Deliverable 3.1

Assessment of climate service components for each case study site

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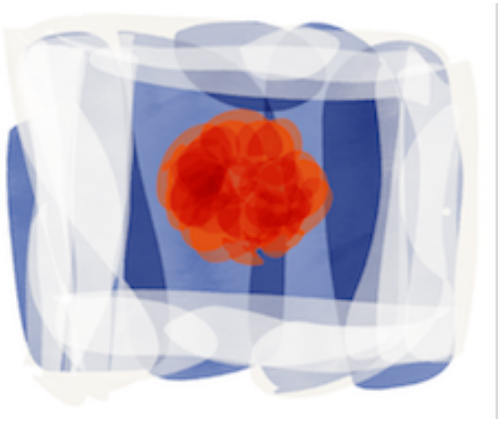

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Executive summary

In the context of CoCliServ's aim to explore novel ways to transform climate services into action-oriented place-based activities, this deliverable from Work Package 3 (WP3) has the purpose to contribute a comprehensive foundation for these activities by providing a systematic empirical study of climate service practices and formats currently applied in the research area. To achieve this objective, we developed and applied an analytical framework to the five CoCliServ case studies to establish an inventory of climate services, which we examine afterwards.

As a basis for all these activities, we bring an introductory discussion in the first part of the report, highlighting the range of definitions of the term 'climate service' and its associated challenges. It finds primarily that the paradigm of climate services are strongly guided by scientific interest and development, which aim to provide information and knowledge to stakeholders and users. (e.g. "translation of science output onto the impact user-relevant space"; Buontempo et al. 2014). We see this rationale in contrast to an increase in user-driven climate service activities, which can be characterized in particular by the aim of embedding and connecting the service of information provision to regional and local issues and replace the goal of scientific advancement as the impelling motive.

Secondly it finds that "localizing" climate science is a central challenge in general for climate services and even more so for their co-construction. In this context, CoCliServ intends to address the co-development of climate services with a local and place-based approach. However, CoCliServ activities are framed and supported by existing national and international climate service activities. Consequently, we briefly take stock of available climate services at EU level before discussing our analytical framework. We emphasize that this framework is moulded by the current discussions in the scientific sphere of climate services as

well as shaped by the experience of WP3 practitioners. Its development process as well as its boundary conditions for the inventory are discussed in the second chapter of the report presenting the methodological approach.

The third part reveals the results of our studies in the form of an overview on the current landscape of climate services in CoCliServ case studies. It draws specific differences and similarities between countries, providers from the public and private sectors, and climate service formats. Empirically, the inventory has been able to substantiate the many-faceted understandings of climate services that became apparent in the literature and to highlight the considerable influence of the providers missions' on the available set-up of climate service formats.

The inventory is able to highlight the considerable range of climate services in the case study regions. It extends from formats, building on information provision where in most cases a transmitter (scientific provider) supplies information and knowledge (e.g. processed data or products) to a receiver ('lay' person, decision-maker or the public at large), to formats characterized by an increase level of interaction between provider and users such as consultancy and educational activities. We find several kinds of formats of information provision including notably tools for experts or user-friendly applications for decision-makers (containing information and knowledge on climate change). Moreover, we find diverse examples of highly interactive activities (characterized by direct communication and direct exchange of knowledge and experience between the provider of services and the users) within the finally implemented format of the service (e.g. as advisory or education).

Chapter four articulates our 'conclusion & outlook', relates our main findings to the ongoing discussion on the provision of climate services. Finally, we discuss options to extend the inventory depending on the needs from narratives or scenarios emerging from other work packages within CoCliServ, present the next upcoming activities for WP3 and discuss how they will be constructed upon this deliverable (D3-1).

Goal/Purpose of the document

It is the purpose of the document to

- present an overview of currently available (regional or, if possible, local) climate service activities and formats in the CoCliServ study sites and
- analyse their characteristics.

Examining the attributes of climate services to deduce their essential components represents the first important step towards the development of a concept for local climate services in the sense of CoCliServ's rationale.

To achieve this goal,

- we come up with an inventory that serves as an overview of climate services and their providers for the five CoCliServ case studies.
- Therefore, we develop an analytical framework to document and scrutinize existing services in the case study areas, in terms of providers, implementation conditions, content and applied formats.

Carrying out the framework in the cases study areas helps us to understand the current landscape of climate services. Moreover, the information gained in this analysis represents a starting point for an evaluation of available services (Deliverable 3-2) as well as a stepping stone to elaborate a concept design for local climate services (major aim of WP3)

Relationship to the Description of Work (DOW)

In the context of the overarching goal of WP3, this systematic empirical study of practices and formats of climate services (D3.1) will contribute to the concept development of new or improved formats of regional and local climate services.

Findings from this analysis constitute a basis for a conceptual and methodological discussion on co-developing local climate services in the case study activities.

Beyond this report, the assessment of climate service components in WP3 (this deliverable) will be contrasted with identified needs and requirements for local climate services based on the empirical, place-specific work of WP1 and WP2 (to be done in Milestone 4-2 and Del 3-2). Furthermore, WP3 will evaluate if local climate services are suited, known and used, where improvement is needed and possible, and which barriers arise within the process of co-developing local climate services (Del 3-3).

The activities of Del 3-1 draw on available outcomes and findings such as from

- WP4: mainly in terms of milestone 4-1 in order to analyse available modes and formats of climate service activities,
- WP1: Del 1-1 provides information about the discourses on which an increased focus should be placed
- WP3: mainly activities in the context of Milestone 3-1 in order to assess the content and local validity of available climate service formats.

Introduction

Climate services are an emerging inter- and transdisciplinary field at the interface between science and practice. Historically, climate services started in the 1980s (defined then as climate data and information products) and were provided predominantly by public climate research institutes. The activities in this context complemented climate services by climate system research (empirical studies, analyses of climate records, development of climate simulation and prediction models, investigation of climate system processes) and climate impact assessment (evaluation of the effects of climate on society, the economy and the environment). In essence, climate services depend largely on progress achieved in climate science (downscaling for instance), but not only because of their multi-faceted nature (e.g. localization is also a key aspect). Building on this progress in the production of improved information, the major focus of climate services, in contrast to climate research, is about serving the users' needs of knowledge about climate and climate change (rather than on increasing the scientific understanding of the climate system; Vaughan & Dessai 2014, p. 279).

For the climate service community, this highly inter- and transdisciplinary character provides opportunities and challenges at the same time. Most of the climate service activities are united by the overarching aim to facilitate the production, translation, transfer, and use of climate information and knowledge for climate-informed decision-making and an improved society's resilience at large (cf. Climate Service Partnership 2018; von Storch et al. 2011; Vaughan & Dessai 2014; Weisse et al. 2015). However, climate services, beyond these vast objectives, represent a collective term bundling a broad range of tools, products, activities and processes. Climate services are not limited to specific sectors; rather they are implemented to support activities and planning processes in the public, private and civil sectors. They are united in addressing climate change related challenges

and are therefore as diverse as climatology itself. For this reason, a continuous and vigorous debate has been ongoing in the scientific sphere on the meaning of the term "climate services" (Weisse et al. 2015; Vaughan & Dessai 2014). Authors such as Vaughan and Dessai (2014) pay attention to the diverse use of the term climate service. Within this discussion Vaughan and Dessai (p.8) deduce the aim of climate services to provide "climate-related knowledge that can be used to reduce climate-related losses and enhance climate-related benefits" as an essential aspect.

A generally accepted definition in science and practice has not emerged yet. However, standardization should not be the objective to strive for, at least from our perspective, and the different perspectives should be acknowledged when considering climate services. Hence, the development of this inventory is an embodiment of the diversity of understandings and rationales of climate services. Moreover, discussing the definition of a climate service shows us, even within CoCliServ, that within this definition exist a plurality of notions and conceptions. Consequently, the CoCliServ project aspires to embed this diversity through a comprehensive understanding and rationale of climate services, which should be highlighted in the different case studies disclosed here. Furthermore, this understanding is a prerequisite for a deeper discussion on the further development of climate services (and their co-development). This report can thus be a contribution to this very discussion.

At this point, we also acknowledge that climate service activities are documented and discussed in different communities and in different forms. The access to these discussions however often takes place via different paths, which do not often meet each other within a broader conceptual debate. Scientific discussions for example are often established with scientific publications; this also applies to the discussion presented here, so far. Nonetheless, other discussions occur outside the academic

literature, especially regarding climate services focusing on practical service rather than on the theoretical frame. These are rarely published in part because they understandably have significantly less relevance for the provider. Thus, there is little, although increasing, exchange between these different climate service communities. This situation of diverse communities of climate service developers and providers was pondered in the production of this inventory and should be accounted for in the other CoCliServ activities.

The challenge of localizing climate science

One central challenge of climate service development in general and for the co-construction of climate services in particular is the need to "localize" climate science (Krauss 2009). Localizing climate science is needed in order to understand the socio-cultural dynamics of the respective areas (von Storch et al. 2011) and in order to make science "meaningful" for local communities (Buizer et al. 2016). In this sense, regional and especially local climate services should enable the transfer of knowledge regarding regional climate change and its impacts. This transfer, as many scholars argue, should be understood as co-produced activities, whereby the term emphasizes the importance of interaction and collaboration between science producers and users to facilitate effective knowledge transfer (Cash et al. 2006; Kirchhoff et al. 2013; Lemos et al. 2012; Lorenz et al. 2017; McNie 2012; Meinke 2017a; Moss et al. 2013; von Storch & Meinke 2008). Begun by climate science in the 1970s-1980s, this transfer was mostly from science to a broader audience outside the scientific community because climate services initially strived to improve access to climate data that was scarce in quantity and scattered broadly (Vaughan & Dessai 2014). On the supply side of climate services, crucial scientific and technological breakthroughs since the 1980s (satellites, radar, telecommunications, supercomputing; Edwards 2011) enabled increasingly skilled

prediction (short-term forecasts; Troccoli 2010) and projections (long-term, with the improvement of climate models; Solomon et al. 2007) leading to the production of better knowledge (and accessibility) about future climate. On the demand side, a growing need for climate information and knowledge emerged from the increasing importance of climate change and its impacts on society. This double development explains the great proliferation of climate services in quantity although they often remained largely science-driven (strongly guided by scientific interest) and user-informed (information provision but little embedding and connection to specific regional and local issues) thereby impeding their relevance and hence their use (Lourenço 2015). However, a recent transition in the field of climate services started in the 2000-2010s towards more user-driven and science-informed[1] services. This picture arises at least from the scientific literature. It is calling for more demand-driven practices (i.e. services evolving out of and strongly guided by societal demand, not necessarily requiring scientific development) such as to make scientific results more accessible and usable[2] by users and decision-makers outside the scientific sphere but hence needing the tailoring of the information and knowledge.

In this direction, CoCliServ puts the co-production process at its core to address the challenge of proactively connecting the climate science with the local communities. Our aim is therefore to facilitate a better connection between the knowledge from the climate science community and the societal concerns at the local level, by asking what concerns, bothers and affects local societies. That is

[1] The term 'science-informed' describes knowledgeable services based on current academic research.

[2] Following Lemos et al. (2012, p. 789) the distinction between useful and usable information reflects on the different ways producers and users perceive scientific information. "Producers may make the assumption that knowledge is useful when they engage in research they think users need (in Stokes's sense), but because they do not completely understand or know potential users' decision-making processes and contexts, the knowledge produced remains 'on the shelf'. Users, in turn, may not know or may have unrealistic expectations of how knowledge fits their decision-making and choose to ignore it, despite its usefulness."

already addressed in part by developing actionable knowledge for the public, regional and local stakeholders (cf. Cash et al. 2002; Lemons et al. 2012; McNie 2007; Vogel et al. 2017). In this case, CoCliServ intends to extend this discussion through exploring new ways to co-develop climate services, in this case by seeking to connect climate services with local narratives of change in order to make it easier for local society to connect and apply knowledge about climate change to their own concerns.

Several studies already showed that rationales about how to produce, use and communicate climate data/information/knowledge differ (sometimes considerably) between providers (such as scientists) and users such as practitioners and decision-makers (Buizer et al. 2016; Cash et al. 2006; Lemons et al. 2012; McNie 2007). Letting go of a rationale to look at the situation from a different perspective might be the essential challenge here.

In this context, CoCliServ aims to explore new ways to transform climate science into action-oriented place-based (i.e. localized) climate services by bringing together the different rationales for engaging, enabling and empowering local communities and scientists to act locally. In this way, CoCliServ will include and address existing discussion on barriers in climate service development as well as the project will investigate the challenges of localizing climate services through a detailed empirical work including new methodological approaches (WP 1 and WP2). For instance, the WP1-WP2-WP3 collaboration will make possible the comparison of the spatial validity of climate services with the climate scenarios and narratives to assess whether downscaling can lead to improvement.

Another aspect in this context includes the question about how can we communicate personal concerns about climate change among the people in the local case study areas. In this work package overarching collaboration, another important aspect is to examine ways to integrate personalized stakeholders'

concerns into the development of local climate services. Answers to these questions will help us to cope with the challenge of more contextualization in local climate services.

Objective of this study

Assessing the climate services provided currently will contribute to identify the nature of the climate service formats and processes available within the CoCliServ case study areas. The inventory of climate services presented here will serve to start the discussion on the extent to which the existing products, services and formats address the local communities' concerns, aspirations and goals in view of climate variability and climate change (CoCliServ Consortium 2016). Comprehensive, systematic assessment and evaluation of local climate information and of service formats represents a necessary, profound basis for this discussion (cf. Bolson & Broad 2013, Porter et al. 2015; Lorenz et al. 2017).

In order to establish this comprehensive basis for the CoCliServ case study sites, we develop an analytical framework that characterizes the existing services in terms of providers, implementation conditions, content and formats.

