn Increase of high temperature extremes, wetter conditions and increased risk of intensified wet events in northernmost areas	Implications for the city's surface water management. timing of the seasons would affect activities like farming; earlier spring: increased precipitation, difficulties to use heavy machinery on the fields	Loss of white winters: loss of the winter sports and snow-play Positive / practical "concern" : learn to live with a changing climate, like they live with the rainfall today; Trust in capacity of Bergensers to deal with increased rainfall		D1.1, p. 43 D1.2, p. 46 D1.3, p. 31-36
	More precipitation (intensity of rainfall events) torrential downpours of rain in summer and autumn	Yes	Until 2025: Increase of precipitation in winter and spring; summer unclear, potential increase in autumn; Future long-term trends: Changes are still uncertain, Impacts: less frequent and intense snowmelt flood, more frequent and intense floods, steep terrain: maybe more wet landslides, debris flows and slush avalanches caused by heavy rainfall	Roads blocked; two major events in 2005 and 2017 causing casualties	Magnitude of landslides beyond anything Bergensers had experienced before, and foreshadowed a new era of weather Need for adaptation: Bergen should be and stay a safe city	Events in 2005 and 2017 sustained torrential rains caused a massive landslide in the Hatlestad residential suburb of Bergen,	D1.2, p.55, 63,64, D1.3, P. 39
Wind	strong winds of storms and the aftermath			Impacts of windfall → interviewee is still cutting up the trees blown over on his land by the Nina storm four years ago		Nina storm 2015	D1.2 p. 64
Temperature	exceptional cold (and snowy) winters	yes	Less information available for exceptional seasons – especially for winter seasons In general high uncertainties for exceptional events	Positive impacts with exceptional cold winters: experiences of clear, cold winter; playing in the snow, skiing	exceptional cold winters: positive experiences but also some concern about losing the magical	major references to 2010/11 and 2017/18	D1.2 P. 41; 43; 48

Weather parameter	Perceived issue	Perceived link to climate change	Scientific Knowledge	Impact	Matter of concern	Particular local focus	Source
			Available scientific predictions that focus on long-term trends / perspectives highlight: - Warming of 1.5-2.2°C until 2025 in autumn and winter	Negative impacts due to exceptional cold winters: challenges of lasting the long dark months leads to changes in mental conditions	Norwegian white winters that used to be the rule, rather than the exception	exceptional cold winters: outdoor activities (playing n in the snow; skiing)	
	Exceptional hot (and dry) summer	Yes	Less information available, high uncertainties for exceptional events. However, exceptional warm and dry summers are partly related to the long-term trends for future summer climate: -Warming in summer and in spring (2025) -Increase of high temperature extremes (2100) - long-term changes in precipitation still uncertain	Positive impacts: wonderful period, "aspect of climate change that we can say 'welcome' to" Negative impacts: "the autumnal reds and yellows; colours are duller"		Particular event: May/June 2018)	D1.2, p. 42,47 D1.3, p. 28
Sea level	in 100 years Bergen have experienced massive sea-level rise; this will affect the safety of the city	Yes	Projected increase of 56-72cm in sea level until 2100 for Hordaland country	Impacts are discussed in WP1 within the context of safety of and more emphasis on public transport, cycle-ways, and walkways	Only implicit: (depicting Bergen as new Venice – explanation was given in the context of discussing public transportation and walking ways)		D1.3, p. 39
Air quality	poor air quality in the city over periods of clear days in winter due to inversion	No		Impacts on health: the week of air pollution after Christmas 2013 that triggered widespread bouts of asthma	Winter of 2013, after Christmas, when pollution was so bad that asthma sufferers were hospitalised		D1.2, p. 58
Shift in Seasons	Climate / weather parameter as part of Bergen's identity	Indirect link: Seasons act as cognitive scripts to plan for	Changes in seasons are underpinned by observation data and model projections: Increase of precipitation in the past in North Norway; Future (2025):	Will have an impact on planting and harvesting seasons (despite large sections of agriculture moving indoors),			D1.2 p. 45, 60-62 D1.3 p. 35/36

Weather parameter	Perceived issue	Perceived link to climate change	Scientific Knowledge	Impact	Matter of concern	Particular local focus	Source
		social activities and routines	Increase of precipitation in winter and spring, summer unclear, potential increase in autumn				

6.1.4 Discussing the results of the entry point analysis

The careful analysis of the WP1 narratives highlights constituent parts of Bergen's narratives of weather and climate and underlines Bergensers concerns about changing conditions. The comprehensive work from WP1 provides a profound and transparent basis; a considerable number of citations and transparent mapping of different perspectives allowed the WP3 analysis to derive potential entry points. In summary, some explicit matters of concern are mentioned with regard to different concrete weather and climate events / developments. In this respect, it should be emphasized that not only negative concerns are expressed, but also positive connotations could be found with regard to some observed and perceived changes. A good localization (spatial aspect) of potential entry points is given by providing insights on already partially implemented measures in Bergen and mentioning of several main weather and climate events representative for different developments (e.g. hazardous landslide events due to heavy rainfall events, exceptional seasons like summer 2018).

With regard to concrete weather- and climate-related entry points the following three topics had been derived from the WP1 narratives of change:

1. Several narratives are directly related to precipitation. As an essential weather and climate parameter for Bergen, 'precipitation' provides different aspects as entry points:
    - The first one arise out of the increasing precipitation rates, experienced and projected for Bergen:

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- Challenges and concerns in this regard includes dealing with increasing precipitation rates and its implications e.g. for the city's surface water management (also in combination with sea level rise). The narratives further highlights the positive "concern" and practical spirit of the Bergensers looking forward to learn to live with a changing climate, like they live with the rainfall today. In particular, insights on future visions highlighted the widespread trust in capacity of Bergensers to deal with increased rainfall.

- Precipitation in the form of heavy rainfall events is related to major concerns about torrential downpours as well as to resulting landslides; this marks a second major aspect and potential entry point for Bergen.
  - Particular landslide events in 2005 and 2017 increased public attention and increased awareness of landslides.
  - Interview excerpts and quotes (mainly in D1.2) unravel a perceived link to climate change in terms of changes in intensity of precipitation events and perceived changes in terms of increase in the magnitude of resultant landslide events, resulting in an (perceived) increased vulnerability to these events.

2. The second major aspect and potential entry point highlighted in the narratives can be summarized under the aspect 'insights about the role and attribution of importance to seasons'. The narratives include two different aspects of seasonal changes; one is the (long-term) shift of seasons; the other one are exceptional seasons.
   - Related discussions and concerns about (long-term) sifts in seasons (here precipitation is again an important parameter) include concerns about individual (unpleasant) living conditions (and weather-based depression) based on bad (and rainy) weather conditions as well as surface water management (also in combination with sea level rise).

- In addition, Bergenser experienced and raised concerns about exceptional seasons in the last years. The interview excerpts from WP1 on exceptional winters and summers shows positive 'concerns' for both (sunny summer, pleasure of white winters); exceptional winters however also come along with concerns about eventually losing the magical Norwegian white winters if these cold and snowy winters used to be the rule, rather than the exception.

3. Moreover, the narratives of change underline the long-lasting and close connection between Bergen's identity and rain / rainfall. Weather in general and rainfall in particular is highlighted as an essential part shaping Bergen's identity; dealing with the rain / precipitation in particular also shape the appearance of the city, and has been included in public stories and narratives.

6.2 Evaluation of related existing climate information & services

For the case study of Bergen the analysis of the narratives made clear that weather- and climate-related topics are closely interlinked and interwoven in societal debates. The evaluation activity should pay attention to this situation. Therefore, we decided to start the evaluation activity for Bergen with a methodological step focusing on how differently (or similar) the frames of local debates (narratives) and of available climate information/knowledge are set with regard to the climate-relevant debates/problems/needs expressed above. This activity will enlarge our understanding about how climate-relevant issues are discussed in both "worlds" (narratives and climate scientific community), provide insights where these discussion already converge and where they diverge but should be broad together. These findings, in particular for the latter case, in turn, will pave the way for the discussion about potential improvement (e.g. new formats, new processes, new foci) needed for effective local climate services, addressing local matters of concern in the case study regions.

Furthermore, findings from the stakeholder workshop, held by the Bergen case study team in November 2018, provided insights with regard to needs and demands of local actors and stakeholders in order to deal with changing climate conditions in Bergen in the next decades. Based on the findings we will discuss at this point, whether the expressed needs and demands are entirely, partially, or not addressed at all with already existing climate services. In this context, we include the assessment through the case study (included in the D2-2) and extend it with a contribution from the WP3 climate-information perspective.

The two analytical steps differ, among other things, in terms of the extent of the results achieved by direct co-development processes. The first analysis on how differently (or similar) the frames of local debates (narratives) and of available climate information/knowledge are set with regard to the climate-relevant debates/problems/needs, is an analysis that had been performed by WP3 in a remote manner. This means that the analysis had been conducted from the desk of WP3 members who are explicitly not local experts, carried out outside Bergen or Norway. This activity did not involve direct co-development with stakeholders or the local community. We are aware of the fact, that this step of the analyst does not correspond to an ideal co-development process, at least not if the latter is based on the assumption that all steps take place in a joint negotiation process with stakeholders and local actors. However, taking into account the project structure, which makes a direct stakeholder consultation for the WP3 team in all five linguistically and spatially highly diversified case study areas almost impossible, this is one way to conduct the evaluation activity. However, in our perspective, this remote analysis is arguable because has it's basis in the extensive and detailed direct co-development work with regard to the collection and processing of local narratives, which had been done in WP1 by the Bergen team.

In the case of the second analysis step, we cannot fully implement it as a co-developed evaluation process either. However, the case study team enabled the WP3 team to participate as an observer directly in the stakeholder workshop, during which

amongst others needs and demands for improved actions in a changing climate were also discussed (wish list, developed in the last step of the workshop, cf. workshop report in D2-2). In this process, WP3 also had the opportunity to get in contact with the participants. Building on this direct stakeholder feedback, we argue that the subsequent step of aligning the deduced needs, demands and wishes with the current climate service landscape may well be through the expertise of climate scientists in WP3. The assessment, which we obtain here from WP3 perspective, then serves as a point of departure for a further discussion on the implementation of possible new formats. The latter will lead to the best results in a community-based discussion process.

6.2.1 Divergence or convergence of discussions about weather and climate related topics in narratives and in the climate science community

Analysing the narratives of change with regard to matters of concern (see above) made clear that weather- and climate-related topics in Bergen are closely interlinked and interwoven in societal debates. In order to effectively address these concerns for local climate services for adaptation, we need to understand *how* these concerns are involved and embedded in the wider societal debate: In what context are these concerns expressed? How are these concerns framed in the debates?

The work of WP1 already gives us deeper insights here. However, for the co-development perspective on local climate services it is not only crucial to know how the concerns are embedded in the social debate, but also to know which kind of frames are dominant in the scientific community talking about the same problem / issue / concern. WP3 activities until now highlighted the importance to understand to which kind of information (physical, impact, adaptation) corresponds each narrative and local debate vs. which is delivered by the available science and services. On one hand, convergence of knowledge between debates addressed in the narratives and scientific findings point to a common frame on which further co-development processes can take place. On the other hand, divergence of knowledge between the

two discourses indicates potential barriers or gaps that need to be overcome in order to develop a common level of discussion and to answer the local narratives/debates.

