Climateurope2

Business innovation for transformative and sustainable societies; recommendations and guidance

Deliverable 3.4

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About Climateurope2

Timely delivery and effective use of climate information is fundamental for a green recovery and a resilient, climate neutral Europe, in response to climate change and variability. Climate services address this through the provision of climate information for use in decision-making to manage risks and realize opportunities.

The market and needs for climate information has seen impressive progress in recent years and is expected to grow in the foreseeable future. However, the communities involved in the development and provision of climate services are often unaware of each other and lack interdisciplinary and trans-disciplinary knowledge. In addition, quality assurance, relevant standards, and other forms of assurance (such as guidelines, and good practices) for climate services are lagging behind. These are needed to ensure the saliency, credibility, legitimacy, and authoritativeness of climate services, and build two-way trust between supply and demand.

Climateurope2 aims to develop future equitable and quality-assured climate services to all sectors of society by:

- Developing standardization procedures for climate services
- Supporting an equitable European climate services community
- Enhancing the uptake of quality-assured climate services to support adaptation and mitigation to climate change and variability

The project will identify the support and standardization needs of climate services, including criteria for certification and labelling, as well as the user-driven criteria needed to support climate action. This information will be used to propose a taxonomy of climate services, suggest community-based good practices and guidelines, and propose standards where possible. A large variety of activities to support the communities involved in European climate services will also be organized.

Executive Summary

As the market of climate services (CS) is broad and diverse, the business models used and applied reflect a wide range of approaches and products. In this report, the so-called Business Model Canvas (BMC) was used to assess different types of climate services from private as well as from public providers with special emphasis on innovation and aspects contributing to transformational adaptation. The BMC is a common framework for the design and implementation for business models. More than 40 interviews with providers of climate services in the form of semi-structured business talks were conducted by different task members. A strong emphasis was on providers from the private sector (about 2/3 of the interviews), thus on business approaches of climate services that have to have a positive balance between revenue and costs. The outcome of the interviews was analysed using a text analysis software following a standardised set of codes and criteria based on the BMC model.

Beside the broad range of CS products and sectors covered in this study, the results showed also some commonalities. Regardless of whether the climate services are offered by a public or private provider, the interaction with users or customers plays a key role in order to run a successful business and to implement climate adaptation measures and support societal transformation. Although the intensity of interaction with users differs, almost all providers underlined the importance of providing tailored products which are understandable and usable. Thus, close interaction with the users, training and feedback are essential components for a successful operating CS.

Furthermore, reliable data sources and model output based on actual scientific knowledge are a sound basis for CS providers and a backbone for a successful CS. Many providers are using publicly available datasets / model output as the development of complex models or comprehensive data sets is cumbersome and expensive. Based on these reliable datasets, analysis tools and products are developed as part of the climate services.

For a successful business, costs must be balanced out by the revenue either by selling products, licensing, subscriptions or through project or institutional funding. The major cost factors for private or public providers are similar: personnel and operational costs (computing and R&D) dominate whereas the revenue streams differ. As project or institutional funding streams dominate in the public sector whereas licensing, subscriptions and usage fees are the major revenue streams of private companies.

With respect to innovation, currently new ideas and developments take place in the areas of AI-based methods, machine learning or digital twins.

The capability of CSs to be successful in the area of transformational adaptation towards a climate resident society requires additional skills such as appropriate scope, long-term perspectives, innovative pathways, and appropriate governance and communication structures to achieve an adequate impact. Here, the CSs investigated in this study demonstrate skills in various areas but also show the need for readjustment and refocusing to better fulfil the specific needs. Due to the diverse user audience, tasks and challenges, there is clearly no “on size fits all” approach for a route to successful transformational climate adaptation. Both private as well as public climate services can successfully support this task with a variety of approaches and products.

Finally, a set of recommendations how to improve the capability of business models for CS to support transformational adaptation processes is provided along the four components of CS defined by Climateurope2 (Decision context, Ecosystem of actors, Knowledge systems and Delivery mode and evaluation).

Keywords

Business innovation for climate services, business model canvas, transformative adaptation approaches

1. Introduction

The climate services market is highly diverse and fragmented, providing a broad range of products on various quality levels to a heterogenous user group addressing many different sectors. Regardless of whether funded by public or private sources a successful climate service needs a well-defined business model. This addresses all elements of a climate service as defined by Climateurope2 (CE2): the decision context, the ecosystem of actors, the knowledge system and the delivery mode (Doblas-Reyes et al. 2024) Within the Work Package 3 "Business Innovation" of CE2, Task 3.2 explores how business models for climate services are designed, enacted and used to unleash benefits and values along the decision-making process. The task will link value management and business model innovation through the configuration approach to make explicit how tangible and intangible resources contribute to the most appropriate business models for climate services.