The results will help us to understand which types of services are applied due to which demands and user needs. In this regard, Del 3-1 documents the existing climate services for the 5 study areas and attempts to deduce the factors that are particularly decisive for the co-development process of climate services in order to better be able later to incorporate these in the project's activities.

Main climate service activities on European level

With the advent of debates on climate services several overarching European strategies and activities have been started and still shape the discussion on the EU-level. In the following subsection a short overview of essential activities (cf. Figure 6 in the annex) is provided as a basis to introduce the features of the inventory of climate services for the CoCliServ case studies (next chapter).

Major activities of climate service research exist at the European level, in part thanks to the Global Framework for Climate Services (GFCS). GFCS was created at the third World Climate Conference in 2009 by the World Meteorological Organisation and implemented in 2012 to "strengthen the production, availability, delivery and application of science-based climate prediction and services, especially in developing countries, in order to support better (more informed) decision-making for saving lives, protecting the environment and improving economic development" (Vaughan & Dessai 2014).

Member States are cooperating in climate service research through different joint programmes such as the Joint Programming Initiative on Climate, Climate-KIC, and Future Earth just to name a few. The European Commission in particular fostered climate service development with tailored research programmes in the form of Copernicus and Horizon 2020 (EU Commission 2014; Buontempo & Hewitt 2018).

The Copernicus Programme provides Europe with an advanced satellite and ground-based observation system and delivers the data associated on its website. As such, the Copernicus Climate Change Service is developing solutions to facilitate the assessment of global climate model projections using well-established metrics and tools, thereby supporting a wide range of applications tailored to different user needs. Copernicus services are based on past and current research promoted under ESA's GMES and LP programmes (European Space Agency's Global Monitoring for Environment and Security; Living Planet), the

Seventh Framework Programme for Research and Technological Development (FP7), and is part of Horizon 2020's research and innovation activities. Most of Copernicus' current services formats can be characterized as one-way activities[3]; these activities are mainly related to data processing, management and provision of climate data (including user-friendly applications such as web portals) and the production of text-based products such as assessment reports, reports for experts or specific target groups, and brochures for non-experts. At the moment some services are already operational (land monitoring and emergency management) while others are in pre-operational mode (atmospheric monitoring and marine monitoring) or in development phase (climate change monitoring and services for security applications[4]). Thanks to the pan-European approach of Copernicus, these services are available in principle in CoCliServ case study areas, or might be integrated into existing services already. This offer should be considered in the development or creation of co-developed climate services within CoCliServ.

Some other pan-European climate services that are especially oriented towards data processing and data provision exist such as from EUMETSAT (European Organisation for the Exploitation of Meteorological Satellites[5]), involved in Copernicus, ECMWF (European Centre for Medium-Range Weather Forecasts[6])

[3] We use the term 'one-way' in relation to the flow of information with an applied climate service format/type. One-way formats in most cases (but not exclusively) include information and knowledge communicated from the scientific provider to the 'lay' person, decision-maker or the public at large. The term mainly refers to the format implemented rather than the entire development process; the latter can still include an exchange between provider and user. Above all, this classification serves to group the finally applied formats and types of services. Opposite to this is the term 'two-way' communication, which, in our understanding, allows direct communication and direct exchange (of knowledge and experience) within the finally implemented format of the service (e.g. a workshop).

[4] Copernicus 2018 website: https://climate.copernicus.eu/services-0

[5] https://www.eumetsat.int/website/home/Data/index.html

[6] https://www.ecmwf.int/

and EURO-CORDEX (European branch of the international Coordinated Downscaling Experiment[7]).

Additionally, activities within the European Research Area (ERA) provide a key impulse to the European community by providing resources for developing better tools, methods and standards on how to produce, transfer, communicate and use climate information for climate services (ERA4CS website 2018). The ERA4CS (ERA for Climate Services) Consortium is aiming to foster and support research in climate services including climate adaptation, mitigation and disaster risk management. Several research projects have started their work under the umbrella of ERA4CS (launch of the first large-scale Joint Transnational Call in 2016), focusing on "the development of tools, methods, standards and quality control for reliable, qualified and tailored information required by the various field actors for smart decisions" (ERA4CS website 2018). CoCliServ is one out of 26 ongoing projects within the ERA4CS Programme funded under ERA4CS call A - Advanced co-development with users (18 selected projects; 8 additional projects are funded under call B - Institutional integration between 30 predetermined Research Performing Organisations (RPOs).

Methodological approach

This inventory aims to document existing climate service formats and activities focusing on the CoCliServ local case study sites (or include them at least): French (Gulf of Morbihan and Brest-Kerourien), Dutch (Dordrecht), Norwegian (Bergen-Bryggen) and German (Jade Bay).

The assessment presented here is divided into two analytical steps; the following chapters are based on this structure. In the first step of this climate service

[7] https://www.euro-cordex.net/060378/index.php.en

inventory we establish the data basis for the inventory (next subchapter). Based on this snapshot of climate service providers and related services available in the case study areas we build an overview of the types of providers and services for the entire database. In this process, we deliberately take a broad perspective to preserve an improved understanding that accounts for the vast amount and wide diversity of rationales, climate service providers and service types in place.

In the second step, we develop and apply an analytical framework in order to perform a more detailed investigation of available climate services. Thereby we characterize the (local) climate services and their providers in order to deduce elements that are assumed particularly decisive for the co-production activities of climate services. We introduced these methodological steps more finely in the following subchapters and the subsequent chapter discusses the results.

Data basis for the inventory: the Climate Knowledge Hub

Our inventory's database is built upon an available mapping activity on climate service providers: the Climate Knowledge Hub (CKH)[8]. CKH is an online map of climate service providers in the countries participating to ERA4CS and abroad. CKH was developed by GERICS (German Climate Service Center) and CCCA (Austrian Climate Change Centre) within ERA4CS activities[9] and serves as a long-term service for climate service users and the interested general public to get an overview about potential providers (Máñez et al. 2014).

Our analysis is largely based on CKH because it contains the four countries within CoCliServ and hence provides a common and practical starting point. However,

[8] http://www.climate-knowledge-hub.org/

[9] The Climate Knowledge Hub is a result of the Fast Track Activity (FTA) 2.2 on "Mapping Climate Service Providers within Europe", which is a contribution of Module 2 "Research for Climate Service Development and Deployment" of the Joint Programming Initiative (JPI) Climate (http://www.jpi-climate.eu/) of the European Commission.

being aware of the fact that CKH is not exhaustive (especially on the local level of the case study areas), an exhaustive catalogue is not the main goal here. Furthermore, considering the broad range of rationales and interpretations of climate services, it remains an open question whether such a completed recording is fundamentally possible and useful. For these reasons and from our perspective in CoCliServ, it is essential at this point to start the analysis taking a broad and non-exclusionary perspective on climate services, while creating the database of the inventory of climate service activities. This broad perspective is essential in order to develop a comprehensive understanding of the climate change discussions and applied services in the case study areas.

In the process of developing the data basis we acknowledge that climate service activities are documented and discussed in different communities and in different forms e.g. inside CoCliServ itself, and we acknowledge the significance of the lack of climate service provider activities in scientific literature. One reason for this is that climate services largely grow through the interaction between the scientific and non-scientific communities, whereas scientific papers are built mostly through the exchange confined to the scientific sphere. Accordingly, an inventory led by a user-driven perspective such as undertaken here necessarily has to go beyond the pure scientific discussions (mostly public) and include as well other activities e.g. in the private sector, which should be ensured by the CKH's extensive mapping.

The network of climate service providers within CKH has been established as a research-driven activity in the first step. In a second step, it has been transferred to a provider-driven activity that initiated the long-term provision of CKH. The FTA 2.2 activity included contacting climate service institutions in the European member states via a questionnaire, ultimately resulting in the upload of about 246 service providers profiles on the CKH (up to the current status in 07.2018; from which 40 providers are relevant for the CoCliServ inventory) which were further

supplemented after by metadata information from the providers. In addition to the CKH cluster of climate service providers, we added individual providers to the analysis if they were important during our research activities on the case study areas. These insights are based on the activities in Milestone 3.1. The Norwegian Centre for Climate Services is an example: not listed in the CKH but included in the inventory.

A Framework to document (local) climate service formats and activities

The analysis of the climate service types and providers identified in the first step is complemented by an in-depth documentation of local climate service formats and activities. Building on the overview of providers and climate service formats, the framework aims to take more stock of applied climate services in the research area. It has the aim to deduce thorough information about who actually provides climate services in the case study areas, which formats are used, and what degree of localization is already available for the case study areas.

A framework has been developed for this purpose by considering the current state-of-the art in conceptual and practical scientific discussion on climate services. The following paragraphs introduce the basic idea of the framework and reflect on the frameworks' development process. The next chapter provides the major findings resulting from the framework's application for the five case study sites.

Drawing upon conceptual debates and practical experiences

Building on our place-based perspective in CoCliServ, the framework explicitly includes practical experience and local perspective. Therefore, to take stock of applied climate services, our framework builds upon the scientific discussion in

particular regarding climate service assessment on one hand and it also deliberately includes the authors' personal experiences as practical climate service providers on the other hand. This approach distinguishes the activity presented here from other approaches, because in most cases, assessment and evaluation criteria are developed and applied by scientists. Only a small fraction of climate services and projects include users in the process of developing the evaluation criteria and provide stakeholder-based evaluation criteria (Meinke 2017b).

For our purpose to draw on conceptual debates and practical experiences as a basis for our analysis, we conducted a literature review on the current scientific discussion on climate service assessment activities. Moreover, we have exchanged views with selected practitioners. On this basis, we developed an analytical framework supporting a structured account of activity throughout all case study areas (Tab.1). In order to structure the deduced indications from the literature review and the exchange on practical experiences and to bring it into the form of an analytical framework, we formed clusters in content representing the three major areas of interests. These clusters group together different elements (components), which initially emerged from the research as relevant for a comprehensive analysis. In order to facilitate the applicability of these criteria to the case study areas, we developed a question for each component that can be directed to the climate service under investigation. The following section reflects on the discussions leading to the deduction of components and the development of the questions. Regarding the current conceptual scientific discussion on climate services, a large body of literature deals with the development (and presentation) of tools and services, while a smaller but increasing part concerns climate service *assessment* and *evaluation* activities in the last years. For the *assessment* of the content (climate knowledge/information/data), several criteria have been mentioned and largely discussed in the literature. This focus on content contrasts with little activity on the assessment of formats and processes (Göranson &

Rummikainen 2014; Máñez et al. 2014; Meinke 2017b; Vogel et al. 2017). CoCliServ activities including this deliverable in particular should strive in this direction and support the scientific discussion by considering the implementation process and service formats in the assessment, additionally to the commonly assessed data quality

An *evaluation* of climate service, as discussed in the literature (Vaughan & Dessai, 2014; Máñez et al. 2014; Göranson & Rummikainen 2014), is beyond the goal of our inventory. However, pondering the current (scientific) discussion and activity on climate service evaluation is useful to deduce essential criteria to also include in the inventory (reflected in the framework). Current debates about climate service evaluation include among others the (economic) value of climate services (e.g. Clements et al. 2013), the process of knowledge exchange (Fazey et al. 2014), or the process of co-development (e.g. Kirchhoff et al. 2013). Another part of literature focuses on the evaluation of the outcome, of usable (climate) science for example (e.g. Ford et al. 2013; Wall et al. 2017; Dilling & Lemos 2011), or on the evaluation of impacts on decision-making and policy (e.g. Cash et al. 2002; Evely et al. 2010; Meinke 2017b). Most of the activities mentioned above concentrate on the assessment and evaluation that are applicable to different types of climate services. Scarce literature touches the assessment of specific climate service formats, except Swart et al. (2017) who reviewed web portals.

All these aspects discussed in the previous two paragraphs are a starting point for the upcoming activities in Work Package 3 (Deliverable 3-2: evaluation of climate service components).

Structure and development process of the analytical framework

The framework is designed to analyze the single climate service products and is facilitated by a set of research questions for each major component (see Table 1).

This catalogue of guiding questions is our "magnifying glass" for taking in the documentation of currently available climate services. Answering these questions for single services helps us to deduce similarities and differences (i) for a single case study area, (ii) between the different case studies and (iii) between different formats.

In general, the framework help us to deduce components that are particularly decisive for the coproduction of climate services in the case study areas. Based on this aim the framework addresses three major areas of interest:

Boundary conditions: This area of interest gathers the general information about the type of service, its development process and its financial background. This information is essential in order to understand which demands (from users or science) led to development of which types and formats of services in the case study areas. Information about the development process is essential in order to understand how collaborative activities are established in practice; and with which kinds of benefits?

Content: This area of interest gathers the information about the content of the analyzed climate service referring to the database, included scenarios, and method applied etc. This information is essential in order understand to what extent localization of climate services is established already, and the kind of information that is available on a regional and local scale in the different cases studies. This insights will be compared with the empirical findings on user demands, for example from WP 2's incremental scenario activity, in order to identify gaps in terms of local, place-based climate services in the case study areas with regard to the regionalized and localized climate data.

Implementation: This component gathers information and insights on the format and application process as well as user-provider communication.

This information is important in order to understand how information about climate change and its impacts are communicated within the existing services and how the knowledge is developed within the existing formats. This insight is essential so that we can suggest or try out contents and existing formats in the case study sites.

The major areas of interests group together different elements (components), each of which we link to one or more detailed questions (indicators). The components and the in-depth research questions originate from both a literature review and practical experiences. Sources included in the last (right) column point to scientific work that already discusses these elements and indicators.

Table 1. Draft analytical framework.