Therefore, we will start the evaluation activity for Bergen by enlarging our understanding about where these discussions in both "worlds" (narratives and climate scientific community) already converge and where they diverge. In this analysis, we focus on the framing of crucial topics / concerns in both "worlds" to analyse how differently or similar the frames of local debates (narratives) and of available climate information/knowledge are set with regard to the climate-relevant debates/problems/needs expressed above.

From a conceptual perspective, this analysis is associated to the major (cognitive) challenge in the form of the difference in the nature of social narratives and climate science, which makes them hard to compare and contrast. The cognitive barrier lies in comparing two knowledge stocks of different natures and origins. Climate knowledge developed in the climate scientific community (by physicists and naturalists who mostly aim at increasing the understanding of our physical environment) should be compared to personal histories, debates and narrations, evolving (and constantly changing) in the local community. Thus, the CoCliServ activities to detect and localize knowledge needs and supply regarding climate-variability- and -change-related questions takes place within a boundary layer where societal debates (supposedly driven by values and interests) and scientific discussions (supposedly objective) meet, overlap and get mixed up.

We are aware that this activity has similarities with a discourse analysis. However, we are also aware that we explicitly cannot (and indeed don't aim to) carry out a profound discourse analysis at this point. In our (WP3) position as external analysts (external in the sense of: limited knowledge of local conditions, no language skills, etc.) we use this activity to give an initial assessment of the discussion spaces in society (made possible by the insight from the narrative, WP1 activity) and the climate science Community (compiled by WP3 using English-language-accessible

material). For this aim, we developed a framework to examine how the climate-relevant societal elements converge and diverge with the science and services in terms of availability, scale and uncertainties. This framework builds on our findings that both the discussions shaping the narratives (with a focus on climate-related issues) and the content of available climate science/services can be assigned to similar joint elements. Although we cannot totally overcome this incompatibility with this approach; but we can connect with them through the elements. Looking at these connecting elements for both sources allows us to contrast them. In this sense, the framework presents different key elements and distinctive features, which appear relevant for the analysis of both climate science/services and the narratives from a joint perspective.

We found that both the discussions shaping the narratives (with a focus on climate-related issues) and the content of available climate science/services can be assigned to the different following **emphases** on:

- **Physical climate** (e.g. future evolution of T)
- **Impacts on the natural and human systems** (e.g. effect of future droughts on the water resource)
- **Actionable adaptation knowledge** (e.g. knowledge about adaptation of agriculture to extreme events, suitable to be embedded in decision-making)

The 'emphasis' describes the orientation of the question/discussion in the narrative or the focus of available climate knowledge and climate services for a specific climate-related topic. We highlight here that we analyse the main current scientific conclusions that are relevant to address the climate-related narratives but do not have the capacity to carry out a full literature review of each specific climate topic in each case study. From a conceptual point of view, we see the three emphases equivalent in their value.

Beyond the "emphases", WP3 empirics show that different **aspects** can be observed in many of the individual case studies being key determinants of the respective emphases. Therefore, they are integrated as additional components in the framework. Aspects draw attention to important considerations for a related emphasis; thus they are key when establishing a comparison between narratives and scientific climate knowledge and services.

- Level of detail (**scale**): Same level of detail between climate services and societal information needs?
- Tolerable level of **uncertainty**: Level of uncertainty in the scientific results when answering a societal question (e.g. for decision-making)?
- Comparability of **frames**: Are frames shaping local debates and used by climate services similar or different to each other?
- **Cooperation and collaboration**: If already established, how can existing cooperation between science and practice partners be described?
- **Climate services**: which climate services are already in place addressing these issues?

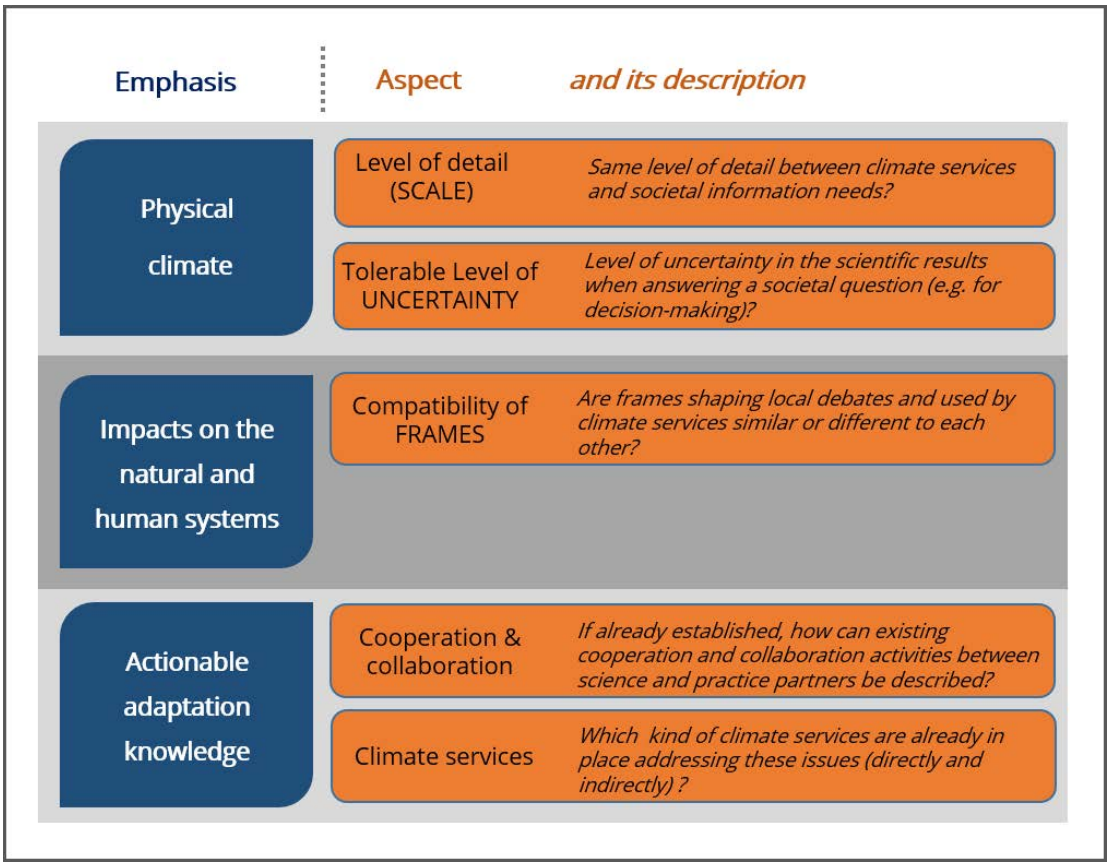

Figure 3. Conceptual framework focussing on difference and similarities in the frames of local debates (narratives) and of available climate information/knowledge with regard to the climate-relevant debates/problems/needs

6.2.1.1 Seasonal changes:

The narratives include links to different aspects of seasonal changes; one is the (long-term) shift of seasons; the other one are exceptional seasons. First, will take a look at each of these issues individually.

Table 10 Analysis of converging and diverging points between local narratives and climate science for the topic 'seasonal changes (long-term) shift in seasonal changes'

Narrative / Topic addressed	**Seasonal changes: (long-term) shift in seasonal changes**
Parameters addressed	**Precipitation; temperature**
Converging and diverging points between local narratives and climate science	
Physical climate	Convergence between local debate (perceived issues) and scientific debates with regard to the development of both parameters rainfall and temperature: more warming in winter than summer, more rainfall in all seasons (smaller increase in spring)

	Scale: Observation data for standard climate parameter are available from local weather stations in Bergen since 1961; downscaling of model results (projections) is commonly used to obtain results with a spatial resolution of 25-50km in for parameters such as temperature, precipitation, etc. Uncertainties: natural variability, climate models, For this topic, the narratives showed that the physical climate in the form of perceived / experienced changes in climate parameters precipitation /snow, temperature and related changes of vegetation periods, represents the **access point in the narrative to the topic**.
Impacts of the natural and human system	**Additional access to the topic** includes a links to impacts: negative health impacts are mentioned; further (future) impacts mentioned include the loss of snow and related limited skiing activities Impacts expressed in the narratives are confirmed by the scientific knowledge available (convergence): the latter describes impacts in the form of longer growing season and less groundwater (especially in summer); important parameters and related analysis (amongst others) include season of growth and soil water deficit Frame: Analysis of the Impact on the natural system is already part of the scientific research; available studies mainly focus on the national and regional scale. Scientific debates and available impact assessments are, beside the focus on natural systems and economic dimensions rather than on social dimensions. The narratives of WP1 show (as mentioned above) that in the Bergen community access to the topic 'seasonal changes' is mainly addressed by fields/topics such as health and social activities. Although these topics are not in conflict with the scientific impact assessment, they have not yet been the focus of such analyses
Actionable adaptation knowledge	Both (natural) climate science and strategic planning and decision-making agencies and institutions are already addressing and discussing climate change adaptation in Norway. Besides the increased knowledge about physical changes (e.g. profound assessment of available knowledge, new analysis and comprehensive transfer of this knowledge is provided by the Norwegian Center for Climate Services) we find a broad agreement between different institutions and authors that, in particular on the international perspective, Norway is well equipped to handle the direct effects of climate change. The work of WP1 highlight the essential role of seasons as cognitive and structuring frames for the Bergensers. According to our research, this link between changes / shifts in seasonal climate conditions and cognitive frames has hardly played a role in the (natural) science debate or even in the area of climate services (work by Bremer (UiB) is an exception here and is closely linked to the CoCliServ project). For the question of starting points for climate services, however, this contextualization may play an important role in effectively integrating the population into the adaptation activities in addition to the strategic and institutional adaptation measures.

Table 11 Analysis of converging and diverging points between local narratives and climate science for the topic 'seasonal changes: exceptional seasons'

Narrative / Topic addressed	**Seasonal changes: exceptional seasons**
Parameters addressed	**Precipitation (Snow), temperature**
Converging and diverging points between local narratives and climate science	
Physical climate	Scale: Observation data for standard climate parameter are available from local weather stations in Bergen since 1961; downscaling of model results (projections) is commonly used to obtain results with a spatial resolution of 25-50km in for parameters such as temperature, precipitation, etc. Uncertainty: Less information is available for exceptional seasons than for long-term developments; this applies for both exceptional winter and summer seasons. This includes an increase level of uncertainty for projections of these rare events. Exceptional warm and dry summers are only partly related to the long-term trends for future summer climate. However, for winter these exceptional winter seasons stays in contrast to the general long-term trend (which project a warming in winter (e.g. 1.5-2.2°C until 2025 in autumn and winter for Bergen)).
Impacts of the natural and human system	The experienced impacts of exceptional seasons in Bergen characterize the **access point to the topic in the presented narratives**: Within the narratives impacts; both positive (exceptional cold winters: experiences of clear, cold winter; playing in the snow, skiing) and negative (exceptional hot (and dry) summer: "the autumnal reds and yellows; colours are duller") are included. Frame: In the context of seasonal changes, the debate in the (natural) scientific community show a major focus on vulnerability and adaptation. Discussion in the social / administrative areas build on these scientific vulnerability assessments and foster the discussion about the need for adaptation to these changed conditions. The separation between long-term changes in seasons and exceptional seasons, as we found them here with the help of the narrative, is included in the frame of vulnerability, but less in the adaptation debate.
Actionable adaptation knowledge	

Major findings for potential starting points with regard to the topic of ‚seasonal changes' in Bergen:

The narratives highlight two different facets determining the discussion about seasonal changes in the narratives: long-term shifts/change sin seasons and single, exceptional seasons (summers and winters). The access points to these facets are well recognisable; they differ only slightly from each other: For long-term shift in seasons the elements of physical climate & impacts are key access points to the topics; for exceptional changes, the narrative articulated access via impacts (positive and negative ones)

Both topics individually might serve as an entry point for improved climate services; however, for long-term changes the scientific knowledge basis is much more comprehensive than for exceptional seasons. However, the fact that the same situation cannot be found one-to-one in the landscape of the Climate Services is shown in the evaluation activity in the next subchapter.