In the Deliverable 3.2 of this task an analysis of various business model frameworks applicable to climate services was performed. Furthermore, an extensive literature review of the penetration of sustainable business model innovation was conducted which has shown mixed results. Despite significant progress in the field of climate services, there are still a limited number of studies reporting on the business strategies, patterns, and innovative mechanisms of CS that ensure their long-term viability and their provision. Finally, specific practices of climate service providers were investigated by an in-depth analysis of a series of climate services or initiatives aimed at developing these services. Key beliefs and practices essential for developing and launching these services were identified. Market evaluation and interaction are crucial to understand user needs and ensure that products address the diverse market segments effectively. In particular for private services cost-effectiveness is key, closely related with the customer willingness to pay. With respect to commercialization success hinges on expertise that spans beyond mere product development. For products that fulfil critical societal functions but are commercially not viable, publicly funded climate services play an important role.

Amongst the various business models for climate services the widely used Business Model Canvas (BMC) (Osterwalder et al., 2010) was used as a basis for the analysis of a broad variety of climate services. For this deliverable (D3.4), a different method, the so-called Five Forces Analysis was originally proposed to perform a detailed analysis of the business model of both successful and poorly adopted climate services ('honourable attempts') to review the success factors and main business bottlenecks.

There are different reasons behind the rationale to choose BMC over Five Forces Analysis proposed by Porter. First of all, although both frameworks are valuable tools for strategic analysis, they diverge in focus: meanwhile the Porter's model analyses industry competition and external threats (Porter, 1980), the BMC offers a holistic and visual overview of how a specific business creates, delivers, and captures value (Osterwalder et al., 2010) along a framework composed by 9 elements (Burmeister et al., 2015). Secondly, the BMC is often preferred in the early stages of development (Umar et al., 2018) because it is more practical, intuitive, and oriented toward designing and refining innovative business ideas (Carter and Carter, 2020). This makes it particularly suitable for climate services, which frequently involve emerging or hybrid markets, co-designed solutions with stakeholders, and a strong emphasis on societal value (Vaughan & Dessai, 2014)—conditions under which traditional competitive frameworks, like Porter's, are less adaptable (Kupczyk et al., 2024).

In consideration of the pros and cons of the two methods (BMC and Five Forces), we decided then to continue to use the BMC also for this deliverable. For the final deliverable of this work package the BMC will also be used as a framework for analysis to build a taxonomy of business models for climate services across multiple sectors.

1.1 Business innovation of CS: Towards transformational adaptation

The concept of transformational adaptation (TA): The term "transformation" is in general related to "fundamental change in society as opposed to change that is minor, marginal or incremental" (IPCC, 2022). These changes might occur without explicit intent (i.e. forced, for example the societal changes induced by the industrial revolution) or deliberately (i.e. envisioned and intended). In the context of Climateurope2 and in line with the understanding described in the IPCC 6th Assessment Report, transformation is understood as "*a solutions-oriented concept, which aims to inform or contribute to societal change*" (IPCC, 2022). With that, the focus is on deliberate transformation as a potential solution. The IPCC 6th Assessment Report promotes the concept of "Climate Resilient Development", which combines strategies to adapt to climate change with actions to reduce greenhouse gas emissions with the final aim to support sustainable development for everyone. Climate Services (CS) are in this context of special value for climate adaptation, as stressed for example in the EU Adaptation Strategy (EU, 2021) ("*We need to push the frontiers of adaptation knowledge, and acquire more and better climate-related data*") or by the Adaptation Community (https://www.adaptationcommunity.net/climate-services/) ("*Without knowing the expected changes in climatic conditions, proactive and anticipatory adaptation approaches are difficult.*"). Considering CS as an enabler for adaptation, it has to be noted that there are limits to adaptation. IPCC (2022) defines these as "*the point at which an actor's objectives (or system needs) cannot be secured from intolerable risks through adaptive actions*" (IPCC, 2022). These limits can either be soft ("*when options may exist but are currently not available to avoid intolerable risks*", IPCC, 2022) or hard ("*when no adaptive actions are possible to avoid intolerable risks*", IPCC, 2022). Thereby, "*soft limits are usually associated with human systems whereas hard limits are more proximate for natural systems due to inability to adapt to biophysical changes*" (IPCC, 2022). An example for a soft limit could be financial constraints, while a hard limit may arise e.g. if the critical water temperature for coral survival is exceeded. Adaptation limits are specific to (local) social, ecological, technological and climatic elements and their interdependencies, and they are dynamic in time, space and context.