	Component	Detailed questions (indicators)	References
Boundary conditions	**Provider**	Who runs the service (maybe a difference between developer and operator?)	
		Who established / developed the service?	Göranson & Rummukainen 2014
	Service development	How was the user requirement collected?	
		Long-term maintenance or tied to project duration?	Swart et al. 2017
		To what extent does local contextualisation play a role?	
		Who was / is the financier?	Göranson & Rummukainen 2014
	Type of service	Information provision or interactive format? What is the product that the user receives?	Milestone 4-1; Milestone 3-1
		Aim of the service (knowledge transfer, knowledge exchange, presenting scientific results…)	Vaughan & Dessai 2014; Meinke 2017b
Content	**Content / Data**	Diversity or focus on the individual parameters / topics / scenarios?	
		What is provided with regard to data / products?	Göranson & Rummukainen 2014
		Method of data processing: is there information/ a description of the method available? Which method has been used?	Meinke 2017b
		Is the goal of enabling users to act and react to climate change already formulated?	
Implementation	**Format and process**	Information or participation? Which methodology?	Fazey et al. 2014; Swart et al. 2017
		How does the communication take place between provider and user?	Fazey et al. 2014; Lemos et al. 2012; Swart et al. 2017
		What is known about the development processes?	Göranson & Rummukainen 2014
		How is the service disseminated to the user	Göranson & Rummukainen 2014; Vaughan & Dessai 2014
		How is the service promoted?	Göranson & Rummukainen 2014; Vaughan & Dessai 2014
	User-provider-communication	Are there a / a few special users - or many users (from many sectors)?	
		Is there a possibility of feedback?	Swart et al. 2017; Vaughan et al. 2018
		Is there / was there an evaluation of the service?	Swart et al. 2017
		Do we know something about the use / query or similar?	
		Is there a reproduction of the service? (e.g. other locations; other sectors)	
		Is there a long-term contact point / contact possibility?	Meinke 2017b

We applied the framework developed (cf. Table 1) for the analysis in the five case study sites. This activity contributes to CoCliServ's aim to provide a systematic empirical study of climate service practices. Moreover, it provides in this context an improvement regarding the method development to conduct systematic studies.

Practical application in the case study areas thus represents a first test of the framework. During this work, it became clear to us that several references, indicators and components highlighted in scientific discussions about climate service assessments, have only limited practical applicability in reality. Based on our experience during this application regarding the practicability of the questions and the validity of the results, we revised the framework in a second step. Table 2 presents the reworked framework. The last column explicitly explains why a question is relevant for the study and the kind of information that can be expected to obtain from the enquiry. This step led to a concretization and, above all, reduction of the framework to the essential questions needed and practically feasible to answer. It also provides a starting point for a concept design of local climate services. In this fashion, we consider the framework versatile and transferable outside the CoCliServ areas, as a tool to assess (map) climate services, too. For CoCliServ it should be noted at this point that the inventory provides rather broad insights for the case study areas at the moment. However, the more specific the orientation of the case studies will become, the more suitable will the analysis be facilitated by this framework support the activities of other WPs and partners in the case study areas.

Table 3 contains the incentives for exclusion of the respective elements. The incentives are due to different reasons that are briefly explained in the following. Based on our experiences we emphasize that the components 'boundary conditions' and 'content' of the revised version contribute sufficiently to provide a

state-of-the-art analysis of the current climate service landscape, even if not all the suggested indicators are suitable. However, the third cluster related to the analysis of the development process of a climate service calls for a retrospective assessment of a *process*, which at least entails a different methodological approach in order to include the developer and users involved.

During the implementation of the framework, it became clear to us that within the third cluster ('implementation') most of the criteria included in this category represent criteria for analyzing *development process* of a climate service; but this analysis is not part of the inventory activity of Del 3-1. On the contrary, the analysis of the development process of a climate service calls for a retrospective assessment of a *process*, which at least entails a different methodological approach in order to include the developer and users involved. We have to distinguish between the aim of the inventory to document and scrutinize existing services in terms of providers, content and applied formats of climate services, and activities outside of this inventory, including the analysis of the development process of individual services or the evaluation of climate services. For the aim of the deliverable 3-1 deliverable, assessing the development process of existing climate services is deemed to have little relevance for the aim of deliverable 3-1 to document existing climate services for the five regions.

Another incentive for the exclusion taking account of the remaining difficulties caused by the difficulties to answer the related research questions when considering individual services. Some of these research questions are much more general questions that can only be answered when considering multiple services at the same time in a study region. Such activities are not addressed by the inventory of deliverable 3-1, but might follow in the further course of WP 3.

Moreover, it applies for many of the analyzed climate services analyzed that climate service providers are not localized in the case study's' immediate vicinity.

In most cases, the services provide information about the region; however, they were not developed in the region. Consequently, it is not relevant for the Del 3-1 to investigate the individual *development process* and communication in service development of services established outside of the study areas. The investigation of the format remains unaffected by the fact therefore the *content* and the *format* are analyzed within the analytical framework, of course.

Table 2 Revised framework

	Component	Detailed questions (indicators)	References	What important information do we receive here?	Why is this information helpful?
Boundary conditions	Provider	Who runs the service (maybe a difference between developer and operator?)		**Information about the provider of the service and potential differences between the developer and the operator of the climate service**	**This information is essential to understand how collaborative activities have been established in practice and which are the benefits of these collective development processes**
		Who established / developed the service?	Göranson & Rummukainen 2014		
	Service development	Long-term maintenance or tied to project duration?	Swart et al. 2017	**Information about the basic conditions for the process of service development**	
		Who was / is the financier?			
	Type of service / format	Information provision or interactive format? What is the product that the user receives?	Milestone 4-1; Milestone 3-1	**Information about the formats in which climate services are available**	**This information is essential in order to improve our understanding of the connection and dynamics between demands (from users or science) and chosen types and formats of services**
		Aim of the service (Knowledge transfer, knowledge exchange, presenting scientific results…)	Vaughan & Dessai 2014; Meinke 2017b		
Content	Content / Data	Diversity or focus on individual parameters / topics / scenarios?		**Information on the tailoring of the information (if available) to the area of study**	**This information is essential to assess the degree of local validity and uncertainty of the climate information provided in the service in order to identify gaps (e.g. contextualization with narratives and improvement in downscaling) that could be filled with place-based climate services in the case study areas.**
		What is provided with regard to data / products?	Göranson & Rummukainen 2014	**Information on the kinds of (relevant) knowledge that is provided for the particular study sites**	
		Method of data processing: is there information/ a description of the method available? Which method has been used?	Meinke 2017b	**Information on the level of local validity and associated uncertainty of the climate information (important for CoCliServ)**	
		To what extent does local contextualisation play a role?		**Information about how far connections are already established between available climate change information and local demands and local needs.**	**This information is essential in order to make an appraisal of the current level of relevance of available information about climate change in current local debates in the area under investigation**
		Is the goal of enabling users to act and react to climate change already formulated?			

Table 3 Incentive for the exclusion of the respective elements

Component	Detailed questions (indicators)	Incentive for exclusion
Service development	How was the user requirement collected?	Important criteria for service *development*, but this is not part of Del 3-1. Due to the few climate services that were developed and established directly in the CoCliServ case study areas, for the Del 3-1 it is not relevant to know how the communication in service development outside of the study areas took place.
Format and process	Information or participation? Which methodology?	Redundant to the question "information provision or interactive format" which is still included in the revised framework under 'Type of service / format'
	How does the communication take place between provider and user?	Component seems especially relevant if you want to understand the development processes of individual services (not part of Del 3-1)
	What is known about development processes?	Important criteria for service *development*, but this is not part of Del 3-1 (but an inventory of services). Due to the few climate services that were developed and established directly in the CoCliServ case study areas, for the Del 3-1 it is not relevant to know how the service development outside of the study areas took place.
	How is the service disseminated to the user?	Information is initially not relevant for an inventory, it mainly concerns the communication that follows after the development process (thus possibly relevant in CoCliServ with regard to the development of new climate service formats)
	How is the service promoted?	
User-provider-communication	Are there a few special users - or many users (from many sectors)?	This information is relevant in an evaluation of Climate Services, but not in an inventory. In part, we addressed this component as a result of analysing the service format in combination with provider types (chapter 'who provides what and why')
	Is there a possibility of feedback?	Component seems especially relevant if you want to understand and evaluate the operation of an individual service and question its usability (not part of Del 3-1)
	Is there / was there an evaluation of the service?	This indicator mainly refers to the upcoming activities in Del 3-2. This information goes too far for an inventory. Moreover, a different methodological approach is needed to provide a comprehensive answer to this question.
	Do we know something about the use / query or similar?	The component turned out not to be relevant for an inventory of existing services in the case study areas; it is rather an overarching question if and where similar formats can be found in the different areas or topics under investigation
	Is there a reproduction of the service (e.g. other locations; other sectors)?	This question seems difficult to answer when considering individual services; it is more of an *overarching question* that summarizes a consideration of many services in a study region; therefore it has been removed from this analytical framework (that focus on climate services individually)
	Is there a long-term contact point / contact possibility?	Component seems especially relevant if you want to understand and evaluate the operation of an individual service and question its usability (not part of Del 3-1)

Results - Landscape of climate services in the CoCliServ case studies

The following section presents a synthesis of the revised analytical framework (cf. Table 2) to the five case study areas, in which the questions structuring the framework are guiding our findings on climate service purveyed in the regions under investigation.

In the first part of this chapter, we consider the nature of providers and of the offered formats from an overarching perspective. In the second part, we concentrate on the 'boundary conditions' and the 'content' (data, method, localization) of available services for each case study.

Boundary conditions - Overview about provider and service types

In the first step, we analyze the types of providers and the types of services they offer. This part of the analysis correspond to the first of the two major areas of interest represented in the framework ('boundary conditions'). The data based used and analysed here (as described above) depicts a different picture for each area in terms of providers with regard to the CoCliServ case studies. The basic database in the form of the CKH conveys the general impression that there are significantly more providers registered for the Jade Bay cases study (Northern Germany) than for three other countries (cf. Figure 1). This distribution should however be treated with caution since this snapshot might be related to the German (and Austrian) supervision of the project during the development phase of the CKH (an above-average number of institutions are registered for Austria, too).

Bergen stands out being the only case study area with climate service providers localized in its immediate vicinity. Consequently, we expanded the area under review for all case study areas (as described below). The following picture emerges for the CoCliServ case study areas:

- Gulf of Morbihan and Brest (France): we analyse the 12 providers from CKH (mostly in Paris).
- Dordrecht (Netherlands): we analyse the 5 providers registered in CKH for the Netherlands.
- Bergen (Norway): we analyse 9 service providers including 2 in the case study area (Nansen Environmental and Remote Sensing Centre, Uni Research Climate) and 6 others throughout the country (1 in Sogndal, 4 in Oslo and 1 near Trondheim).
- Jade Bay: we analyse 17 providers in the CKH (the analysis comprises providers in Lower Saxony, Bremen, Hamburg and some selected examples from Schleswig-Holstein).

Who provides climate services?

Based on CKH, the analysis shows a variety of different providers in the case study areas. By classifying providers into different types, we want to highlight the diversity of providers that we found in our empirical research. This classification in individual categories is our subjective approach to set out an objective overview at this stage in the analysis. As such, the derived figures presented thereafter represent and interpret the classification that was used in the inventory; another categorization method hence would have brought slightly different results without significantly altering the main insights.

The main types of climate service providers can distributed into three different groups: (A) commercial enterprises (business ventures or corporates) (B) research institutions (universities and governmental research centers), including those

institutions focusing on climate services and (C) governmental agencies (administration).

The type of provider refers in particular to their primary mission but also in a second degree to the origin of their resources / their source of financing (governmental funding, national or international research funds, or contract work for customer). This categorization brings into light a striking pattern in terms of which climate service types are supplied by which providers (cf. Figure 3) thus highlighting empirically a multiplicity of services relating to the different understandings and definitions of climate services, and self-conceptions of providers. CKH represents a well-suited data basis for this activity, since the providers can register voluntarily. Thus, CKH also gives an overview of who understands himself as a climate service provider.

For Type-A providers ('commercial enterprises') climate services are part of an economic business model. Their mission is to provide the paying customer with services individually tailored to their demands. Scientific objectivity might be contradicted by the fact that they are often profit-orientated. The commercial enterprises considered here mainly supply services regarding information provision such as data or products for their clients. Since the customer might want to use this service to generate a commercial advantage over his competitor, that particular service has to be purchased through single orders and hence won't be suited or even available for the public or stakeholders. This would also explain the apparent lack of acquisition and representation of climate services provided by commercial enterprises in the (scientific) literature as well as it provides an argument why mapping the private providers of climate services is more difficult than for the public providers (especially in terms of service types). Climate services provided by commercial enterprises might be well tailored to specific costumer's needs; but they can hardly serve as a common scientific basis for society in order

to develop a broad adaptation strategy or to initiate social transformation processes.

Public availability of relevant information for society is an important prerequisite in this context, which might be fulfilled by the two other types of climate service providers, the research institutions (B) and the governmental agencies (C). The Type-B providers differ in their mission, while some research institutions may have the mission to educate society (university), others have the mission to conduct basic research in natural sciences or they are conducting research to contribute to solving grand challenges facing society. The climate services offered by type-B providers are therefore assumed to be much more scientifically extensive, more apt to explain causes for complex phenomena, and better able to localize the societal risks and challenges for society. We further subdivide Type-B category between 'university / research institutions' and 'research institutions focusing mainly on climate services' (cf. Figure 1) to emphasize the different leitmotivs of these institutions. The latter category includes those providers which devote entirely (e.g. the Norwegian Climate Service Center) or dedicate individual departments (e.g. the Northern German Coastal and Climate Office) to specialize in the development of climate services. It also consists of providers belonging to scientific non-profit organizations focusing on climate adaptation and climate services (for example the Dutch 'Foundation Climate Adaptation Services (CAS)'). This work therefore explicitly takes place at the interface of research practice, while universities and other research institutions communicate this as a sub-goal but not as their whole work-orientation. A particular task of such research institutions that focus mainly on climate services might be to test and convey options for action.