6.2.1.2 Wetter weather and mainly heavy rainfall events resulting in landslides and torrential downpours*:*

Table 12 Analysis of converging and diverging points between local narratives and climate science for the topic 'landslides / torrential downpours'

Narrative / Topic addressed	**Landslides / torrential downpours**
Parameters addressed	**Precipitation**
Matter of concern (Del 3.2.A.1)	The narratives contain a directly expressed matter of concern: • Magnitude of landslides beyond anything Bergensers had experienced before, and foreshadowed a new era of weather • Need for adaptation: Bergen should be and stay a safe city
Converging and diverging points between local narratives and climate science	
Physical climate	Convergence with regard to the perceived changes and scientific observations / projections with regard to more precipitation and runoff in winter. Scientific findings highlight annual precipitation increase (less increase in spring), more frequent and intense heavy rainfall, more runoff (especially winter and autumn, decrease in summer), more evaporation

	Scale: Observation data for standard climate parameter are available from local weather stations in Bergen since 1961; downscaling of model results (projections) is commonly used to obtain results with a spatial resolution of 25-50km in for parameters such as temperature, precipitation, etc. For future perspectives highly local data might be needed – improvement still needed Uncertainties: natural variability, climate models
Impacts of the natural and human system	Frames: In the narrative discussion single, prominent events, characterized by it outstanding impacts provide **access to the topic**: *"Events in 2005 and 2017 sustained torrential rains caused a massive landslide in the Hatlestad residential suburb of Bergen"* *"Magnitude of landslides beyond anything Bergensers had experienced before, and foreshadowed a new era of weather"* Furthermore, contextualization in the narrative takes place through individual experienced events with severe damage / loss in Bergen The scientific debate provide a comprehensive debate and profound results for observation data of events and observed impacts (damage recording). In addition, impact assessments and related vulnerability analysis are available. Moreover, impact assessments represent an essential core of the current climate science debate in this context. Insights from these assessments highlight amongst others less frequent and intense snowmelt flood, more frequent and intense floods, steep terrain: maybe more wet landslides, debris flows and slush avalanches caused by heavy rainfall Vulnerability analysis mainly provide information at country and regional scale
Actionable adaptation knowledge	Adaptation towards increased landslides (caused by heavy rainfall) is a topic discussed in both the scientific community and is transferred to the strategic planning and decision-making processes. In these debates particular sectors are mainly addressed (and are obviously mainly affected) such as infrastructure, flood management, emergency services. Collaboration and cooperation between state institutions (implementation / maintenance) and research is actively promoted / requested: Norwegian Public Roads Administration, other transport agencies and advisors must actively contribute to national and international climate-related research by responding to their needs and contributing to good coordination between research projects. Climate services in the form risk maps and tools are already available (e.g. Landslide-tool: https://www.nve.no/flaum-og-skred/skrednett/ provided by NVE, providing compilation of landslide-related data and information and for use in landslide prevention work)

Also for the topic 'landslides and torrential downpours', the narrative shows that access to these events is made through the (key determinant) 'impact'. In this context,

on the very local level, personal / direct experiences of the vent and the resulting impacts, play an important role placing the topic on the mental agenda.

In general, the exchange of insights on events such as landslides, avalanches, (and also flooding) seems well established between science and planning / decision-making (estimation from the WP3, non-local perspective).

Our next step, evaluating the Climate Services already available, will show if, from our perspective, existing services are already noticing and transporting the topic (assuming that we consider Climate Services to be the convergence and translation effort between the two debates in the understanding the science community and society). In addition, we try to clarify which aspects are covered in these services, and compare these findings with the broad picture drawn here of the aspects relevant to this topic for both sides.

6.2.1.3 Climate / weather parameter as part of Bergen's identity:

Table 13 Analysis of converging and diverging points between local narratives and climate science for the topic 'climate / weather parameter as part of Bergen's identity'

Narrative / Topic addressed	**Climate / weather parameter as part of Bergen's identity:** **Contextualisation: Long-lasting connection between Bergen's identity and rain / rainfall**
Parameters addressed	**Precipitation, run off**
Converging and diverging points between local narratives and climate science	
Physical climate	This topic mainly refers to the observed changes until today; However, the question of correct classification (on the basis of quantity and frequency) is not the crucial point in this context - rather it is the handling of the parameter in society. The narratives for Bergen in particular highlighted the positive, adaptive approach of Bergensers dealing with the weather and climate parameter precipitation.

Impacts of the natural and human system	Rainfall is indicated as major element of identity; often positive and practical connotation Related impacts that are included in the narratives: flooding, increased run off rates, impacts on sewage systems. These impacts are also discussed in the scientific debate – but the scientific discourse on change sin weather and climate parameters in general and precipitation in particular pay far less attention to the link to Bergen's identity. Frames: The scientific and narrative debates therefore differ in particular on the focus of frames: the scientific debate focuses on factual impact assessments; The contextualisation of the population is mainly done through proactive, action-oriented (discussion about) adaptation
Actionable adaptation knowledge	Even if it is not adaptation in the true sense, the **access point here is rather "benefit from a specific climate situation"**. This positive perspective might be the driver of the sensitization process towards the issue of precipitation in Bergen, which in turn has shaped today's handling and adaptive handling of the changes in this climate parameter.

This topic underlines very clearly, how close, especially at the local level, the connection between climate dialogue and social and cultural debate can be. And how little material and discussion actually exist that focus on this connection and deduce conclusions about climate knowledge, adaptation measures and climate services from these findings. From our WP3 perspective, the following overarching objectives (and questions) arise for the topic 'weather parameter as part of Bergen's identity ' requiring research work, above all enhanced transdisciplinary research work:

- What possibilities arise from the close connection to the local identity with regard to the use and development of climate services?

- Increase our understand about how bonding (and identity formation) in a local society is related to a weather and climate parameter and how it is maintained (who and what is important in these processes)

6.2.2 Comparing information needs (WP2) with available climate services

Based on the analysis of the entry points for climate science in the narratives of change (through matters of concern), and the analysis of frames wherein the

discussion about these matters of concerns took place (discussed in the previous subchapter), the evaluation activity for Bergen will be completed by evaluating the existing climate services regarding the matters of concern. Subsequently, the wishes and suggestions of the stakeholders for the improved handling of the challenge of climate change mitigation and adaptation from the WP3 perspective are discussed.

In the following subsection, we compare the information needs from the narratives and, mainly from the scenario workshop (D2.2), with the available climate services (with support of the existing work in D3.1, M3.1, M3.2), by providing an appraisal from WP3 perspective about the service's fit of function to address the matters of concern.

Table 14 Evaluation of existing climate services for the matter of concern 'seasonal changes: shift in seasonal changes'

Matter of concern: Seasonal changes: shift in seasonal changes, including two different aspects: • Long-term shifts in seasons; major parameter: Precipitation, temperature • Exceptional seasons; major parameter: Precipitation (Snow), temperature	
Climate Services available (mainly based on D3.1 assessment)	**Appraisal from WP3 perspective about the service's fit of function to address the matter of concern**
Climate Projections provided by KSS via the KSS-website[1] (2 time horizons: near and far future; 2 scenarios: RCP8.5, RCP4.5)	*What does the climate service provide and is of importance for this matter of concern:* • Visualisation of data via digital maps and (partly) additional diagrams • Parameter available include: temperature (different indices Max T, Min T, growing season), precipitation, snow, run off; o data available for yearly and seasonal timeframes – but no discussion of exceptional seasons • The available level of detail for the information includes national up to regional scales *If and to what extend does the climate service address the matter of concern:* Data are presented for the 4 seasons; however, changes between or within the changes are not further discussed or displayed in additional text or diagrams. This climate service is supportive for the topic with regard to the database provided; however, personal effort and a certain level of knowledge is needed to read and analyse the data sets.

[1] https://klimaservicesenter.no/faces/desktop/scenarios.xhtml

	Moreover, it is hardly suitable for the question of exceptional seasons. Although (future) seasonal data can be shown, it will not give any insight into possible extreme seasons.
'Klimaprofiler' (Climate fact sheets) and scientific reports	*What does the climate service provide and is of importance for this matter of concern:* Climate fact sheets provide a concise summary of the current climate, expected climate change and climate challenges; two different scales available (national and regional), which differ in their extend: • Regional report: short and easy to understand summary • National report: scientific report It provides background information on weather and climate parameter, past and future changes; including aspects of seasonal changes of the parameters (development of parameters in different seasons) *If and to what extend does the climate service address the matter of concern:* Information about major parameters are presented for the 4 seasons; similar to the previous climate service. However, changes between or within the changes are not further discussed. Thus, this service cannot fully support the discussion. The main theme (seasonal changes) is not treated here as an independent topic.

The topics 'seasonal changes' as well as 'exceptional seasons' do not appear as a bundled, independent topic in the currently available Climate Services for Bergen that are considered in the WP3 assessment and evaluation activities. The information available (which is mainly information about the physical climate parameters temperature and precipitation in different seasons) is included partly in those climate services tools that present the users a general picture about climate change in Norway and Bergen. Using these tools to answer questions with regard to shifts in seasons and related impacts, may be a way for experienced readers, who are able to work out and put together the individual information from these tools. Without these skills and knowledge, however, this task can hardly be accomplished. None among the available (evaluated in D3-1) services focuses, or exclusively deals, with the topic of seasonal changes; or at least present a subsection or subchapter focussing on shifts of seasons or exceptional seasons. As a result, from our perspective, it seems difficult for a user to ask questions about the changed seasonality to one of the existing Climate Services and get a profound answer.

As the previous analysis (M3-2 and D3-2 matters of concern) highlighted already, differentiation between long-term changes and extremes is an important aspect in the discussion about climate change and climate change adaptation - both in the

climate research community and society. The evaluation activities further underpin the findings of the Bergen case study team that the cognitive and structuring characteristic of seasons for the everyday life of many Bergensers provide promising and essential starting point for additional local, Bergen-specific climate service activities. The challenge for the development of new local climate services in this context lies in the different amount of findings available. The broad scientific base on the physical seasonal climate changes contrasts with a much smaller scientific basis on cognitive seasonal scrips themselves and the impact of physical climate change on these scripts. A local climate service activity for example could emphasis in particular on bringing these two different perspectives together. With regard to the question, how these climate service activities should look like, hints are given above all by the findings of the WP2 activity. The latter makes clear that this emphasis calls for climate services in the format of enhanced social process, in the form of interdisciplinary, research-based arena and physical meeting spaces for climate communication and dissemination.