If systems reach their adaptation limits, stakeholders may implement incremental or transformational adaptation measures to tackle the intolerable risks. Incremental adaptation "*maintains the essence and integrity of a system or process at a given scale*" (IPCC, 2022), while transformational adaptation "*changes the fundamental attributes of a socio-ecological system*" (IPCC, 2022). Fedele et al. (2019) describe transformational adaptation as referring to "*changes that fundamentally alter the entire system's ecological and/or social properties and functions. It aims to reduce the root causes of vulnerabilities to climate change, such as social, cultural, economic, environmental, and power relations, by transforming them into more just, sustainable, or resilient states*". Measures e.g. like building higher flood dams or house elevation constitute incremental adaptation actions, as they accommodate change but preserve the existing system. In contrast, relocating houses to safer areas or restoring wetlands upstream, are transformative adaptation actions, as they react to change altering the characteristics of the social-ecological system and

reduce vulnerabilities. If tolerable risks cannot be avoided through incremental adaptation, "*transformational adaptation may be able to extend the potential to sustain human and natural systems*" (IPCC, 2022). Thus, "*transformational adaptation can allow a system to extend beyond its soft limits and prevent soft limits from becoming hard limits.*" (IPCC, 2022). According to Cools et al. (2024), "*the goal of transformational adaptation is to create societal and economic systems that are resilient and flexible enough to adapt to future uncertainties by addressing what makes the EU particularly vulnerable to current and future climate impacts. By adopting proactive strategies that adapt to future conditions, transformational adaptation ensures long-term sustainability and reduces future risks.*"

Distinguishing transformational from incremental adaptation: To distinguish transformational from incremental adaptation, several authors define criteria (e.g. Filho et al., 2022; Fedele et al., 2019). Cools et al. (2024) take up and expand these criteria defining five categories that describe TA, each containing several criteria (Table 1).

Table 1: Five categories of characteristics which determine transformational adaptation (Source: based on Cools et al., 2024)

Category	Characteristic
Scope	**System-wide** (affects "an entire system", e.g. a geographical area, an ecosystem, a community)
	Multi-scale (has an "impact across multiple scales or multiple beneficiaries")
	Scalable ("has the potential to replicate the adaptation")
Depth	**Path-shifting** ("the system's current trajectory is altered towards a new direction")
	Restructuring ("existing structures, processes, or relationships (the way things are done) are fundamentally altered")
	Innovative ("the system changes to a state which previously did not exist in that area, without necessarily requiring entirely new means or actions. Innovation can be achieved in various aspects ranging from new technology, a changed mindset or organisational approach")
	Addressing root causes (e.g. by "allowing rivers to overflow and shape their courses naturally" instead of "relying on engineered dykes and levees to prevent flooding")
Impacts	**Beliefs and attitudes** ("requires a change in mindsets or beliefs, among the public and policymakers towards accepting risks and undergoing disruptions of the status quo")
	Governance (e.g. "a substitution of top-down decision-making with the involvement and interaction between various stakeholders with different views")
Temporality	**Persistent** ("with long-term impacts, no intention to return to the prior state")
	Long-term vision ("acknowledges future uncertainties in both climate impacts and the potential implications of the change")
	Future benefits ("should generate benefits over time, rather than only targeting current needs")
	Dynamic ("implying flexibility to adapt to evolving climate risks and to learn from past experiences")
Inclusivity	**Equitable** ("should benefit all groups of the population, and thus follow the ´leave no one behind´ principle")

Category	Characteristic
	Synergetic ("delivering other benefits than adaptation")
	SDG-aligned ("address other Sustainable Development Goals in addition to climate action")

Barriers to transformational adaptation: Designing and implementing TA is consequently more challenging compared to incremental adaptation actions, as the deep changes to the socio-ecological systems require effort in many dimensions (see Table 1). From this, considerable barriers to transformational adaptation arise. According to Cools et al. (2024), TA requires 1) the involvement of various actors and balancing of their different interests, 2) the allocation of human, financial and time resources and 3) the presence of a "*far-reaching vision in an unpredictable world.*"