Type-C providers, namely 'Governmental agencies', involves providers in governmental institutions and public authorities. Some of them are closely related

to the scientific community; the Dutch KNMI (Koninklijk Nederlands Meteorologisch Instituut, Ministerie van Infrastructuur en Waterstaat) or the Norwegian meteorological institute are examples. Climate services provided by governmental authorities in particular are in many cases guided by a certain mandate. These providers are thereupon often obligated by law to provide an operational service e.g. in order to ensure the functional capacity of infrastructures and traffic (incl. e.g. air traffic and shipping). Thus, a climate service of this provider type is expected to address the basic needs of society, e.g. through warnings and recommendations for short-term and medium-range actions. Since the services with different foci provided by these public authorities (e.g. weather services) have been established already decades ago, they are by now well known by society and perceived as credible service providers. This gives them, besides a different intention, a different starting point, compared to climate service providers of the other categories (especially Type-A providers).

Figure 1 shows the distribution of providers within these categories for each country based on our rough classification of climate service providers.

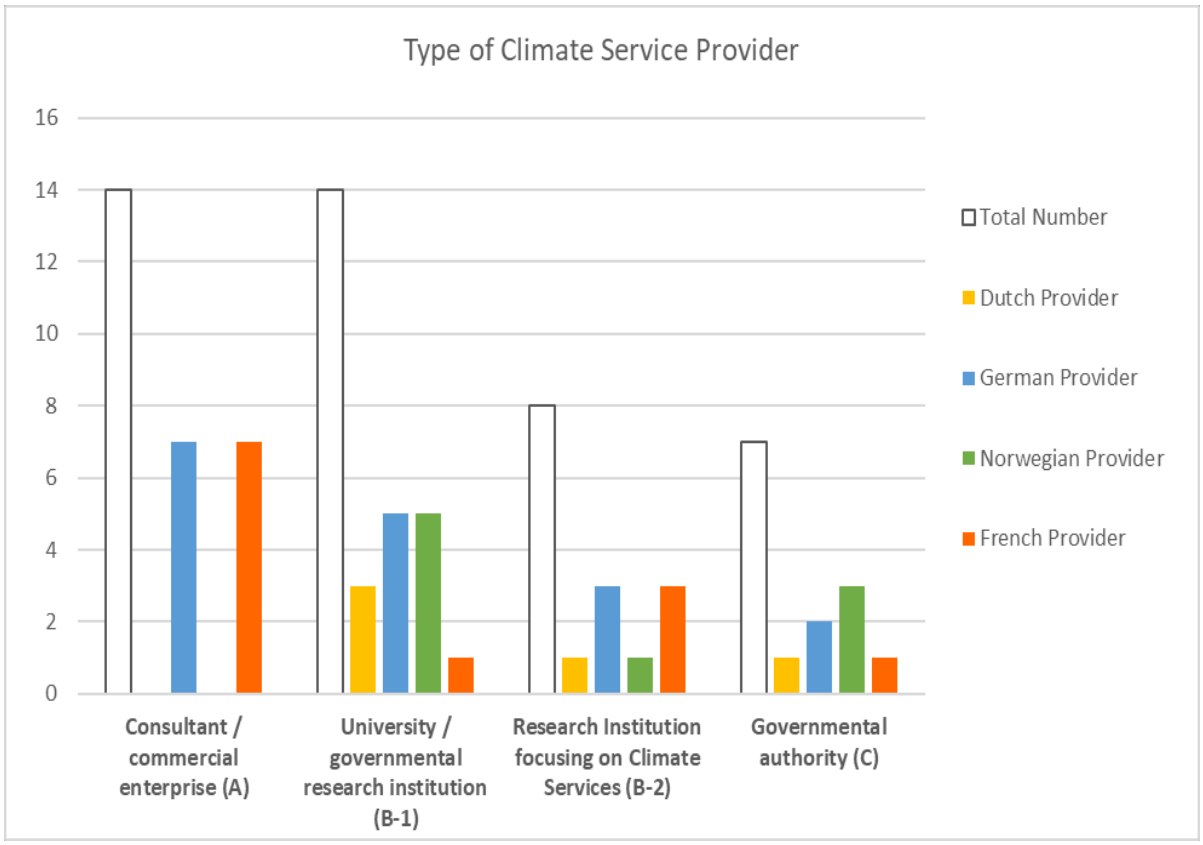

Figure 1 Types of climate service providers represented in the five case study areas under review by CoCliServ (data: CKH complemented by additional institutions).

Within the CHK database, Type-A providers 'consultants / commercial enterprises' can only be found in the German and the French case studies. The high proportion of private providers was particularly noticeable in these two countries (three case studies). The other categories are represented in all countries. With an overarching view on the providers there are significantly more climate services produced by national (cf. Figure 2) than EU providers (cf. Figure 6 in the Annex) at least in terms of data and research media. Overall, the majority of climate services comes from the research institutions (B) and governmental administration (C) (cf. Figure 6 Annex and Figure 3 for details).

In some of the considered case studies areas, we also find providers, who focus their activities on a (defined) region[10]. In the French case study providers like the Brittany Environmental Administration and Météo-Bretagne focus on the region of Brittany, within which the (local) CoCliServ case study sites are located. In Germany, the Northern German Coastal and Climate Office represents a climate service provider with a regional focus (including mainly the federal states along the North and Baltic Sea) including the local CoCliServ case study site. With regard to the Dutch and Norwegian case study site, no directly comparable institutions with an exclusive regional focus can be found in the considered data set. For Norway, the 'Western Norway Research institute', located in Sogndal, sets itself the task to support actively the development in West Norway. However, in its role as an international research institution it further aims to participate in national and international research. Thus, this provider has no exclusively regional focus. For the considered Dutch climate service providers, in the analyzed dataset the thematic cluster of flood protection and its related activities and institutions of the Delta Commission appears to be a more dominant focus than a spatial, regional focus.

What is offered when we talk about climate services?

Within the analysed set of climate service providers, we see a broad range of different climate service products and formats. The resulting landscape of climate services within each case study discussed in the following paragraphs relies on the classification of providers and service formats that we developed and explained in the previous chapter. As also explained in the chapter before, the present analysis

[10] These providers should be understood in contrast to providers whose national and regional activities target different regions throughout the country (e.g. performed by the Climate Service Center Germany).

does not include the development process because we not deem this information mandatory for what we want to achieve here (i.e. an inventory but not an evaluation of climate services). We explicitly focus our analysis on the final service format.

The climate services investigated differ largely in their portfolio owing largely to their different boundary conditions (set by the providers, as discussed above) and to the different (user) demands that they are serving. These preconditions frame the specifications on which the format and user-provider level of interactivity of a given climate service are built.

Figure 2 reveals an overview of the different types and formats of services. According to their main components, we encountered and distinguished five different groups of climate service formats in our database: services on data provision and data management (1), dialogue and educational formats (2), data based products (3), text based products (4), and advisory services and products (5). The description of these groups follows.

(1) Data provision and management: This category bundles the services on data provision (via internet platform or by request), raw data acquirement as well as data processing and services related to data management. Data in this context refers to climate data including observations, reanalysis, and simulations (predictions/forecasts and projections). The quantitative evaluation of the CKH database shows that data-related services are the most frequently offered (highest number listed) in the regions of study although pondering that other services are not well documented in CKH (leading to an incomplete finalized database).

(2) Dialogue and educational formats: These activities bundle interactive formats such as direct inquiries, stakeholder events (discussion rounds, conferences, exhibitions, fair stands and related campaigning), concept

development activities (e.g. for public events about climate adaptation, sustainability etc.), workshops as well as expert presentations to a broader audience.

(3) Data based products: includes services and products that provide processed data in different stages of analyses and interpretation (this distinguishes them from category 1), especially digital web applications. Web applications provide interactive access to the analysed data with understandable (accessible) interpretation. Most of these interactive web tools address a broader user (target) group and involve digital application in different formats, including online games, climate atlases and climate monitoring tools. For some of these products we know based on our own practical experiences that the development has been caused by user needs from different stakeholder groups. According to the web tool development, there were often test periods with different user groups before it went online. Then, the exchange between the provider and the user is often organized online via the web tool.

Within this category in general, we further differentiate between digital solutions for experts, in particular the software programs and models that in most cases had been developed for the use by other experts themselves (in contrast to anyone); and user-friendly applications directed to a broader public. In some cases, the latter have been developed as a response to frequent inquiries about the subject in question or similar topics (as we know based on our own practical experiences for some of the analyzed products). Accordingly, to the queries, data is systematically analysed in different contexts and is prepared in a user-friendly (easily approachable/accessible) way. An example is the Climate Atlas provided by the Northern German Coastal and Climate Office (www.norddeutscher-klimaatlas.de).

(4) Text-based products: This category represents another climate service format pursuing the objective to provide easy access to scientific knowledge. We broadly clustered different kinds of written and published material in this category (text based products which are available online or in paper print) ranging from work of popularization up to specialized substance for experts with many other subtypes in between. For instance, online formats in this category are mainly web based knowledge plat forms and story maps[11] (provided e.g. by the Dutch provider CAS – Climate Adaptation Service).

An important distinction should be made between the subcategories of 'understandable summaries' and the subcategories of 'documentation of scientific knowledge' and 'assessment reports'. The former groups information brochures and understandable summaries that address in particular the general public as well as tailored user groups outside the scientific cadre. Within these formats, a special effort is made to keep the language as simple as possible, trying to avoid complicated terminology. On this topic, texts that are easily understandable as well as providing contextualized information represent an important element in the making of climate services. The latter mainly addresses an audience, which is at least experienced in climate science to a certain degree (including the scientific cadres as well as professional out this cadre but with related fields or activities). For this audience, 'assessment reports' systematically document the published scientific knowledge of certain aspects of climate change and bundle this documentation in a peer reviewed scientific book. The category 'documentation of scientific knowledge' bundles additional

[11] Story maps are interactive maps that give users insights into the consequences of climate change on the basis of a story. Such a story can focus on certain effects, a specific area or a certain period. (cf. https://www.climateadaptationservices.com/en/products)

scientific reports and journal papers. For these reports, a basic knowledge of climate science is a prerequisite. Written and printed products are the second largest group among the documented climate services in our dataset with a preponderance of reports and formats bundled in the category 'documentation of scientific knowledge'.

(5) Advisory services and products: This category includes activities and formats providing guidance to help the people in charge (decision-makers and stakeholders) particularly when those have to implement regulations and policies. The associated climate services involve conceptualising, implementing and monitoring activities in accordance with EU or national laws and regulations. Moreover, it includes the resulting products (tailored to specific sectors, authorities or municipalities) regarding the mitigation and adaptation to climate change, and impact studies or flora and fauna maps depending on the user's (customer's) needs.

An important aspect of this family (5) of services is its fluency in transitioning to environmental services combined with a very broad rationale of climate services from the perspective of consultants and private business owners. Particularly due to the mix with environmental services, we will not include these types of services in the more detailed analytical steps.

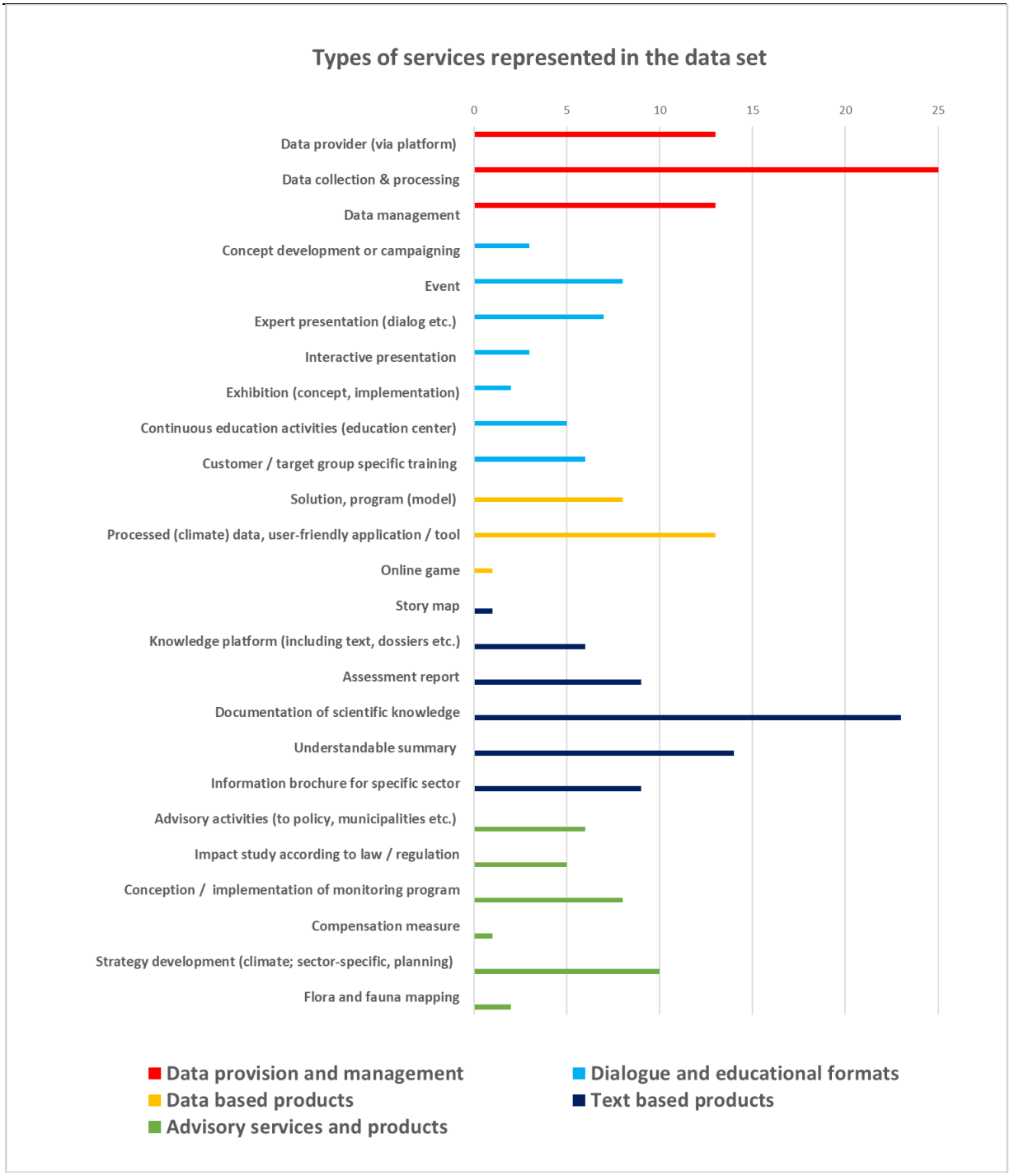

Figure 2 Overview of the different types of services included in the analysed dataset from all (Dutch, German, French and Norwegian) case study sites.