Table 15 Evaluation of existing climate services for the matter of concern 'increasing risk and impacts from) landslides / torrential downpours'

Matter of concern: (increasing risk and impacts from) Landslides / torrential downpours	
Climate Services available (mainly based on D3.1 assessment)	**Appraisal from WP3 perspective about the service's fit of function to address the matter of concern**
Climate Projections provided by KSS via the KSS website[2] (2 time horizons: near and far future; 2 scenarios: RCP8.5, RCP4.5)	*What does the climate service provide and is of importance for this matter of concern:* • Web interface; visualisation of data via digital map • Available date and parameter of interest: data about floods (200-year flood event) on yearly basis; days with snow cover; snowfall • Changes in snow cover, rainfall and run off rates • Scale: National level (with small degree of zooming in) *If and to what extend does the climate service address the matter of concern:* The data displayed in the tool build the basis for landslide and torrential downpours; however, the tool does not provide detailed knowledge on the actual event "landslides" or its impacts. Because the spatial scale is very coarse, this tool is valuable for a general overview about risks, but less helpful for answering local questions about the risk of flooding, torrential downpours and resulting impacts.

[2] https://klimaservicesenter.no/faces/desktop/scenarios.xhtml

Precipitation intensity (IVF values) provided by KSS[3]	*What does the climate service provide and is of importance for this matter of concern:* • Web interface that allows the user to choose a location via map and provide available data in the form of a diagram; figures and data available for download • Available information / data of interest: Return intensity and return values, which gives insights about the development of rainfall intensity • Scale: Estimated values on 1x1 km grid (stationary data) *If and to what extend does the climate service address the matter of concern:* From our perspective, this climate service is only partly helpful for the discussions. It is supportive for the topic with regard to database but personal effort and a certain level of knowledge is needed to read the data sets and transfer the information into the context landslides and related impacts. This cannot be assumed to the extent required by every user. Without this knowledge, however, the contribution of this service to the discussion of the matter of concern is very limited.
Information about extreme precipitation via the online platform of KSS[4]	*What does the climate service provide and is of importance for this matter of concern:* • Web interface that allows the user to choose a location via map and provide available data in the form of a diagram; figures and data available for download • Available information / data of interest: Precipitation (normal and extreme) • Scale: Not Bergen-specific information *If and to what extend does the climate service address the matter of concern:* This climate service is helpful in terms of providing insights about the parameter precipitation as an important parameter for the topic of landslides. Although this service provides basic information about the parameters, it does not provide information about the events themselves and the impacts, which, however, are in the focus of the matter of concern debate. Therefore, it provides only an indirect contribution to the debate about the concern concerning landslides and torrential downpours.
Landslides and flood atlas Norway (NVE Atlas[5])	*What does the climate service provide and what is of importance for this matter of concern:* • Web tool / atlas from NVE, presenting the results of the national hazard zone mapping of landslides in steep terrain (for selected areas prioritized for mapping). The mapping covers the avalanche types of snow avalanches, southern avalanches, rock leaps, landslides and flood avalanches. • also available for rockslides, flood zones, historic flooding events snow avalanches attention areas, etc. • Available information is also prepared in the form of area reports • Scale: (landslide information) available for the municipality level (for the whole country) *If and to what extend does the climate service address the matter of concern:*

[3] https://klimaservicesenter.no/faces/desktop/idf.xhtml
[4] https://klimaservicesenter.no/faces/desktop/article.xhtml?uri=klimaservicesenteret/dimensjonerende-nedbor
[5] https://atlas.nve.no/Html5Viewer/index.html?viewer=nveatlas#

	The NVE atlas is helpful in terms of providing insights about effected areas (hazard zone), the related reports provide comprehensive insights about landslides events (including observations made during the inspection as well as model calculations e.g. used to present different probability levels) The level of detail is very high, which makes it usable for very local assessments. The maps and report show a very comprehensive picture of the danger situation, but no impact assessments are directly involved. This tool offers a comprehensive and diverse climate service and is tailored in many respects very suitably to the demands / aspects of the matter of concern.

Of the three matters of concern analysed here, the aspect 'landslides / torrential downpours' is the one with the most comprehensive information and knowledge in the form of climate services is available. Above all, there are already Climate Services that deal explicitly and some of them also exclusively with this aspect. A starting point for improving / optimizing the existing offer, from our perspective, is the claim for a very local resolution, which is needed for the Bergen-specific discussion.

Even though we are not experts in this field in WP 3, it can at least be assumed that the fact, that information provision is possible in general (as the available services from mainly national providers showed), means that the basics, above all in the form of the necessary methodology, is already available and applicable. This allows us to conclude that implementation on a local level is conceivable; however, it is out of our scope and expertise to make an appraisal about time, cost and labour needed to implement this local analysis. Current provider of the national Climate Services seems to be the obvious first contacts.

In the context of a feasibility study on the possibilities of implementing these services on a local scale, the tackling following questions can be helpful:

- How far are the tools and information (available) intended to also address public / local population and
- How far are these tools already used by them?

Table 16 Evaluation of existing climate services for the matter of concern 'Climate / weather parameter as part of Bergen's identity'

Matter of concern: Climate / weather parameter as part of Bergen's identity: Long-lasting connection between Bergen's identity and precipitation/ rainfall	
Climate Services available (mainly based on D3.1 assessment)	**Appraisal from WP3 perspective about the service's fit of function to address the matter of concern**
Climate Projections provided by KSS via the KSS-website [6] (2 time horizons: near and far future; 2 scenarios: RCP8.5, RCP4.5)	*What does the climate service provide and is of importance for this matter of concern:* • Web interface; visualisation of data via digital maps and (partly) additional diagrams • Available information / data of interest: precipitation / snow, run off; data available for yearly and seasonal timeframes • The tool provides insights about the development of parameters in different seasons – but no further discussion of parameters or links to societal discussions *If and to what extend does the climate service address the matter of concern:* This climate service is hardly suitable for the debate about a climate / weather parameter shaping Bergens identity. This climate service is an example for a common situation: Currently available "traditional" climate services often provide mainly information about the physical climate parameters, their changes over time and often also about related, mostly economic and ecological impacts. What is missing is a debate about the social impacts, including the perception, awareness and potential cultural and historical embeddedness of an alleged 'pure' physical climate parameter or weather event.
Precipitation intensity (IVF values) provided by KSS[7]	*What does the climate service provide and is of importance for this matter of concern:* • Web interface of KSS: chose of location via map, data as diagram; for download available: figure and data • Return intensity and return values • Development of rainfall intensity • Estimated values on 1x1 km grid, stationary data *If and to what extend does the climate service address the matter of concern:* Hardly suitable for the debate about a climate / weather parameter shaping Bergen's identity; → supportive for the topic with regard to database but personal effort and a certain level of knowledge is needed to read the data sets and transfer the information into the societal debate

[6] https://klimaservicesenter.no/faces/desktop/scenarios.xhtml
[7] https://klimaservicesenter.no/faces/desktop/idf.xhtml

Information about extreme precipitation via the online platform of KSS	*What does the climate service provide and is of importance for this matter of concern:* • Web interface of KSS: text and data (e.g. rainfall records); manual "how to build your own weather station" • Available information / data of interest: Precipitation (normal and extreme) • Scale: Not Bergen-specific information • Material comprises different findings from different methods, data measurements not Bergen specific information *If and to what extend does the climate service address the matter of concern:* Helpful for the parameter precipitation, but no direct link / no contextualisation for the place-specific debate for Bergen

This topic underlines very clearly how close, especially at the local level, the connection between climate dialogue and social and cultural debate can be. And how little material and discussion strands actually exist that focus on this connection and deduce conclusions about climate knowledge, adaptation measures and climate services from these findings. The already established (traditional) climate services do not yet provide comprehensive information or knowledge. As already described for the individual services above, the physical parameter precipitation is considered by different services. However, an arrangement or even a focus on the cultural and historical embedding and the close connection between the parameter precipitation or the rainfall events and the social life cannot be found in the portfolio of the available climate services.

At this point, we should question whether the previous climate service formats represent the right starting point for such a topic, characterized by the close link between physical climate parameters and cultural, historical and social debate. Especially for this topic, the needs and demands elaborated in the small groups of scenario Workshop s (as part of the WP2 activity in Bergen) are an important source, as some very viable options have been suggested by the stakeholders.

6.2.3 Wish list (WP2 outcome)

In D2-2 the Bergen case study team presented the process and the results of the scenario workshop held in Bergen on November 19th 2018. The workshop built on the previous WP1

work on narratives of changes of climate and weather in Bergen, asking the participants to use these narratives as a starting point for building ideal scenarios of how Bergen should develop to be more resilient to climatic change by 2050 (cf. D2,2 in preparation). The Bergen case study team's invitation made it possible for a WP3 team member to attend the workshop as an observer. This opportunity has been very helpful in facilitating co-development not only between academics and stakeholders but also between WPs as much as possible. Thankfully, even one stakeholder group work and the final presentation were held in English, so the language barrier in this co-development situation did not present a barrier to the observers from WP 3 and 4. The final step in the workshop activity involves the formulation of needs that are essential to achieve the identifiable goals and enhance actions towards the goals and goals. This activity was converted into the formulation of a wish list due to time constraints. As a result, the wish lists (cf. the result presented in D2-2) include ideas and needs of the stakeholders that they thought were most important to achieve the different steps on their way to reach the scenario vision. These needs include anything "from climate science and information, to material resources and finance, political will, experience and expertise or laws and policies for example" (D2-2, in preparation; Bergen scenario workshop report, p. 12).

In the following table (Table 17), we have extracted those wishes from the three wish lists[8], for which, from the WP3 perspective, we see potential contributions from natural climate science perspective to foster, support, or strengthen demands and wishes highlighted in the Bergen Scenario workshop, in its practical implementation as local climate services (column 4). If possible, we have assigned these wish to the matters of concern (column 3).

[8] The complete wish lists for all three stakeholder groups can be found in D2-2.

Table 17 WP 3 perspective about potential contribution from natural climate science perspective to foster, support, or strengthen demands and wishes highlighted in the Bergen Scenario workshop (Source for column 1 and 2: Bergen case study team, report of the scenario workshop in Bergen, provided in D2-2)

List of wishes ***(result of the group discussion in the scenario workshop)***		**WP3 perspective and comments**	
		Direct link to a matters of concern / topic / entry point discussed above?	**Potential for contribution from natural climate science perspective to foster, support, or strengthen these demands in its practical implementation as local climate services**
Group 1	*Encourage volunteer-based campaigns for raising awareness around climate*	Is related to all matters of concern / cross-cutting demand	Can be supported by scientific experience e.g. with regard to available methods and formats; furthermore, support can be provided by providing background information about the climate / observed changes a / expected changes
	An interdisciplinary, research-based arena for climate communication and dissemination	Is related to all matters of concern / cross-cutting demand	These demands (which is included here several times in slightly different formulations) stands as a concrete example for the stakeholders demand to enhance and strengthen social processes, exchange and communication – in the form of a social climate services. (Climate) scientists are not only essential participants in these processes, but they can play an important role in shaping the development of these processes and the creation of physical spaces in the course of climate service development.
	Local meeting places, e.g. "Soup and Climate Measures"	Is related to all matters of concern / cross-cutting demand	These demands (which is included here several times in slightly different formulations) stands as a concrete example for the stakeholders demand to enhance and strengthen social processes, exchange and communication – in the form of a social climate services. (Climate) scientists are not only essential participants in these processes, but they can play an important role in shaping the development of these processes and the creation of physical spaces in the course of climate service development.
	Incentives to reduce private consumption		Potential support from natural climate science could include initial assessment about what are the best, most effective measures; these assessment might provide one out of several elements based on which the incentives are developed
Group 2	*A research arena where the 'kommune' can ask questions*	Is related to all matters of concern / cross-cutting demand	This demand (which is included here several times in slightly different formulations) stands as a concrete example for the stakeholders demand to enhance and strengthen social processes, exchange and communication – in the form of a social climate services. (Climate) scientists are not only essential participants in these processes, but they can play an important role in shaping the development of these processes and the creation of physical spaces in the course of climate service development.
	A competition on good measures for initiating a change in	Climate / weather parameter as part of Bergen's identity	Again, support from evaluation / assessment is possible / helpful from a climate science point of view

	attitudes in the 'rain city' Bergen		
	Education aimed at the public Sector	Is related to all matters of concern / cross-cutting demand	Support in creating the curriculum and for constantly adapting and updating the curriculum to the current state of knowledge
	Arenas for dialogue and cooperation across a variety of sectors in society	Is related to all matters of concern / cross-cutting demand	This demand (which is included here several times in slightly different formulations) stands as a concrete example for the stakeholders demand to enhance and strengthen social processes, exchange and communication – in the form of a social climate services. (Climate) scientists are not only essential participants in these processes, but they can play an important role in shaping the development of these processes and the creation of physical spaces in the course of climate service development.
	Financial means and climate information to organise 'rain festivals' in Bergen	Climate / weather parameter as part of Bergen's identity	Here existing and new information or scientific findings can be integrated
	Information on waterways, rain and floods	Increasing risk and impacts from landslides / torrential downpours	This wish is one of the few that can specifically assigned to the matter of concern 'landslides and torrential downpours'. However, at this point it is still too vague to recognize whether additional information and additional knowledge has to be generated to fulfil the stakeholders request; or if the necessary information is already available, but not yet communicated and exchanged via the appropriate contact persons, formats or appropriate processes.
Group 3	*Positive framing of climate projects*	Is related to all matters of concern / cross-cutting demand	Science can also (partly) contribute to this aspect / wish, for example by scientist who are making their projects more transparent for an audience outside the scientific community (also by including / getting help from science communication experts at this point). This would also help to set up or enhance the contact between scientists and potential users, or those affected by the results or those being researched, especially in climate change mitigation and adaptation projects.

6.3 Discussion and outlook

The analysis of matters of concern, based on the extensive and detailed material from WP1, made it possible to highlight different concerns in terms of physical or climatic parameters. In addition, the evaluation activity was able to show a few places where there is a potential need for expansion of existing or even newly developed climate services. Furthermore, the results of WP1 and WP2 as well as the evaluation activity based on these results provides an interesting starting point with regard to the

question of whether we might have to think differently about climate services (different goals, different formats, different approaches than commonly applied today). In the case of the Bergen case study in particular, this includes the call for increased participatory and social local climate services and processes that enable the exchange of different actors on climate relevant themes.

In this sense, as a further step with regard to the upcoming activities of a feasibility study (D3.3) we might consider developing an inventory of existing climate services for the precise stakeholder-driven demand of enhanced social climate services, in the form of interdisciplinary, research-based arenas and physical meeting spaces for communication and dissemination. This inventory explicitly should cover the local situation including similar formats but with currently different foci, as well as similar formats available outside the CoCliServ-case study areas on similar topics. The aim of this activity is to deduce potential formats and ways how a climate service in Bergen on this topic could look like.

7 Gulf of Morbihan

(Florentin Breton)

7.1 Analyses of narratives as potential entry points

Table 18 Analysis of narratives related to climate and weather for the Gulf of Morbihan

Weather/ climate parameter	Perceived issue	Perceived link to climate change	Impact	Matter of concern	Particular local focus	Source	Scientific knowledge	Source (scientific knowledge)
Seasonal rain and humidity	Drier summer and more frequent winter rains	yes				D1.1 p. 83	More rainfall in winter and less in summer, more and stronger summer droughts	https://www.morbihan.fr/fileadmin/CSEM/csem_etudes/MPCLI0035_ChangementClimatiqueMorbihan_Juin2012.pdf http://www.meteofrance.fr/climat-passe-et-futur/climathd
Weather conditions/seasonal cycles	Timing of the seasons	yes	Agriculture: earlier harvest			D1.1 p. 84	Consistent with literature (phenology)	https://www.bretagne.bzh/upload/docs/application/pdf/2013-08/cseb_connaissances_actuellescc_juillet2012_2.pdf
Sea surface temperature (and oxygen content)	Warming, development of toxic algae, anoxia		Reduction of coastal water quality (for drinking and irrigation)	yes		D1.1 p. 85	No study found at the scale of the Gulf of Morbihan	
Storms	yes		Coastal destruction	Yes		D1.1 p. 86	Potentially more storms in winter	https://hal.archives-ouvertes.fr/tel-

								01280874/file/Charles_Memoire_These_2012.pdf http://imfrex.sedoo.fr/web/documents/downloads/rapport_final_imfrex.pdf
Sea level	Yes	yes	Sea submersion, worsened by land subsidence	yes		D1.2 p. 70	SHOM (past, local) and IPCC (future)	http://refmar.shom.fr/fr/evolution-niveau-marin-brest
Storms, flooding, submersion, (coastline changes)	Yes, increased risk of floods and storms in winter (heavy rains and strong winds)	Yes?	Increased coastal territory exposure and risk		Yes?	D1.2, p. 71	Potential increase of storms and heavy rainfall in winter	http://imfrex.sedoo.fr/web/documents/downloads/rapport_final_imfrex.pdf
Water resource	Summer tourism causes more pressure on water resource		Increased vulnerability and decreased adaptability to coastal extreme events	Yes		D1.2 p. 73 and D1.3, p. 48-49	Decrease future streamflow	https://www.morbihan.fr/fileadmin/CSEM/csem_etudes/MPCLI0035_ChangementClimatiqueMorbihan_Juin2012.pdf
Coastal erosion	Coastal path		Retreat because of erosion			D1.3, p.49-50		
	Traditional activities (oyster farming, salt production, organic farming)	Yes	Threatened by climate change and need to adapt			D1.3, p. 50		
	PCAET		Plan for climate adaptation of the territory			D1.3, p. 50-51		

Table 19 Analysis of potential information needs related to climate and weather for the Gulf of Morbihan.

Who	Information needed	Why	Source
Local decision-makers	• Occurrence of extreme events • Local future scenarios including parameters/economic activities of the territory (urban planning, tourism, agriculture) and the impact of extreme events (heatwaves, flooding) • Mapping of climate hotspots, sensitive positively or negatively to climate change • Future demand for drinking water/freshwater use in touristic summer period and consequence on deep water reservoir/groundwater availability in South Brittany • Evolution of the coastline	Adaptation/planning of the territory to climate change	D1.2, p. 71
Livestock farmer	• How to reduce carbon footprint (climate mitigation) • Seasonal forecasts and long-term local trends	Overly dry summers and autumns and excessively wet winters and springs kill the grass necessary to feed the livestock	D1.2, p. 74
Oyster farmer	• Local temperature forecasts • Future sea level and storms (frequency, intensity)	Oysters need cool waters to grow and warm waters incubate a virus that kills oysters	D1.2, p. 75
Salt producer	Seasonal forecasts and long-term trends of summer rainfall	Intense rainfall prevents salt crystallization, worse in summer during harvest season	D1.2, p. 75-76

7.1.1 Weather and climate related narratives (D1.1)

Considering the general aspects of potential entry points (cf Table 18), the narratives are related to a few weather parameters (although they are vague) and matters of concern (crop harvest, water quality, coastal destruction by storms). The first reference to climate and weather is within the chapter on the natural environment of the Gulf of Morbihan (5.1.3, p. 83), which identifies the Gulf as a microclimate where the population is sensitive to climate change (e.g. drier summers and more frequent winter rains) and climate change already has an impact on agriculture (earlier harvest):

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> 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) and, seasonally, the winter expansions of the continental polar anticyclone systems, with cold north-easterly winds and the summer expansion of the warm subtropical continental anticyclone (Office National de la Chasse et de la Faune Sauvage 2011). At local scale, the closed sea just south west of the alignment of low hills running from Pointe du Raz to the river Loire valley, residues of the old hercynian mountains isolates along the coast a micro "marine mediterranean" type climate with high insolation (more than 2000 hours annually) and moderate precipitation rates (around 700 mm/year) mostly in winter. Local people are sensitive to climate change, with the winter rains more frequent, and summers dryer. Hay and wheat harvests are typically one month earlier nowadays than 50 years ago.

Another issue is raised in the chapter on modern economic and social settings (5.1.4, p. 85), where water quality is reduced by the warming of surface waters, the frequent development of toxic algae, and the apparition of anoxic water. This seems to be a matter of concern but there are no details on who is affected and how:

> Access to water (both for drinking and irrigation) becomes progressively more difficult, especially during the summer touristic season. Other uses than drinking becomes forbidden during these periods. Linked to that problem and to the warming of surface waters, coastal water quality deteriorates, with frequent development of toxic algae, when collection of shells for eating is forbidden, and sub-surface apparition of anoxic water, when divers observe local mass mortality of fishes and crabs.

In the chapter on the local population and perception of climate change (5.2, P. 86), several events are mentioned to have awakened the local population to climate change and its consequences. This represents a matter of concern, however, the sources and the link to climate change are not clear:

> The storm Xynthia (end of February 2010), was not an especially strong storm (winds in the 120 km/h range), but arrived just at the peak of a relatively strong high tide (102 coeff), with a direction and path maximizing an associated coastal storm surge of about 1,2m. The maximum impact was about 200 km south (Vendee and Charente-Maritime), but the 50 persons who died with the event, the pictures of destructed piers, boats throne on the beaches, and wide submerged areas has been an "electro-shock" for the whole Atlantic coast inhabitants.

7.1.2 Chronology of narratives and their changes & reconstruction of main weather events (D1.2)

The author describes that the economic and leisure activities in the Gulf of Morbihan are strongly influenced by the weather (4.4, p. 66-67), which can be disturbed by climate change and extreme events, impacting through sea level rise (sea submersion), warming, freshwater shortage and storms. However, climate change and extreme events are very general issues and it is not precised by whom they are perceived. For example, it is not clear which spaces will be affected by sea level rise:

> Golf du Morbihan everyday life is also linked to weather as the economic and leisure activities are strongly influenced by it. The Golf du Morbihan is undergoing climate change and extreme events. The Golf was an estuary, flooded 3000 years ago, and now expanding. Many housing and economic activities will be impacted by rise of sea level and temperature as well as fresh water shortage and storms.