The investigation of the data on climate services pertaining to the CoCliServ case study areas confirmed a great diversity in climate service formats. Differences in rationales of climate services extend from understanding them as pure data provision services up to participatory, capacity building processes (as far reaching

as online games and story maps). Depending on the logic used (from the provider), a climate service can be understood as data, an advice, a tool (for example a web portal providing processed data), a product (maps of downscaled temperature projections for instance) or a process (e.g. workshop series to increase the resiliency of a local population against a climate risk).

Most of the climate services considered can be characterized as long-term activities, contrasting with research-project activities that are tied to stricter limitations in time, money and personnel. Data and text related products (such as data services, web applications, printed media) mostly prevail in quantity over activities including communication processes and interactive formats (advisory, education). Many of the climate services that we mapped focus on knowledge transfer in order to achieve more awareness toward climate change impacts and the need for mitigation and adaptation to climate change. Additionally, many climate services, as described by the providers, aim to give an impulse for action (e.g. Adaptation toolkits, provided by Climate Service Center Germany (GE); story maps, provided by the Foundation on Climate Adaptation Services (NL)). However, recommendations and guidance given to the user, especially to start climate change adaptation and mitigation in practice, vary greatly between the different services. They range from very concrete instructions (as in the examples mentioned above) to rather vague statements (e.g. the product, in this case the Climate Fact Sheets of the Norwegian Climate Service Center (KSS) should "provide a knowledge base on climate challenges for overall planning, and a climate change climber"[12]). These differences are in part because of their different missions to which the services are suited.

[12] Cited from https://klimaservicesenter.no/faces/desktop/article.xhtml?uri=klimaservicesenteret/klimaprofiler

Who provides what and why?

We talked above about the “boundary conditions” of climate services in terms of types of provider and service. Looking at both these types is useful to determine whether typical combinations of providers and formats can be identified i.e. detect patterns in the landscape that we are observing and confirm the above-mentioned assumptions about the providers' missions.

In most of our cases studies, there are a few prominent providers who provide a large number of services. These are Météo-France and IPSL in the French case study, GERICS (the German Climate Service Center) and the Northern German Coastal and the Climate Office, KNMI (the Royal Netherlands Meteorological Institute) and CAS (Climate Adaptation Services) in the Dutch case study and KSS (the Norwegian meteorological institute) in the Norwegian case study. Most of these institutions belong to the category of research institutions (Type-B providers) also focusing on climate services (GERICS, Northern German Coastal and Climate Office, IPSL, CAS, KSS), while the minority (Météo-France and KNMI) are governmental agencies (Type-C providers).

Figure 3 shows a detailed list of the different types of climate services supplied by provider types. The following section looks at the individual categories of services and relates them to the type, mission and portfolio of their provider.

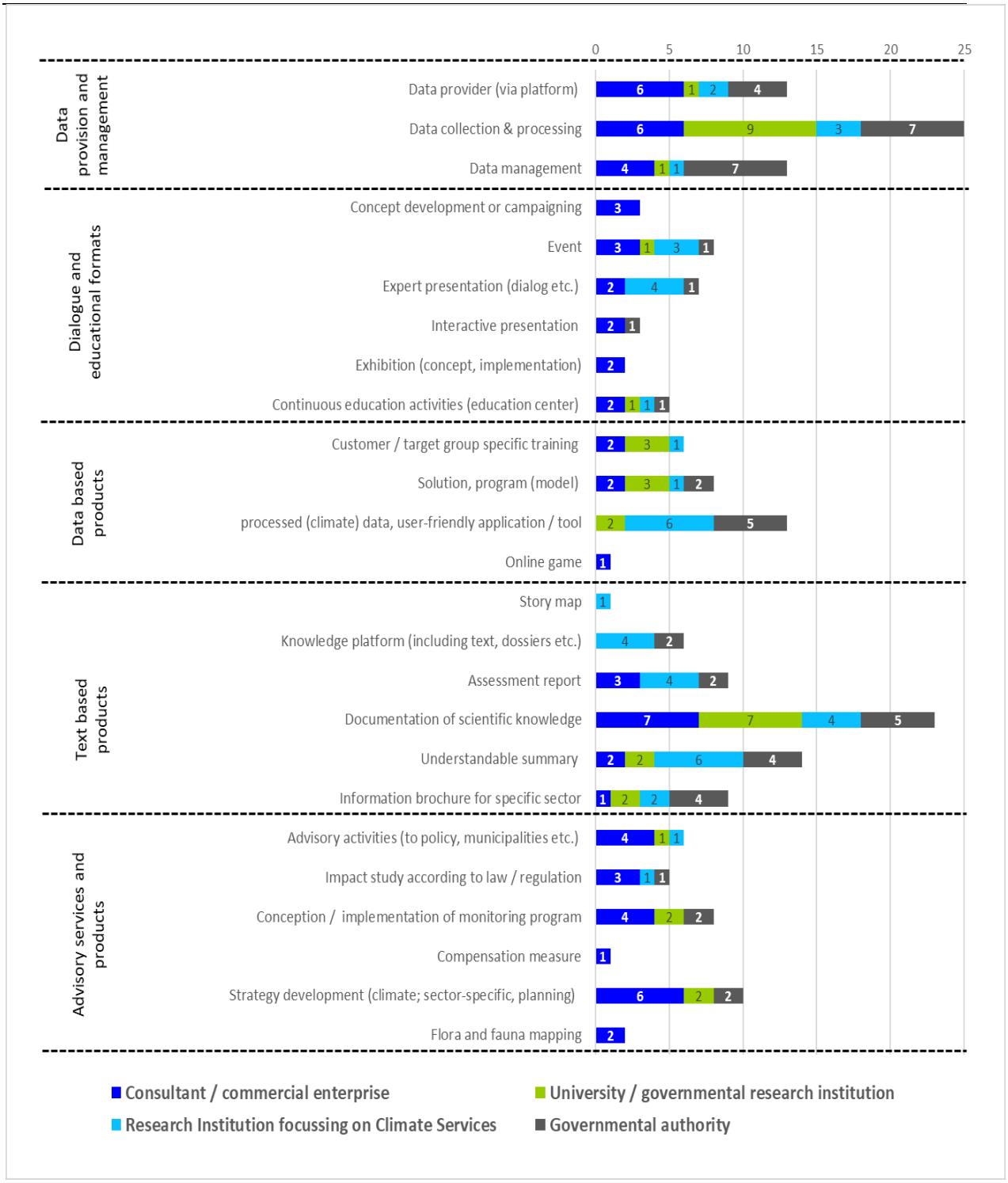

Figure 3 Types of climate services provided by different types of providers

For data services (first and biggest category in quantity), activities from 'universities and governmental research institutions (B)' lead the way

quantitatively for all sub-services. Activities of these providers are low due to '(raw) data provision (via plat form)' and 'data management' but is concentrated to the 'data collection & processing'. Here 'universities and governmental research institutions' are the major type of provider with regard to the used data set. In contrast, research institutions focusing on climate services play a minor role in this cluster of climate service formats. In the category 'data provision and data management' as a whole, provider from the category 'governmental authorities' are particularly strongly represented. Furthermore, in relation to all categories of service types (1-5) it shows: most of the services of the 'governmental authorities' (C) are listed in this category (cf. Figure 3). Many of those data-related services correspond to operational services (meteorological monitoring and extreme weather alertness). These often proceed within a given governmental mandate - as assumed in the initial hypothesis.

With regard to the second type of services addressing 'dialogue and educational formats' (2), the number of services registered for this category is significantly lower than for the other four categories. For all six categories considered here, the climate services are largely provided by the private sector in four of them, and almost exclusively for the two interactive formats. In some sub-categories (concept development or campaigning, exhibitions, compensation measures, flora and fauna mapping) the private providers are the only registered within our dataset.

For the service types 'concept development and campaigning' and 'exhibitions (concepts, implementation)' commercial enterprises are the only providers registered for these services within the used data set (with 3 and 2 mentions; cf. Figure 3). For example, research institutions (and those with a focus on climate services) supply services limited to numerous events (interactive character, green events, workshops) and expert presentations, a few education activities and group

trainings. Governmental authorities appear in a limited extent here. It is important in this context to remember that governmental authorities often represent the recipients / users of their services (even if the institutions that use the services are not the same as those registered as providers here).

Most of the data-based products (third category) examined here come from the provider groups 'research institutions (including research institutions focusing on climate services)' and 'governmental agencies' Formats of the type of 'processed (climate) data, user-friendly applications and tools', 'story maps' and 'online games' are exclusively made available by the Type-B and Type–C providers. The content of these data based products (and tools) is often information about climate change effects on a national and regional (rarely local) level. In this regard, the activities and products hence reflect the missions of the research institutions, particularly the universities and the institutes focusing on climate services, one of which is to provide scientific climate knowledge to support the discussion of socially relevant issues.

The (fourth) category of 'text-based products' represents the second largest (numerous) category of climate services according to our classification. Most of the services in this category and all subcategories are supplied by research institutions with a focus on climate services. They are the major provider except for the expert reports (led by universities, governmental research institutions and the private sector) and the information brochures (mainly done by governmental authorities).

It is interesting to note the high activity of research institutions focusing on climate services in the areas of text-based products and processed data (data based products). This is consistent with their mission, which is to make the knowledge from climate research understandable and usable for a larger audience for answering individual questions and to support societal and decision-making

activities regarding climate variability and change. Events and presentations also seem to be other well–suited tools to fulfil this mission.

'Advisory services and products' (fifth category) are mainly made by private providers (see also Figure 6 in the Annex), and exclusively for compensation measures and flora and fauna mapping. German private providers in particular offer a broad portfolio of services dealing with conceptualising, implementing and monitoring activities according to EU or national laws and regulations. A similar specialization can be found in private businesses that focus on data-related services. These points converge with our earlier assumption that there are more user-specific services offered by the private sector (compared to public institutions), because they get individual demands from their customers.

In the light of the detailed discussion above, we can conclude different emphases in the profiles of the different type of providers. Using the five proposed categories clustering the types of services, the following picture emerges for the different types of providers (aggregated for all five case study sites):

Above all, we see that providers of types B (including B-1 'university / governmental research institution' and B-2 'research institution focusing on climate services') and C ('governmental authority') are quite similar in their portfolio of climate services types. Type-A providers (commercial enterprises), on the other hand, stand out with a noticeably different set-up and focus of provided climate service formats to achieve their mission. Figure 4 provides a visual summary of these set-ups.