In the case of Gulf of Morbihan, the risk of submersion from sea level rise is worsened because the land is geologically sinking at a rate of about 1mm/year (4.4.2 p. 70:

> On the same time, the Golf du Morbihan is undergoing a submersion derived from a large-scale tilt and collapse of the West of the Southwest Britanny and its associated continental shelf (BrSCSA – cf. fig. 8), along the fault following the western boundary of Hercynian western mountains (Bos, 1988). A submersion speed of about 1 mm/year is confirmed by radiocarbon dating of submerged oak roots and megalithic menhirs, and gallo-roman houses and roads.

The exposure of the Gulf to increasing risks of storms, flooding, submersion and coastline changes might alter the geo-social narrative and lead to a new one (4.4.2, p. 71):

> The cumulative effect of submersion and sea level rise affect the Golf du Morbihan. The Gulf will thus undergo in the following years a new geo-social narrative. Due to sea level rise, the Gulf, its inhabitants and its economics activities will be exposed to increasing risks of storms, flooding, submersion, as well as coastline modifications.

Also, the author writes that the local decision makers need to prepare the territory against future climate change (4.4.2 p. 71) and require information about the occurrence of extreme events, local future scenarios, climate hot spots, and the future

of freshwater. This is very interesting for us, however, it remains broad and lacks details and sources:

> The local decision makers (at municipalities and regional scales) have to respond in urgency to the national demand for territorial planning against the effect of future climate change. They do not have the tools to cope with this demand and needs data about:
>
> • occurrence of extreme events,
>
> • local future scenarios incorporating changing parameters of the territory (urban planning, economic activities (tourism, agriculture) and the impact of extreme events (heat waves, flooding)),
>
> • mapping of 'climate hot spots', sensitive positively or negatively to climate changes, and
>
> • future demand for drinking water in the touristic summer period and consequence on deep water reservoir in South Brittany.

Historically, agriculture and oyster farming have been old economic activities in the Gulf and tourism was only largely developed in recent decades but is leading to conflict of land-use (4.4.3, p. 71-72):

> The Golf du Morbihan has been developed around agriculture and oyster farming, and an industrial hub around Vannes. The most developed and adapted activity in the Gulf is oyster farming set up in the 19th century. [...] Tourism has grown considerably in recent decades. Infrastructure has grown accordingly; many second homes appear on the outskirts of coastal villages. [...] Because of pressures from urbanization, tourism and accelerated agricultural devitalization, the gulf suffers problems of occupation and maintenance of the rural area. Tourism also leads to conflicts about tidal zone uses with oyster farmers and about the need of protection for sensible natural zones.

As described by the author, tourism has been shaping the territory and changing its identity in relation to agriculture (4.4.3, p. 72-73), while climate services could possibly help to inform the adaptation of agriculture, tourism and housing, especially regarding risk management (river floods, sea submersion). However, the description of the influence of climate change on economic sectors is not precise enough to derive entry points.

> The Golf du Morbihan modern historical narratives result from the development of tourism, mostly based on secondary homes. Tourism shapes a new territory, in terms of economic activities, land use planning and everyday life habits. Tourism leads to a decrease of agricultural farms' number coupled with a very strong increase of organic farms that decide to develop direct sale (by effect of training and sharing of knowledge). Oyster's farmers and salt workers

> also uses the significant presence of tourists to sell their products directly. These primary sector economic activities are strongly influenced by climate change, weather and season and could need climate services to adapt (see following narratives). On the other hand, these secondary homes are constructed near the sea and have caused inappropriate river management generating overflows during heavy rains. Some homes are already in flood risk areas and protected only by dikes and dunes, some will become endangered when the sea level will rise. Here, we can interrogate the risk perception of people and decision makers, who accept to build and live on risky area (for more details on required climate services, see geo-social narratives).

There is a strong seasonality in the weather and economic activities of the Gulf, with heavy rain and strong winds in winter leading to an increased risk of floods and storms (4.4.4, p. 73), while there is a larger (mostly touristic) population in summer in combination to a higher risk of freshwater shortage:

> In winter, the Golf undergoes risk of inundations due to heavy rain and of submersion due to strong wind and, on a less frequent basis, storms. Southwestern winds accelerate the rising tide, while northeastern winds increase ebb speed. These climatic events affect economic activities as well as housing, even if the Rhuys and Quiberon peninsulas constitute barriers to mitigate their effects (for more details on required climate services, see geo-social narratives). In summer, the population increases tenfold. This situation does not facilitate a balanced development of the territory with residents who feel invaded during summer and secondary residents who do not invest themselves in local development. This phenomenon is coupled with soaring land prices, which do not allow people providing service jobs to settle. Lastly, the access to fresh water (for drinking, irrigation and oyster farming) becomes progressively more and more difficult, especially during the summer touristic season.

Most changes identified in the Gulf are related to economy and climate change has only a small role in the background (4.4.4, p. 74). However, at least one of the interviewees (a livestock farmer) is interested in climate mitigation (reducing carbon footprint) and adaptation (seasonal forecasts and long-term local trends):

> Their perceived changes in the Gulf are associated to urbanization, agriculture, youth and culture, leaving climate change far behind in the background noise. Both interviewees have little perception of a local change in climate, and their major preoccupation regarding climate is to reduce their carbon footprint. The prominent climate issues encountered in the farmer's work are overly dry summers and autumns, excessively wet winters and springs, because it destroys grass necessary to livestock, and he is interested to get seasonal forecasts along with long-term local trends (temperature, humidity, extreme events) for adaptation.

One strong matter of concern, and perceived change, is coastal seawater warming and the damages it can have on oyster production through the incubation of a virus and because oysters need cool temperatures to grow (4.4.5, p. 75). This is leading to the adaptation of oyster farmer practices and they could be interested in local temperature forecasts and future sea level and storms (frequency, intensity):

> Beyond the rising waters, a strong impact of climate change, already felt in the Gulf of Morbihan, is the increase in the temperature of water. The exploratory interviews enables us to expose a first lifetime experience of climate change through an oyster farmer in Sarzeau. When asked about his work nowadays, the oyster farmer spontaneously evoked climate hazards. Seawater warming is damaging for the production as the swarming of oysters need lower temperature conditions, which is now more easily found in La Manche. This comes in addition to spat mortality (oyster of less than a year) due to a variant of herpes virus oyster that affects since 2008 between 60 and 90% of production in most French oyster sites. Oyster production is hence encountering difficulties during the high touristic season, which takes a heavy toll on the activity. Highs and lows of oyster cultivation have important consequences on the economy and tourism in the Gulf. The future is worrisome for next generations, as there is a rapid and negative shift in the activity. The oyster farmers have to adapt their practices. For example, they can diversify their culture between different strains of oysters, develop a collective production in a closed loop with water pumps, or even begin to develop algae production for balneotherapy use. The interviewee's needs are local temperature projections (forecasts for the next 2-3 years to adapt way of cultures to keep water-cooled down below 15-16°C), and future sea level and storms (frequency, intensity).

Salt production is another old traditional economic activity in the Gulf, for which the weather issues are intense rainfall (especially in summer) and storms. The salt producer perceives climate change through a change in the timing of seasons, weather disturbance, fewer but stronger hot summers, and would be interested in seasonal forecasts and long-term trends of summer rainfall for adaptation (4.4.5, p. 75-76):

> The Lasné salt marsh in Saint-Armel exists since the 15th century and was bought in 1978 by the department of Morbihan. The Paludière's work is to manage water and the production of salt, as well as to educate the public during visits onsite. The salt is sold directly on a local market and indirectly through a cooperative. Present weather issues for the salt producer are too much rainfall (which drives down salinity in the salt marsh hence hindering crystallization and thus production), especially in summer during harvest, and storms. Climate Change is perceived

> through a shift in the timing of seasons, weather disturbance, and fewer but stronger hot summers. Climate information needs for the salt worker are seasonal forecasts and longterm trends of summer rainfall for adaptation.

Both extreme events (the Xynthia storm of 2010 caused a lot of damage) and local associations can increase the awareness of the local population to climate change, its consequences and the need to adapt (4.4.6, p. 76):

> An extreme event, coupled with other factors, helped to start awareness of the local population to climatic change and its consequences. The storm Xynthia (end of February 2010) had its maximum impact 200 km south of the Golf du Morbihan (Vendee and Charente-Maritime), but the 50 persons who died, the pictures of destructed piers, boats on the beaches, and wide submerged areas has been an 'electroshock' for the whole Atlantic coast inhabitants. Polemics about who should have better acted to protect the population have mobilized all persons in responsibility (in particular the state agencies). On the other hand, the publicity given to the Peace Noble Price for IPCC, the long-term action of local environmental associations (Eau et Rivières de Bretagne and Bretagne Vivante), and the mobilization towards local production of organic agriculture was an opportunity to several local actors to promote mobilization on climate change consequences among the local actors (creation of the association Clim'actions Bretagne Sud and of the climate change actions of the Natural Regional Park).

A contrasting conclusion from the Gulf of Morbihan is that if a part of the population does not express concerns about climate change and the need to adapt, the geo-social narratives indicate that adaptation is necessary to avoid the loss of economic activities and coastal urban areas (4.4.7, p. 77):

> People working directly in marine environments (oyster's farmers and salt workers) are more knowledgeable in climate and more interested in climate services than those working in terrestrial environments (farmers). This is most likely because the former are more climate-sensitive since marine areas experience climate and climate change more directly (sea level, temperature warming, acidification, extreme weather events) than terrestrial territories (shift in the timing of seasons, disturbance of water cycle). Therefore, the narratives of a part of the population (inhabitants, farmers) do not necessarily express concerns about the effects of climate change and the need for adaptation. At the same time, the signals of the geo social narratives are very clear: the adaptation is necessary to avoid seeing hundreds of houses and economic activities disappear. The challenge thus becomes, beyond the modalities of adaptation, the need to lead the population to take hold of this question of climate change.

7.1.3 Key issues and desired futures (D1.3)

One of the key issues is the activity of tourism and housing, which brings income in the region but increases vulnerability and decreases adaptability to climate change and especially coastal extreme events (4.3.1, p. 48):

> So, the inhabitants are not encouraged to invest their time (or their money) to develop ideas and activities, to plan for the future in the Golf du Morbihan. This could explain the inconsiderate development of residential areas inside present or future flood risk areas. Some homes are already under the sea level, protected only by dikes and dunes, and are extremely vulnerable to sea level rise. Moreover, houses have caused inappropriate river management generating overflows during heavy rains. Based on these insights on "What is at stake" in the Golf du Morbihan cases study (above) the following connecting points for discussions about desired futures pave the way to the next Work package (identification of hinge points in the scenarios design): 1. the level of place attachment and its role in the individuals and decision-makers decisions, 2. the risk perception of people and decision makers, who accept to build and live on risk areas; 3. the planning and development capacity with a temporary and aging population.

The tourism and housing activity also increases the economic seasonality (summer vs. winter) of the region and the pressure on the water resource in summer (4.3.2.1, p. 49):

> In winter, the Golf du Morbihan is calm. Many houses and part of shops (open in high season) are closed, leaving the impression, in some neighborhoods, of ghost town. In summer, the population increases tenfold (between seven and seventeen times according to municipalities), leading to problems of congestion, use of recreational (mostly beaches) and commercial spaces and access to fresh water (for drinking, irrigation and oyster farming). This leads permanent residents to live two different lives in the same territory depending on the season, with a rejection feeling against these temporary inhabitants coming only during summer. In these conditions, how to manage the needs for housing development in the Gulf and especially on the seafront to meet the needs of the incoming populations. They handle the legacy territorial land use planning but should find a balance way between development, prevention and conservation. The second set of interviews arise important questions to consider for scenarios design: What are the determining factors for decision-makers? What is important in management of the forthcoming risk? As the people are not installing over the long term, is there a question of place attachment that should be handled? How to address the issue of insurance and the nature of the damage covered by the guarantee when the government declared a state of natural emergency?

Another key issue is the coastal path, undergoing erosion, and disputed between private and public property (4.3.2.2, p. 49-50):

> the coastal path is a chronotope, undergoing erosion. The coastal path mainly corresponds to 3m right of way on private property along the shoreline. The erosion of the banks leads, by transition, to erode private land, forcing homeowners to move back their fence to leave the right of passage. These lands along the edge of the sea are in themselves symbolic of the movement of the territory. Traditionally, these lands were the least valuable as they are less fertile than those inland. These lands have increased in value with the development of resorts and tourism, lands that erode year after year. This has led to a landscape enclosure over modern times, and thus the need to create a coastal pathway (right of way) to regain its access for all.

The traditional activities of the Gulf (oyster farming, salt production, organic farming) are strongly connected to its identity but are threatened by climate change and could be assisted for their adaptation (4.3.2.2, p. 50):

> Alongside the issue of housing and urbanization, the sustainability of marine economic activities, iconic of the Golf, must be taken into account. As exposed in deliverable 1.2., the exploratory interviews enabled us to expose lifetime experiences of climate change through an oyster farmer, a salt workers and an organic farmer. These activities, iconic of the Golf, are and will be impacted by climatic change, and ask for climate information needs (seasonal and local temperature forecasts, long-term trends of summer rainfall, and future sea level and storms (frequency, intensity)). These economic activities, the custodian of that Golf identity, raise concerns and uncertainties to solve and to take into account in planning process of visions for the Golf du Morbihan.

The Gulf of Morbihan is currently making his plan for climate adaptation (PCAET) which could be supported by climate information and services such as on the occurrence of extreme events, the evolution of the coastline, and the future demand for drinking water and its consequence on deep water reservoir (4.3.3, p. 50-51):

> Climate planning has been compulsory in France by the Loi Grenelle 2 2 for urban areas with population over 50,000, through the adoption of the legally mandatory Territorial Climate, Air and Energy Plans (PCAETs), mandatory by December 31, 2016. The local decision makers (at municipalities and regional scales) have to respond in urgency to the national demand for territorial planning against the effect of future climate change. The Golfe du Morbihan-Vannes Agglomération is in the process of planning its PCAET. The work done in the framework of CoCliServ should be able to help this planning, with support of the scenarios process and, in particular, by providing climate services (WP3) relevant for public decision-makers. From the second set of interviews, we noted three main climate services: occurrence of extreme events,

evolution of the coastline, and future demand for drinking water and consequence on deep water reservoir.

7.1.4 Discussion and outlook

We found 8 issues or topics related to weather and climate in the WP1 materials (local narratives) for Gulf of Morbihan, of which at least 3 are matters of concern (MoC). They are:

- Changes in seasonal rainfall and humidity
- Shifting of harvests in time (in relation to the seasons)
- Storms and sea submersion (in relation with winds and sea level), MoC
- Extreme events (heat waves, dry spells, cold spells)
- Heavy rainfall and flooding
- Water resource, MoC
- Coastal water conditions, MoC
- Coastal erosion

The findings of WP2 for Gulf of Morbihan are very consistent with those from WP1, the largest concerns for stakeholders being:

- Impact of storms, sea level rise and marine submersion for coastal risk management
- Occurrence of extreme events for agriculture, tourism and territory planning
- Seasonal changes for primary activities and tourism
- Temperature rise (air and water) for primary activities, tourism and, to some extent, territorial planning
- Rainfall changes for agriculture

Most climate-related topics (especially issues or questions) found in the local narratives can be extensively informed by the existing literature with different levels of uncertainty depending on the topic (e.g. there is a clear signal for droughts and

heatwaves whereas the situation is much more complicated for storms). The options for improvement could be:

- Trying to reduce the uncertainties about unclear present and future states of weather/climate for some topics, e.g. future coastal risks
- Suiting the information (local impacts) to the local stakeholders when possible (depends on the spatial scale of the scientific findings)

7.2 Evaluation of related existing climate information & services

We did the evaluation of climate services in the Gulf of Morbihan and Kerourien based on interviews with the case study leaders supported by a framework of evaluation criteria (Table 20). The objectives of the framework were to provide an easily applicable (short, simple, and fast) list of user-oriented criteria of climate services. The criteria and subcriteria were determined through a desktop research of the literature in climate service evaluation (e.g. Meinke 2017).

Table 20 Framework to evaluate climate services according to a matter of concern

Criteria	Sub-Criteria
Accessibility	- Information easy to find and to access? - Information easy to understand?
Credibility	- Trust in the producer? - Transparency of data, methods, and uncertainties?
Usability	- Appropriate format to address the question/problem? - If uncertainty is included, does it increase the usability of the information/knowledge for decision-making?
Relevance	- Relevant spatial and temporal scales? - Can this service cover all aspects of the initial question? - Uncertainty of the information allowed (small enough) or not allowed (too large) by decision-making?
Additional criteria and remarks mentioned by the interviewee being important to evaluate available climate services	What's not covered by the criteria above so far – but is important from your perspective to evaluate available climate services for this specific matter of concern?

We focused on climate services under the form of free online tools because they are the most accessible, interactive, and flexible for decision-makers and stakeholders. Other less accessible and interactive forms of climate services exist (such as assessment reports or project reports) but they are less readily available to undergo an evaluation by criteria such as undertaken here. In the preparation of the evaluation, we gathered the most pertinent online climate services according to the matters of concern. The matters of concern that we considered for the Gulf of Morbihan were:

- Impact of storms, sea level rise and marine submersion for coastal risk management
- Occurrence of extreme events for agriculture, tourism and territory planning
- Seasonal changes for primary activities and tourism
- Temperature rise (air and water) for primary activities, tourism and, to some extent, territorial planning
- Rainfall changes for agriculture
- Attribution of weather changes to climate change (outside natural variability)

The two online climate services Climat HD and DRIAS developed by Météo-France are very relevant to address all the matters of concern so the evaluation mostly focused on them to find utility and limitations. The main results from the evaluation are shown in Table 21 (the full analysis by criteria is not shown here due to redundancy between climate services on different matters of concern). A first conclusion from the analysis is that the key strengths of the climate services used are their accessibility, understandability, credibility and transparency. Their key weaknesses are the lack of information about variables (e.g. seasons and water surface temperature), spatial distribution (e.g. storms and extreme events), spatial scale (e.g. extreme events), past (e.g. attribution to climate change), future (e.g. storms), uncertainty (represented through different climate models and scenarios in about half of the cases). The combination between the strengths and weaknesses of these climate services makes their use possible in some cases but very limited in all the cases, although the

combination between different climate services can partly remedy the gaps of individual services. Following this identification of gaps in climate services, the next step will be to find ways to improve existing climate services or build new ones depending on specific knowledge needs arising from the case study.

Table 21 Main results from the evaluation of climate services for Gulf of Morbihan

Matter of concern	Climate service	Strengths	Weaknesses
Impact of storms, sea level rise and marine submersion for coastal risk management	Climat HD (Météo-France)	- Accessible, understandable, credible, and transparent information - Scale of Brittany is sufficient	- Information only on past storms - Little information on future coastal risks - Little information about uncertainty - No information on storm intensity
	Copernicus (European Union)	- Accessible and credible but less than Climat HD	- Information not usable (coarse scale)
	Surging Seas (Climate Central)	- Didactic - Usable for sea level rise (relevant spatial and temporal scales) - Uncertainties considered	
Occurrence of extreme events for agriculture, tourism and territory planning	Climat HD (Météo-France)	- Information on droughts, hot and cold days at the scale of Brittany - Didactic	- Information on heatwaves and cold spells but only at the scale of France - Format supportive of action but not precise enough to know what to do in Brittany - Uncertainty not considered - Unknown location of extremes, information at the scale of Brittany would be useful
	DRIAS (Météo-France)	- Spatial information (maps) more precise, and easier visualization than Climat HD - Uncertainty considered (between climate models and scenarios) - Spatial (maps) and semi-temporal (time horizons) are helpful to answer questions	- More difficult to use and to answer questions with than Climat HD - Credible but not very transparent (data and methods) - No time series - No local data (Brittany)

Matter of concern	Climate service	Strengths	Weaknesses
Seasonal changes for primary activities and tourism	Climat HD (Météo-France)	- Lot of information on changes of climate variables in seasons - Appropriate format for seasonal changes but assuming the structure of seasons doesn't change with climate change	- No data on seasons themselves so little information for agriculture and tourism about change of seasons - Need to know the effect of climate change on the structure of seasons and condition the climate variables by changing seasons to determine the impact on agriculture and tourism - Lot of information on changes of climate variables in seasons, but not on seasons themselves
	DRIAS (Météo-France)		
Temperature rise (air and water) for primary activities, tourism and, to some extent, territorial planning	Climat HD (Météo-France)	- Time series can partially answer the question - Uncertainty considered (between climate models and scenarios)	- Unclear which temperature is considered (soil surface, air surface) - No information on water surface temperature - No maps
	DRIAS (Météo-France)	- Maps more precise than Climat HD - Uncertainty considered (between climate models and scenarios) - Spatial and semi-temporal information to answer the questions	- No time series
Rainfall changes for agriculture	Climat HD (Météo-France)	- Information on annual, summer and winter precipitation - Clear maps and explanation - Complementarity between time series of Brittany and maps of Morbihan over different scenarios and time horizons	
	DRIAS (Météo-France)	- Maps more precise than Climat HD - Uncertainty considered (between climate models and scenarios) - Spatial and semi-temporal information to answer the questions	- No time series

Matter of concern	Climate service	Strengths	Weaknesses
Attribution of weather changes to climate change (outside natural variability)	Climat HD (Météo-France)	- Visible, understandable, and credible attribution of temperature, precipitation and soil humidity according to scenario - Uncertainty considered (between climate models and scenarios) - Small divergence between scenarios in 2030 makes planning less uncertain - The different scenarios make attribution more evident in the future but the attribution is less clear in the past (natural vs. anthropogenic)	- Attribution of past storms but not future
	Clim4energy demonstrator	- Credible - Many climate variables and projections from different models	- Difficult to access, understand and use - Spatial scale too coarse (no local detail)

8 Kerourien in Brest

(Florentin Breton)

8.1 Analyses of narratives as potential entry points

8.1.1 Weather and climate related narratives (D1.1)

Three representations of climate change are mentioned (6.2, p. 98) and include changes in the Western English Channel (which is far away from the case study) such as warming. However, there is no information about why these changes may be relevant and for whom as well as how they constitute matters of concern:

> Changes in the Western English Channel have been estimated for the previous decades from high-resolution satellite data. Coastal seas, well separated from offshore waters by intense frontal structures, show colder SST by 1–2°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, but weaker in coastal waters (0.23°C/decade), 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 scenarios 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 that in winter. This increase in SST may strongly affect marine biology, particularly phytoplankton phenology, macro-algae biomass and benthic fauna, including exploited shellfish (L'Hévéder, 2016).