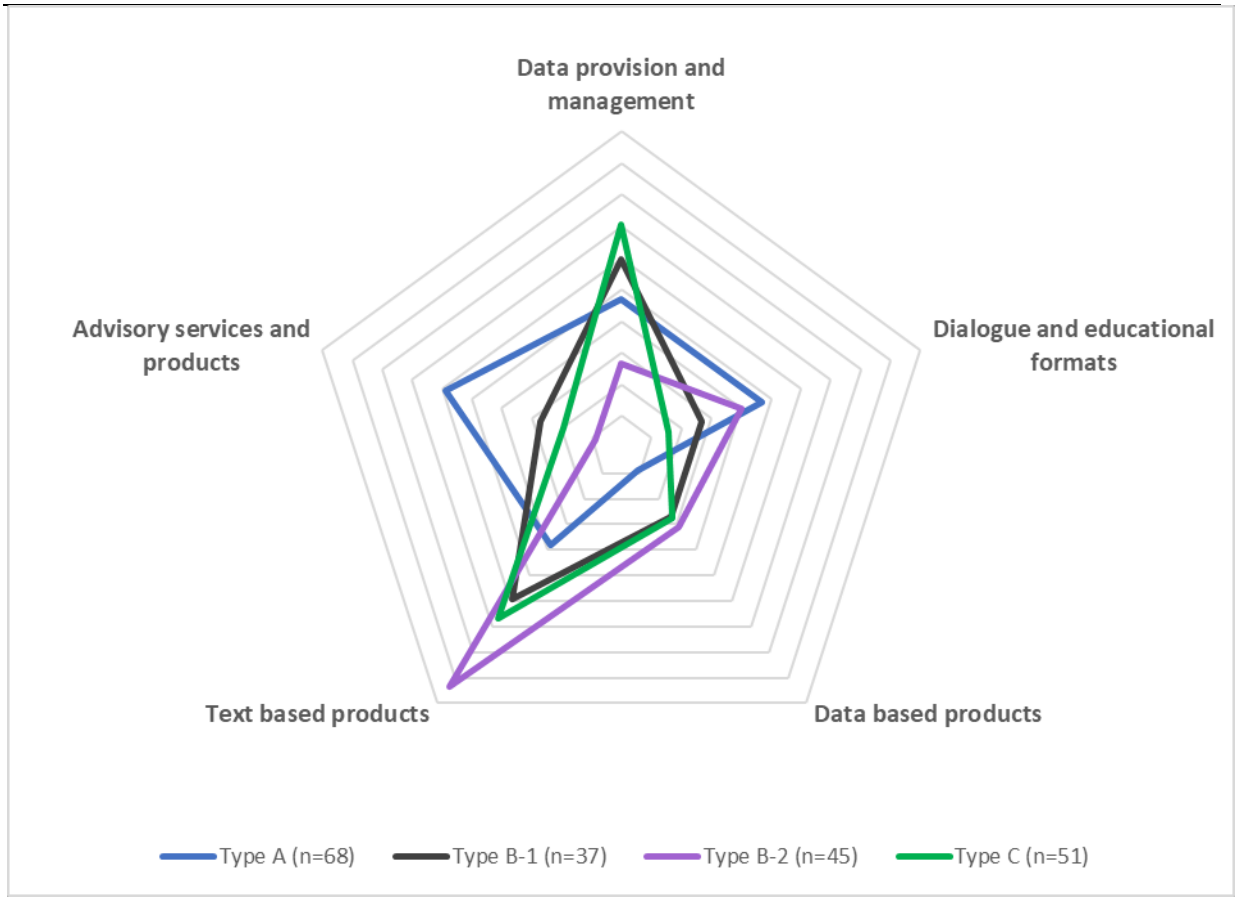

Figure 4 Analysis of the profile / focus of different types of providers, using the five proposed categories clustering the types of services; n refers to the number of services included in the data set for each type of provider. Type A (blue): commercial enterprises (business ventures or corporates), Type B-1(black): universities and governmental research centres, Type B-2 (purple): institutions focusing on climate services, Type C (green): governmental agencies (administration);

Universities and governmental research centres (Type B-1) and governmental agencies (administration) (Type C) show a high level of similarity; according the applied data set main emphasis of both types of providers is in data provision and management (climate service format (1) and text based products (climate service format (4). The number of all other categories of of applied climate service formats is significantly lower for these two types of providers. Dialogue and educational formats (2) are more often used by universities and governmental research centres than by governmental agencies.

The trend within the profile of Type B-2 providers is similar to the previously mentioned, but differs on closer inspection on certain emphasis. The text-based

formats (category 4) clearly predominate the B-2 activities. In addition, mainly 'data based products' and 'dialogue and educational formats' can be found in the portfolios of the Type B-2 provider. 'Advisory services and products' appears in a very small number within the considered data set.

The profile of Type-A providers (commercial enterprises (business ventures or corporates), differ significantly from the others described above; in particular because of the high number of service formats in the category 'advisory services and products'. A similar large offer is registered with regard to activities of commercial enterprises in terms of 'dialogue and educational formats'. In contrast, their activities in the fields of data based (3) and text-based products (4) are significantly lower than for types B-1, B-2 and C.

These profiles emphasize once again distinct differences between providers from the private sector (Type A) on the one hand and on the other hand, providers related (climate) sciences (B) and public administrations.

Content - A glance on the climate service landscape in each case study area

Application of our framework offers the opportunity to elaborate detailed information about existing climate services on the local case study scale (cf. Figure 5). For this evaluation, it has to be noted that the number of services considered in this inventory differ significantly for the different case studies. The number is higher in the German and French case study than in the case study of the Netherlands and Norway. This is mainly due to the conditions under which the CKH has emerged, already mentioned above. For this reason, the amount of service do not initially indicate anything about the climate service landscape in the respective areas. For the analysis of the existing climate services landscape on the

local case study scale, the question of how information is contextualized is an important consideration for CoCliServ, since the project explicitly investigate the role and benefit of place-paced, local climate services. The objective of contextualization is particularly addressed by the component 'Content/Data' within the analytical framework. By asking for the local contextualization, we understand the question about if and how classification of observation data and scenario projections takes place in local 'contexts' already. Contextualization is about how far connections have been made between observations and projections (data) and the current debates, local demands and local needs in the case study region. These relationships influence the content, meaning and validity of the information provided from climate sciences.

For CoCliServ so far, we (WP3) do not know which explicit topics, current debates and narratives are or will be relevant in the individual regions. It is therefore difficult for us to assess whether and to what extent the information presented is integrated into the current debates on the ground. In the first step, we make use of the review on scientific knowledge of climate change in the case study areas, collected in the Milestone 3-1. Thus, we mainly refer our statement on contextualization on the aspect of spatial resolution. An in-depth assessment of local contextualization is likely to be possible only in close collaboration with the case study leaders (who are the local experts).

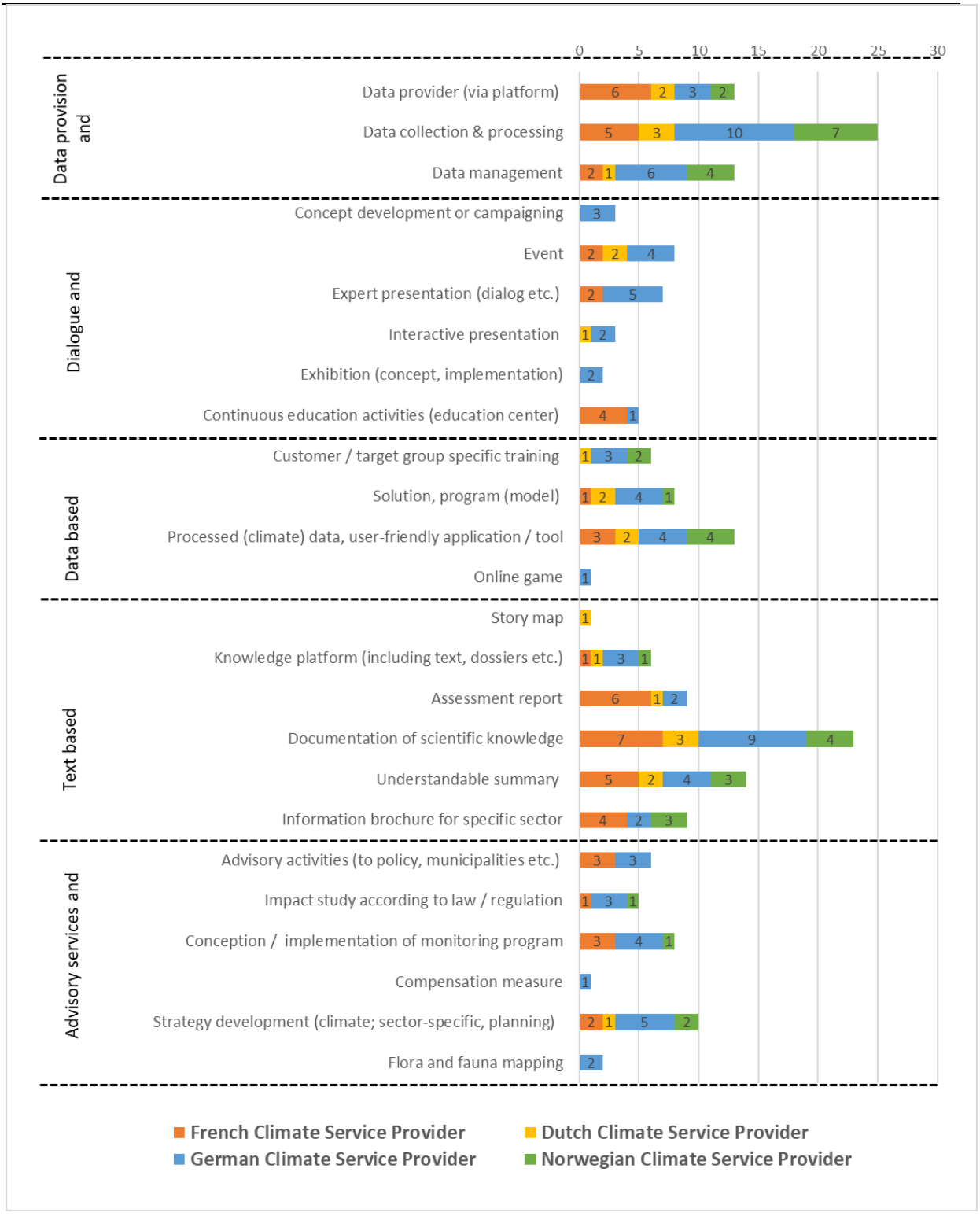

Figure 5 Types of climate Services available in each case study (due to applied data set)

Gulf of Morbihan and Brest (Brittany)

For Brittany (France), all three types of providers are represented. The highest number of individual providers exists for 'consultant / commercial enterprise' (A). Content wise, however, Météo-France (type of provider: 'governmental authority') and IPSL (type of provider: 'University / governmental research institution') are the two most important providers, providing plenty of data and research media, involving ample content at local spatial scale. 'Data based products' (climate service type (3)) and 'text based products' (climate service type (4)) are well represented.

As mentioned above, the spatial resolution of the information provided by the climate services provide an important part of the contextualization that we are currently able to assess. Within the French case study, climate information included in the climate services investigated here, ranges from very coarse (160 km to 50 km) to high resolution (25 km to 8 km) and most studies examine the 20th and 21th centuries. Major variables and derived parameters that are investigated in these services include for instance the temperature, rainfall, droughts and flooding. Two providers, namely the 'Brittany Environment Scientific Council' and the 'Scientific Council of Environment in Morbihan', already provide (regional) climate information for the particular study areas considered in CoCliServ. In this context, several activities specifically focus on the regional impact of extreme events (e.g. effect of droughts on soil water variability for agriculture) and coastal risks induced by extreme storm events are considered.

In the French case study, we identified significantly more services tied to project duration in contrast to the others where most of the services are characterized as long-term activities. Project activities are limited in time, money and work force by research projects. In these cases, the service resulting from projects always appears in the form of scientific (assessment) reports (which are part of the

climate service format type (4): 'text-based products') (cf. Figure 5 and Figure 9 Annex).

Dordrecht

For the Dordrecht case study, climate service providers present in the area belong to the category B: 'research institutions' whereby both types 'universities and governmental research centers' and 'research institutions focusing on climate services' are represented) and C: 'governmental authority'. Two providers provide a considerable amount of the climate services that are analyzed more in detail here: the Climate Adaptation Services (CAS, type of provider: 'Research Institution focussing on Climate Services') and the Netherlands Meteorological Institute (KNMI, type of provider: 'governmental authority'). They focus on data and text based products (service types (3) and (4)), whereas formats in terms of dialogue and educational formats' (service type (2)) are rare according to CKH (cf. Figure 5 and Figure 10 Annex).

With regard to the level of contextualization of climate information in the areas under investigation in CoCliServ, there is extensive climate information on national and regional scale available. Climate variables such as temperature, precipitation, wind, sea level, and river discharge are well-studied variables in both past and future. Water management (coastal and inland) is a major facet addressed on the national, regional and local level. This information is predominantly provided in the form of web applications (that belong to the group of 'data based products' (3)) and text-based services (representing the type of format group (4)) that are provided particularly from public provider (non-profit organisation and governmental authorities). These services are often long-term services, maintained continuously.

In addition, local investigations for the Rijnmond-Drechtsteden Region (including Dordrecht) have been initiated already, focusing on impact and problem analysis in the area. This information is available as 'text-based product'.

Bergen

Climate services investigated for the Norwegian case study are provided by a mix of providers, and include in a descending order: 'universities and governmental research centers' (provider type B 'research institutions'), 'governmental authorities' (provider type C) and 'research institutions focusing on climate services' are represented (part of provider type B 'research institutions'). The Norwegian Climate Service Center (KSS; type of provider: 'research Institution focussing on Climate Services') plays an important role as provider, in particular for climate change information on the national level.

The inventory on climate services for the Norwegian case study showed a concentration of information provision on the national and partly on the regional level. Local contextualisation, many in terms of downscaling activities of climate information to the local scale and related climate service products processing this information for a local discourse, is scarce. Downscaling is commonly used to obtain results with a spatial resolution of 25-50km.

With regard to the question how currently available information on climate change (in this case, at national and regional level) is processed and communicated, the inventory highlights the use of predominantly data and text-based products (climate service types 3 & 4) in the current Norwegian landscape (cf. Figure 5and Figure 12 Annex). Most of these national and regional services consider climate changes in the 20th and 21th centuries, by addressing the inter alia the parameter of temperature, precipitation, wind speed. A lower proportion of the climate services under investigation here, focus on the future impact of changes and extremes on sectors of the society in Norway.

Jade Bay

Climate services are available in the extended area of investigation for the Jade Bay region covering the whole spectrum of different types (from 'data provision and management' to 'advisory services and products') but are concentrated on 'data based products' and 'text based products'. Major providers of climate services, included in the inventory for the Jade Bay region, include the Northern German Coastal and Climate Office (Helmholtz-Zentrum Geesthacht, type of provider: 'Research Institution focussing on Climate Services'), the Alfred-Wegener-Institut (AWI; type of provider: 'University / governmental research institution') and the Climate Service Center Germany (GERICS, HZG; type of provider: 'Research Institution focussing on Climate Services').

According to the spatial resolution of climate information in the Jade Bay Region, our data set provides the following insight: comprehensive climate information is available at the regional level (50 km down to 20 km). Mainly 'text based climate service formats' and operational web tools and programs (models) (part of 'data based products') contribute to a comprehensive study of climate variables (temperature, precipitation, wind) and derived parameters (drought periods, heavy rainfall days etc.) in the past and projected in the future for this area (cf. Figure 5 and for more details Figure 11 Annex). Impact analyses for different sectors (e.g. agriculture, tourism, inland and coastal waters, coastal protection) are also emerging from regional research projects.