Climate change or weather conditions almost do not exist in the narratives except in three cases (6.4.3, p. 106):

> The explicit expression of "climatic change" or expressions that are semantically linked to it are absent from the narratives of Kerourien residents and stakeholders. They are not used in daily-life narratives or in the recorded interviews. Only when we ask, "And what about CC..." then answers appear as, "Ah, yes, it is extremely important," and then they connect with IPCC mainstream discourses, with three exceptions in this initial mapping of narratives: (i) residents affected by building degradation and unhealthy life conditions; (ii) public servants who implement the national and regional CC framework downscaled from the IPCC; and (iii) scientists working on the topic mainly from natural sciences perspectives.

Considering the general aspects of potential entry points, the narratives are not related to weather parameters or matters of concern in connection with climate change.

8.1.2 Chronology of narratives and their changes & reconstruction of main weather events (D1.2)

There is little or no role of weather and climate in the main narratives of Kerourien (4.5.4, p. 90):

> The five main narratives confirmed through D1.2 are:
>
> (i) How community priorities such as housing and physical safety are connected with climate narratives in representations of daily life and world-views;
>
> (ii) How participants embody, through their personal trajectories and experiences, climatic histories that bridge regional and global questions;
>
> (iii) Potential connections between expectations and climatic conditions;
>
> (iv) Political choices regarding climatic questions; and
>
> (v) The dialogue between those political choices and residents' dynamics.

8.1.3 Key issues and desired futures (D1.3)

The four main narratives lines are little or not connected to weather and climate change (4.6.3, p. 72):

> In conclusion, at this stage we rephrase the above quotes to shape four main narrative lines under exploration in WP2, WP3, WP4 and WP5:
>
> N_K_1: Social justice related with climate change and local weather.
>
> N_K_2: Migrations and their associated consequences at each unbalanced step.
>
> N_K_3: Housing and urbanization in a changing climate context.
>
> N_K_4: Questions related to how gender weaves into the above narrative lines.

8.1.4 Discussion and outlook

There is a strong social component expressed in Kerourien's narratives and weather/climate (including climate change) only plays a very minor role in them. This questions how climate services could help to improve the situation. However, in some cases, maybe climate knowledge could support the planning of climate change adaptation. The main narratives lines are:

- Housing and urbanization in a changing climate context
- Building degradation and unhealthy life conditions

- Physical safety and health troubles related to weather/climate conditions
- Social justice related with climate change and weather
- Planning (climate, water scarcity, energy, urbanization)

Most of them are difficult to inform because they are very local and specific. Nevertheless, they could be coarsely informed by findings and conclusions at regional and almost local scale (from 10 to 50km) about the future of temperature, precipitation, humidity, extremes events (droughts, heat waves, and cold spells), and water resource (e.g. Climat HD, DRIAS Climat).

8.2 Evaluation of related existing climate information & services

The evaluation of climate services for Kerourien (Brest) was done similarly to the Gulf of Morbihan but according to the matters of concern:

- Physical safety
- Climatic conditions
- Social justice related with climate change and weather
- Migrations and their associated consequences at each unbalanced step
- Housing and urbanization in a changing climate context

The main results of the evaluation are shown in Table 22. Most weather and climate services are little known and used partly because they do not address the topics of interest: building squalor in relation to weather and climate change, renewable energies including solar energy collection, water management threatened by sea level rise, air quality threatened by ship traffic pollution.

Table 22 Main results from the evaluation of climate services for Kerourien (Brest).

Matter of concern	Weather / Climate services	Conclusions
Physical safety	• Météo-Bretagne • Météo-France • DRIAS • Surging Seas • Copernicus • ECMWF	• Most services are accessible but unknown to inhabitants so little used, with the exception of extreme events when they are discussed in the local news. • The main topics of interest are not fully treated by the climate services:
Climatic conditions	• Météo-Bretagne • Climat HD	

	• Copernicus • ECMWF	- Building squalor and insulation (climate change not considered when building the homes, but could worsen the living conditions) - Renewable energies including solar energy collection - Water management (threat of sea level rise to current infrastructure, impact of pollution by seawater on drinking water access) - Air quality (pollution of particles from ship traffic)
Social justice related with climate change and weather	• Global Carbon Atlas • Global Carbon Project • IPCC	
Migrations and their associated consequences at each unbalanced step	• Météo-Bretagne • ECMWF • Copernicus	
Housing and urbanization in a changing climate context	• Climat HD • DRIAS • IPCC	

8.2.1 Discussion and Outlook

A few services can inform the needs, such as Météo-Bretagne and Météo-France for renewable energies (wind and solar), Surging Seas for sea level rise although it lacks detail, and The World Air Quality Index for air quality. The next steps will be to find ways to fill the gaps identified in knowledge from climate services for addressing the planning of housing, energy and water management, and to answer further specific knowledge needs arising from the case study.

9 Conclusion

For each case study site, the local WP1 narratives were evaluated according to potential entry points for local contextualization of climate information. Based on the findings, further steps for the evaluation of climate service components are derived and carried out for each case study site. In addition, workshop results of WP 2 were included, if they were provided for the case study sites until December 2019.

The WP 1 narratives, which should serve as basis for the evaluation of related climate services, are quite diverse in terms of the given insight on the various interviewees' perception. In some case studies, many quotes from the conducted interviews are provided, whereas others provided only few or none. Since the WP3 analyses of the narratives is limited to the existing reports of WP1, only those aspects can be accounted, which are traceable in the reports. In this context, it is important to mention that a perceived link to climate change could only be detected, if it was stated in the report. Particularly difficult was the identification of the climate related personal concerns of the interviewees without quotes. Matters of concerns are understood as individual consequences of the perceived climate issue. For example, if everyday life is changed by climate change, if climate change makes people feel in danger or if accidents or losses of people are related to certain weather conditions or climate change, they are matters of concern. In combination with a particular local focus, they may serve as entry points to contextualize climate information locally. In this regard, quotes of the interviewees' perception are central for the WP3 analyses. Otherwise, the WP3 analyses of matters of concerns were limited on the interpretation of the perception of the respective WP1 author. In these cases, mostly only more general aspects of locally perceived climate change could be analysed from the WP1 reports. Thus, personal and local matters were not a major part of the found issues. Due to the described differences of the provided material among the case studies in the WP1 reports, the evaluation required different methods for each case study site.

Obviously, due to the location of the case study sites, situated in coastal regions of North-western and Northern Europe, seasonal changes, extreme weather events and interaction with water are with respect to climate change general aspects in all case study sites. However, further analyses showed also local specific characteristics:

Although the narratives in **Dordrecht** do not highlight specific perception about climate change, interviewees seem to be quite aware of the water related risk and future threats. Since they are already acting with regard to climate change, it seems that it is *not* climate change information, which is *predominantly* needed for action. Instead, it is the real existing personal impairment, the individual experience from past events combined with a diffuse perspective of increasing threats, which induce people to act. Nevertheless, some gaps and needs for improvement in the current climate service landscape for Dordrecht have been detected. Quantification of climate change impacts would support communities to develop more tailored long-term adaptation strategies. In particular, quantification of disasters and their impacts are not yet provided accordingly. Furthermore, visualisation of local climate change impacts and different adaptation measures are requested but none of the available formats can currently adequately meet these needs. Moreover, local climate service could increase the consideration of positive side effects of adaptation measures in order to be more suitable for integration in local decision-making and planning processes.

The analyses in the **Jade Bay** region clearly showed that the reason for missing climate change related action is not due to a gap of knowledge on climate change or missing place based climate information. Instead, significant discrepancies within several social areas were identified as source for missing climate related action. One important reason for missing climate related action was the missing personal impairment due to climate change. This is consistent with the findings in the Dordrecht case study where action resulted from direct personal impairment. The existing climate information for the Jade Bay region was largely perceived as sufficient. Additional information needs were localized according to sources of

anthropogenic greenhouse gas emissions and the direct personal impairment of climate change. A group with diverse information need is the agricultural sector. Ecosystem services and seasonal prediction are research fields with particular relevance here. Diverging and sometimes even contradicting matters of concern indicate the broad range of individual matters of concerns even within one sector. This suggests that matters of concern need to be collected systematically and comprehensively for each sector. Since isolation was raised as a main obstacle for co-developing climate change related strategies, formats allowing participation in order to share life backgrounds and experiences with regard to climate change are promising.

For **Bergen**, the WP1 and WP2 activities provided a profound and transparent basis (including considerable number of citations, transparent mapping of different perspectives, good localization of specific places) for the WP3 analysis to derive potential entry points. With regard to the question of whether sufficient climate information is available, the evaluation showed several starting points for enhanced climate services i) The topics ‘seasonal changes’ as well as ‘exceptional seasons’ appeared as important topic but they do not appear as a bundled, independent topic in the currently available climate services for Bergen. This gap should be closed by further climate information and services. ii) For the aspect 'landslides / torrential downpours' the evaluation showed that improving / optimizing the existing services is needed in order to fulfil the claim for a very local resolution, in order to be usable for the Bergen-specific discussion. Iii) Already established (traditional) climate services do not yet provide comprehensive assistance to support and strengthen the long-lasting connection between identity and climate parameter(s); a focus on the cultural and historical embedding cannot be found in the portfolio of the available climate services (at least for Bergen) yet. The Bergen case study in particular made clear that elements such as identity and long-term experiences are important entry points for contextualization. Integrating these elements sufficiently into the existing climate service landscape is an essential gap that needs to be closed.

The conclusions from the analysis in **Gulf of Morbihan** are that the key strengths of the climate services evaluated are their accessibility, understandability, credibility and transparency. Their key weaknesses are the lack of information about variables (e.g. seasons and water surface temperature), spatial distribution (e.g. storms and extreme events), spatial scale (e.g. extreme events), past (e.g. attribution to climate change), future (e.g. storms), or uncertainty (represented through different climate models and scenarios in about half of the cases). These combined strengths and weaknesses of climate services makes their use possible for some matters of concern and stakeholder knowledge needs but very limited in most cases, although combining different climate services can partly remedy the gaps of individual services.

The main result of the evaluation in **Kerourien (Brest)** is that although a few services can inform the needs, most weather and climate services are little known and used partly, because they do not address the matters of concern and knowledge needs. These are e.g. building squalor in relation to weather and climate change, solar energy collection, water management threatened by sea level rise, and air quality threatened by ship traffic pollution.

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