As Figure 1 showed already, many providers in the area under investigation are 'consultants / commercial enterprises'. At the local level, these providers provide services in the area of strategy development in terms of climate change mitigation strategies for the municipalities Friesland or Wesermarsch for example.

Conclusion & Outlook

For the CoCliServ case studies, the inventory presented provides an overview of already existing climate services and providers; this information is essential to start more detailed investigations and stakeholder discussions in the case study areas. The presented inventory of climate services (and their providers) for the CoCliServ case study areas underlines the broad variety of climate services available. The proposed categorization of climate service providers and formats enables us to show the relationship between the (different) missions of providers and the related offered range of climate service formats.

Moreover, we find that the diversity in types and formats of climate services relates closely to the equally diverse span in understandings and rationales of climate services. The latter differ widely for instance between providers from private businesses (looking for viability through profit and user interest) and from public providers (whose mission is to provide information to citizens on climate change and its impacts). The extensive range of climate services, expanding from activities such as the provision of processed data and products (e.g. climate indexes, variables or climate change impacts), up to advisory or education (group training or participatory capacity building processes).

We can conclude that the different missions and the different understandings and rationales of climate services are decisive components that need to be considered for further CoCliServ activities. Embedding these empirical findings in the multi-faceted conceptual discussion about climate services mentioned in the introduction, we conclude for the CoCliServ cases study regions that climate services stand within a span from customised climate-related formats (including economic value for the provider), a mandatory service of science to the society.

Based on the presented inventory we can concretize our own understanding of climate services insofar as that from our perspective provision of climate services should be guided by the aim of enhancing the understanding of climate effects in a *long-term perspective* (cf. also Vaughan 2014). Climate services can open up perspectives and provide options to deal with climate-related development and impacts (including future climate change) – however, in order to achieve these aims local contextualisation of climate services seems to be crucial here. Connections have to be made between observations and projections (data) and the current debates, local demands and local needs in the case study regions Hence, we should understand climate services as user-driven[13] processes focusing on the use, need and delivery of usable information / services (cf. Göransson & Rummkainen 2014; Lemos et al. 2012; McNie 2007). In this regard, it was a major aim of this deliverable to provide starting points for conceptual and methodological discussion on co-developing local climate services.

More detailed recommendations (specific to each case study region) can only be given in further activities depending especially on the needs from narratives and scenarios for each case study. The framework presented here has indeed turned out to be a helpful, analytical tool. On this basis, it is possible in the upcoming activities in WP 3 (Del 3-2 & Del 3-3) to question whether and how these services are applied, and what needs for improvement or need for other services exist in each region. However, in order to be able to work out clearer and more detailed answers for each cases study area, we see the urgent need to focus the work of the case studies on a specific topic or research questions that are more specific. At this point, we (WP3) are looking forward to more detailed insights from (WP1)

[13] This user-driven perspective is consistent with the overall ERA4CS framework, which "consider Climate Services as the user-driven development, translation and transfer of climate knowledge to researchers and decision-makers in policy and business. This includes knowledge for understanding the climate, climate change and its impacts, as well as guidance in the use of climate knowledge." (http://www.jpi-climate.eu/ERA4CS)

and activities in terms of local narratives (WP1) and scenario activities (WP2), in terms of identifying the contexts in which a discussion on climate change and climate change adaptation should be established at the local level. In order to recognize possible gaps in the offer of the current Climate Services (Del 3-3), the contact with the local population (or the local stakeholders) is decisive. Without this contact, we will not be able to know if the gaps we see in the inventory are relevant to the societal demands in the test regions.

In addition, refinement of the inventory is largely possible and WP3 stays at the service of the other CoCliServ work packages for diving into more relevant and in-depth information. Said information could be needed for the case study sites regarding specific national climate services or climate studies (local scale knowledge or information) as well as private or European available climate services. Furthermore, a frequent and diagonal exchange between all work packages seems decisive to accomplish a co-development process inside CoCliServ and thus a better level of success for the project as a whole.

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Annex

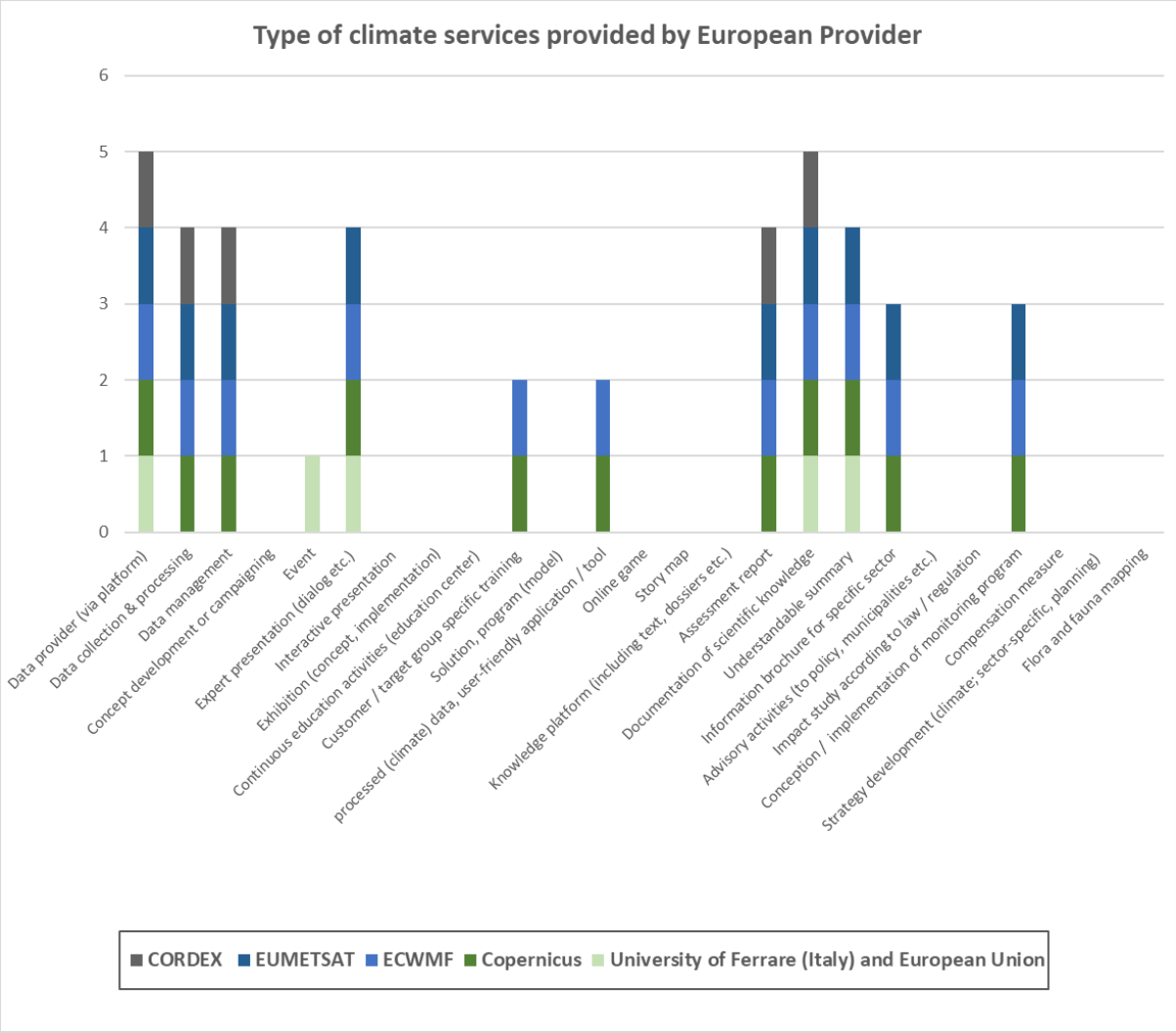

Figure 6 Types of climate services provided by European institutions

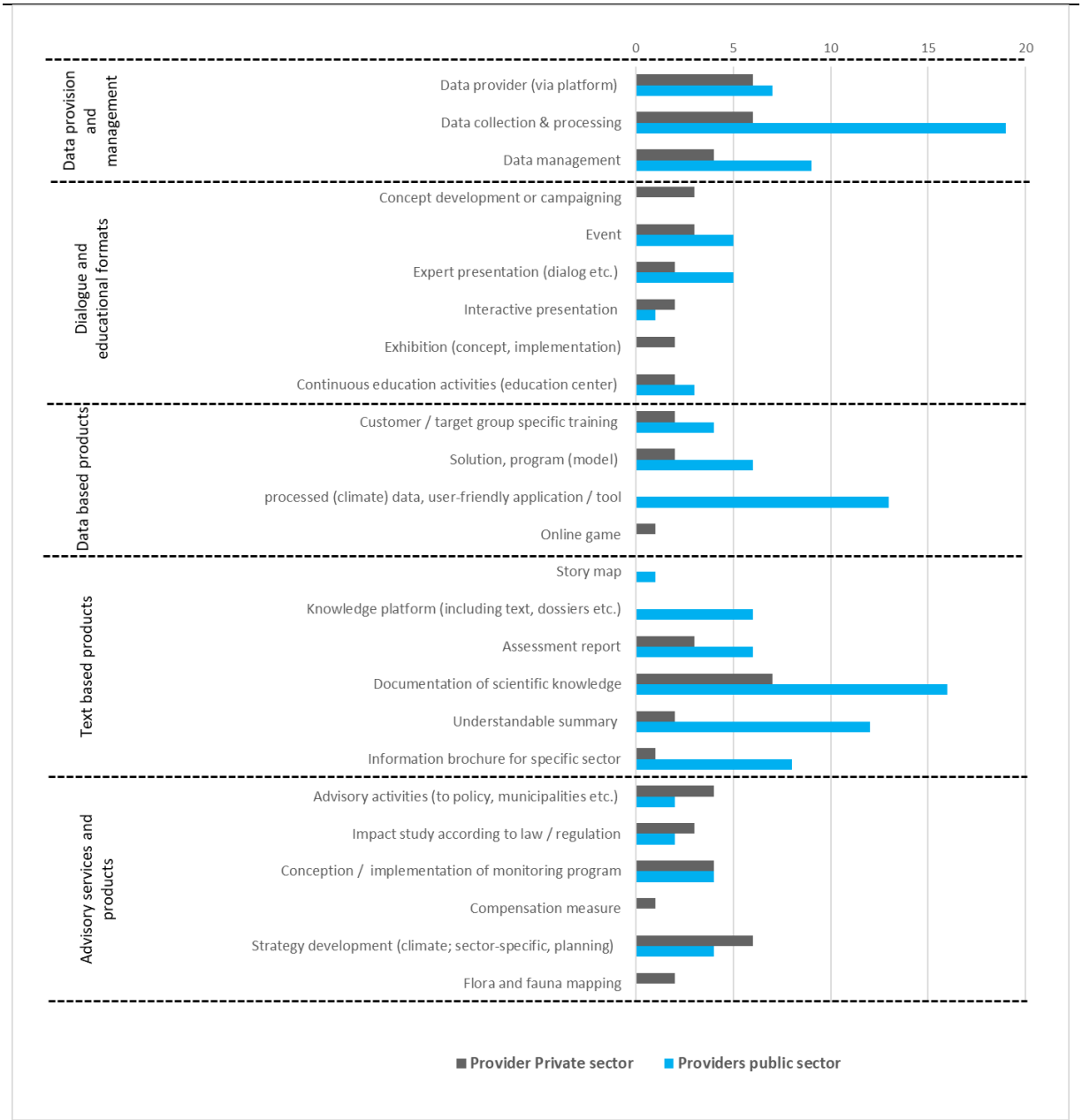

Figure 7 Types of climate services provided by sector.

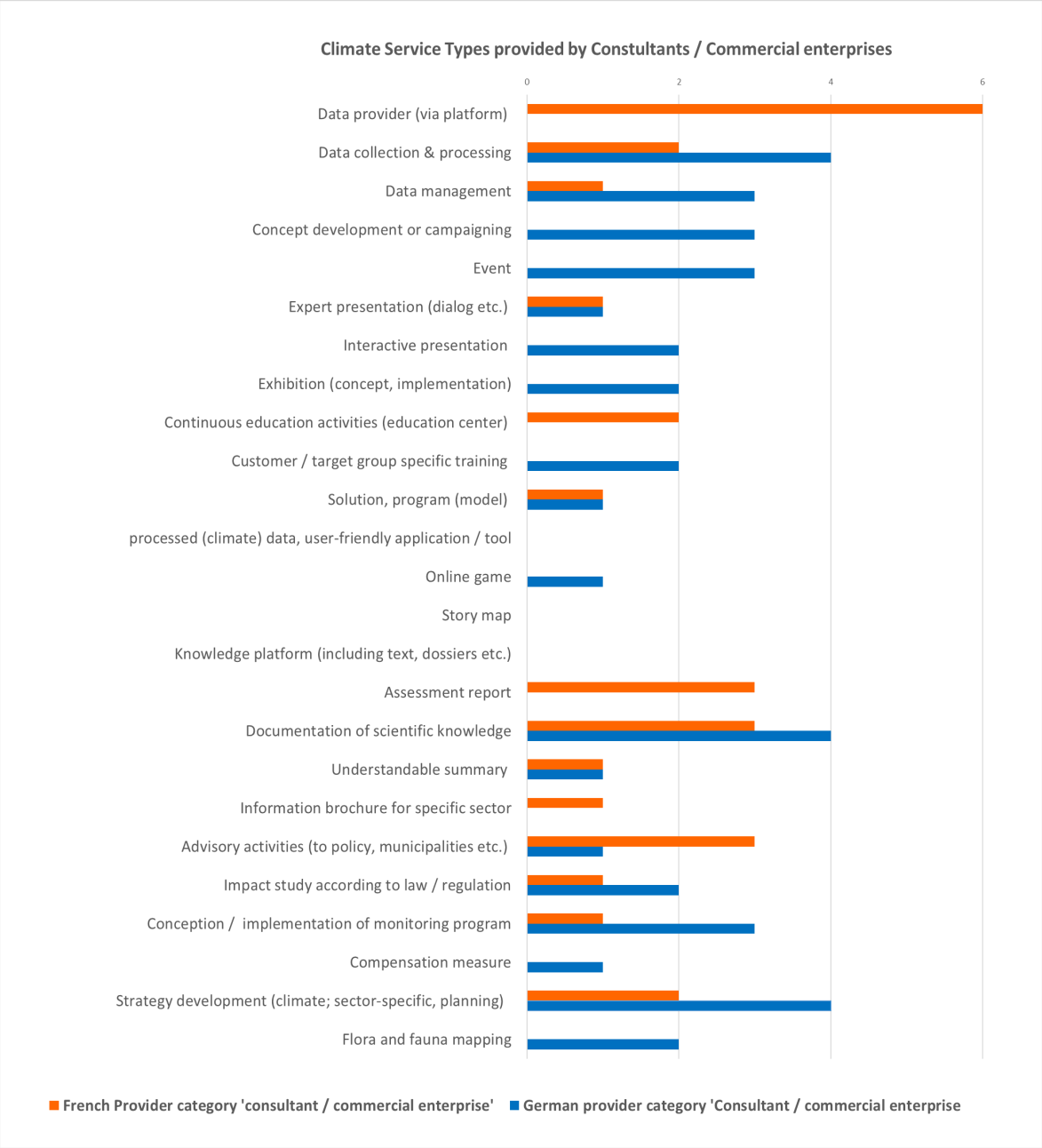

Figure 8 Types of climate services provided by providers from the category 'consultant / private businesses' presented for French (left diagram) and German providers

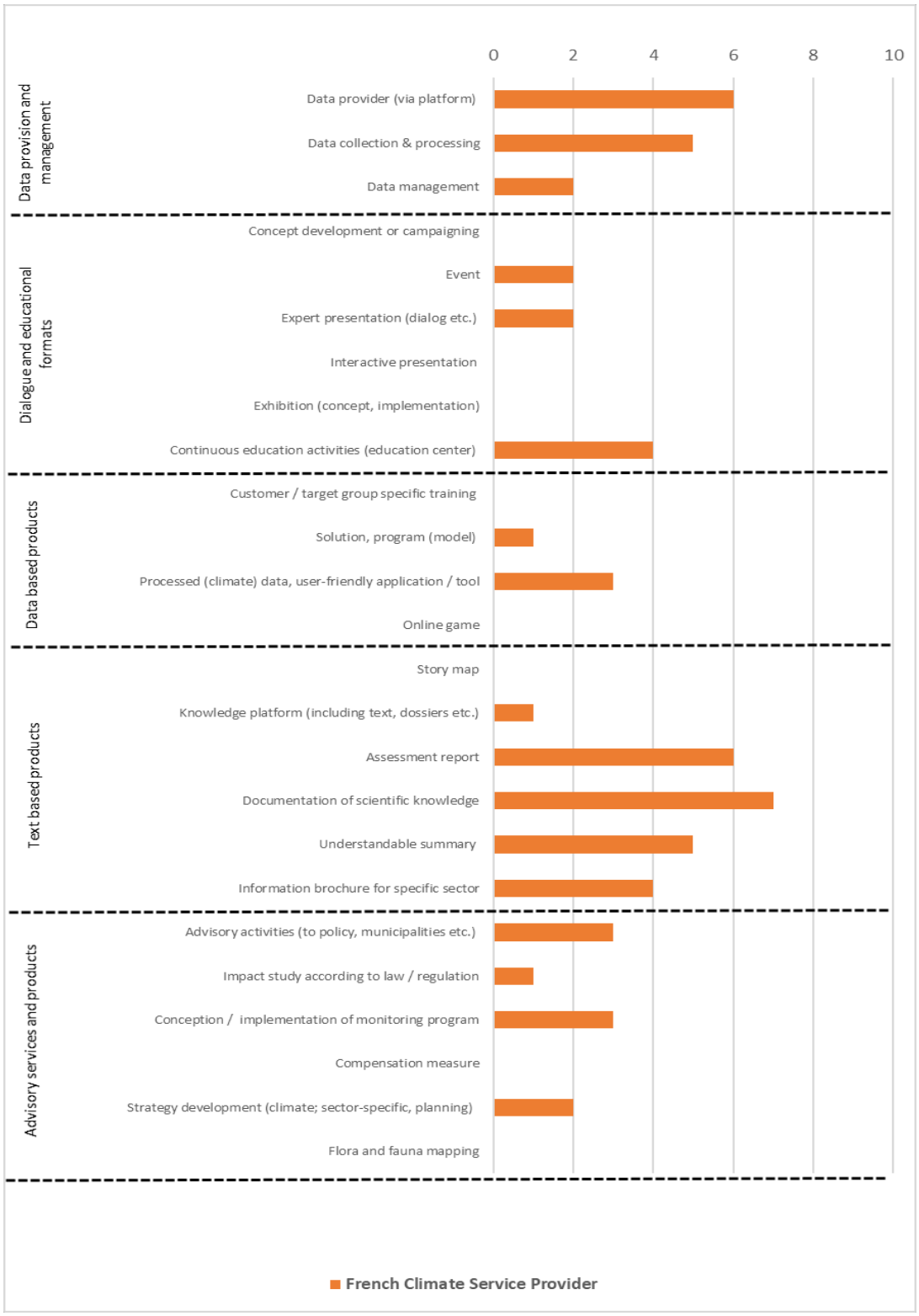

Figure 9 Overview about the type climate services data set analysed for the French case study sites (Gulf of Morbihan and Brest)

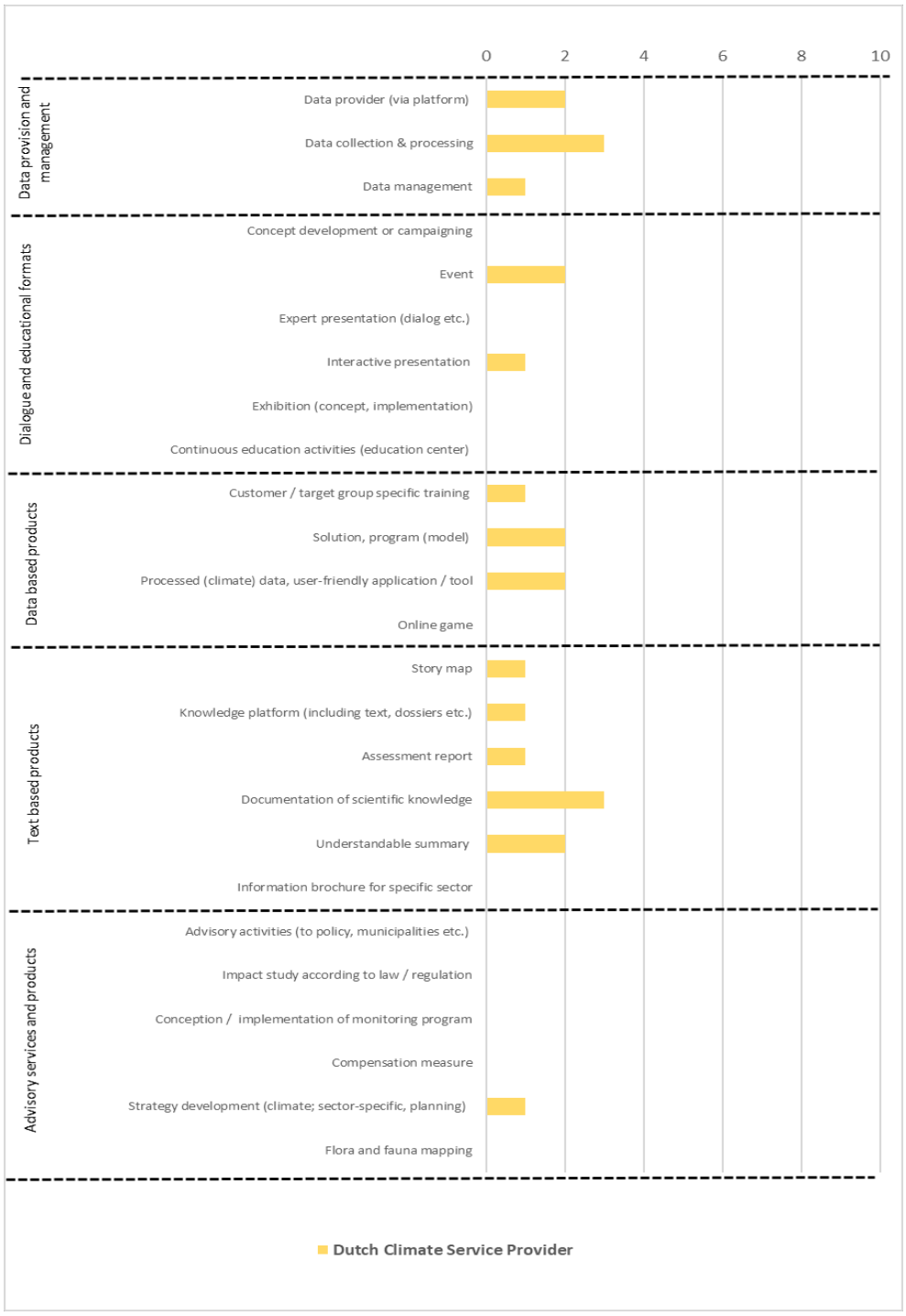

Figure 10 Overview about the type climate services data set analysed for the Dutch case study site

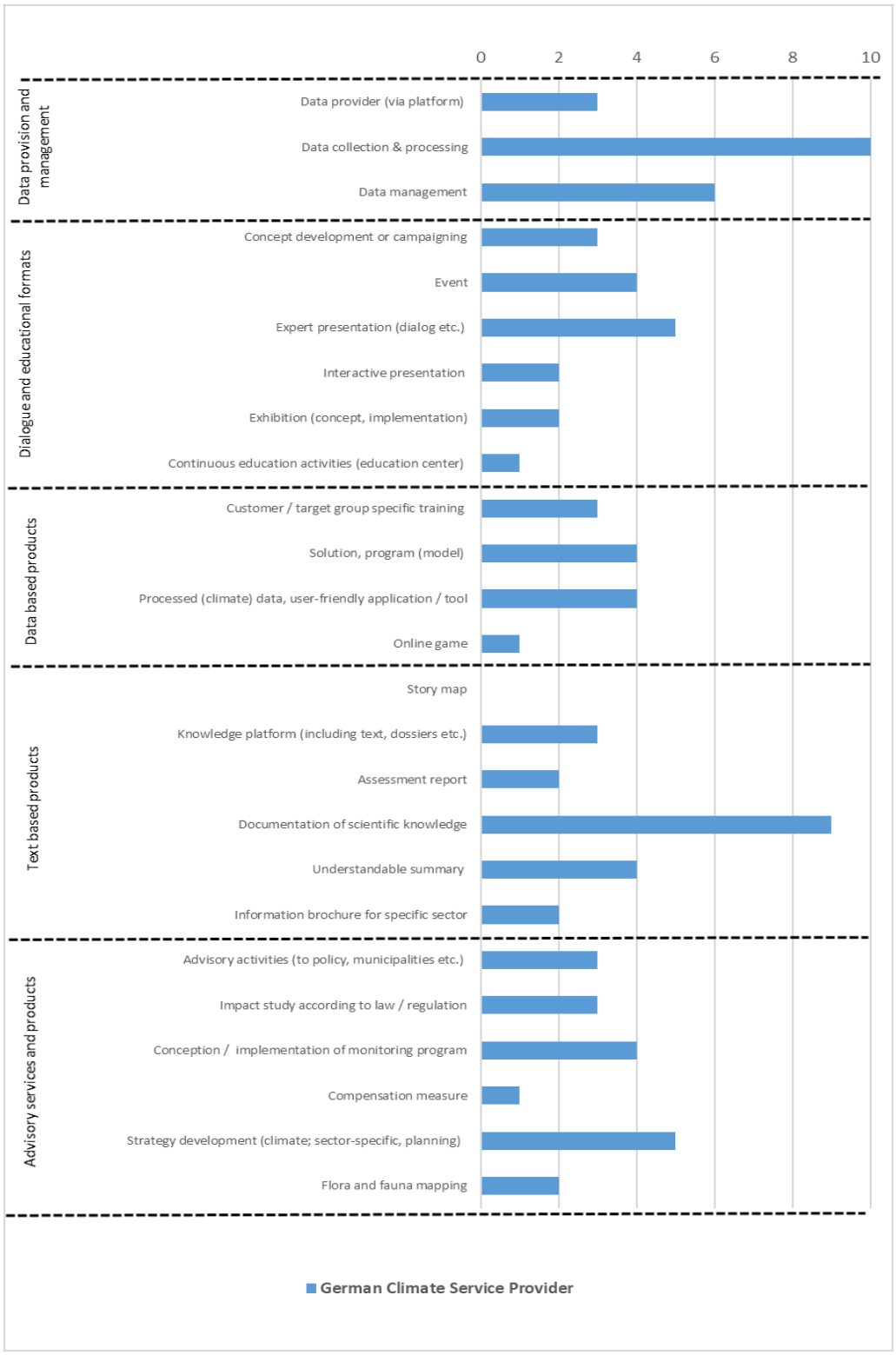

Figure 11 Overview about the type climate services data set analysed for the German case study site

Figure 12 Overview about the type climate services data set analysed for the Norwegian case study site