Climate services and transformational adaptation: Well-designed climate services can help to overcome the barriers mentioned above, e.g. by providing data that supports the creation of a common vision of the involved actors and helps them to balance interests and allocated resources. With that, climate services can address the "gap between climate change knowledge and meaningful action" (Cools et al., 2024). CS can help to plan and implement both incremental and transformational adaptation measures and are indispensable especially for deliberate transformational adaptation. If CSs match the characteristics given in Table 1 above, they are of special value in supporting transformational adaptation. CSs support the scope of the TA strategy by covering the complete system under consideration and deliver on multiple scales (e.g. spatial, jurisdictional, or sectoral scales). They support deep transformation by e.g. supporting the impact assessment for new, innovative approaches. They can help to increase the impacts of TA e.g. by supporting a data-driven change in belief and attitudes. Concerning the temporality, CS are indispensable for shaping scientifically sound long-term visions including broaching and explaining uncertainty and for convincing actors on the future benefits of the strategy. Inclusivity of TA can be supported by CS through delivering un-biased and objective data and analyses.

Related to this study, the focus is primarily on assessing the structure of business models for CSs with special emphasis on innovation and aspects contributing to transformational adaptation as outlined above. Building on the outcome of Deliverable 3.2 for this study a series of interviews with providers of climate services have been conducted to achieve in-depth insides in the business model of their climate services, innovative methods and their contribution to transformational adaptations. As Deliverable 3.2 had a major focus on the services provided by the public sector, D3.4 has a stronger emphasis on private providers of CS (a share of 2/3 private and 1/3 public providers was envisaged for this study). The interviews follow a format of a business talk as further described in Section 2 and Appendix 1. The results were anonymised and analysed with a coherent approach. Key findings are presented and discussed in section 3 and 4, respectively. The results of the deliverable 3.2 and 3.4 will be incorporated in Deliverable 3.6 "Technical briefs and taxonomy of sustainable business model innovation" to form a taxonomy of business models for climate services across multiple sectors. The taxonomy will cluster climate services according to their value creation process and will help assess barriers and bottlenecks to their uptake.

2. Method

How to get more insight into the business models used for climate services, assess their innovation potential for the future development of the CS market with particular focus on aspects relevant for transformative and sustainable societies? Building on the outcome of Deliverable 3.2 Framework and patterns of business (model) innovation, collection of good practice examples which mainly focused on examples from the public sector for this study the focus shifted more towards CS provided by the private sector.

Furthermore, this deliverable builds on prior research into climate services business models, particularly the study by Larosa & Mysiak (2020), using a revised Business Model Canvas (BMC) to conceptualize value creation and innovation pathways in climate service provision. Their exploratory study highlighted key components such as value propositions, customer segments, delivery channels, and partnerships through a conceptual and network-based analysis grounded in case data. However, they did not address all nine elements of the original BMC systematically. Our work for this deliverable advances this foundation by drawing on a larger and more diverse empirical base by in-depth interviews with a wide range of climate service providers across Europe. In the interviews we are applying a structured and empirically grounded coding framework across all nine BMC elements. In doing so, this deliverable provides a more differentiated and up-to-date view of how climate service providers operationalize and adapt their business models in practice — offering concrete evidence of emerging patterns, challenges, and hybrid strategies in the field.

As pointed out before, the analysis is based on the Business Model Canvas as described by Osterwalder et al., 2010) and Section 2.1. To obtain more in-depth insight in the business (model) innovation of the CS the primary source of information were semi-structured interviews with representatives of the CS providers. The interviews follow a format of a business talk as further described in Section 2.2. The results were anonymised and analysed with a coherent approach (see Section 2.3).

2.1. The Framework - Business Model Canvas

The Business Model Canvas (BMC) is a strategic management and entrepreneurial tool that allows organizations to visually map, describe, and innovate their business models. Developed by Osterwalder and Pigneur (2010), the BMC divides a company's business model into **nine interconnected building blocks**: **Customer Segments**, **Value Propositions**, **Channels**, **Customer Relationships**, **Revenue Streams**, **Key Resources**, **Key Activities**, **Key Partnerships**, and **Cost Structure**. These elements provide a comprehensive framework to understand how a firm creates, delivers, and captures value as in Figure 1.

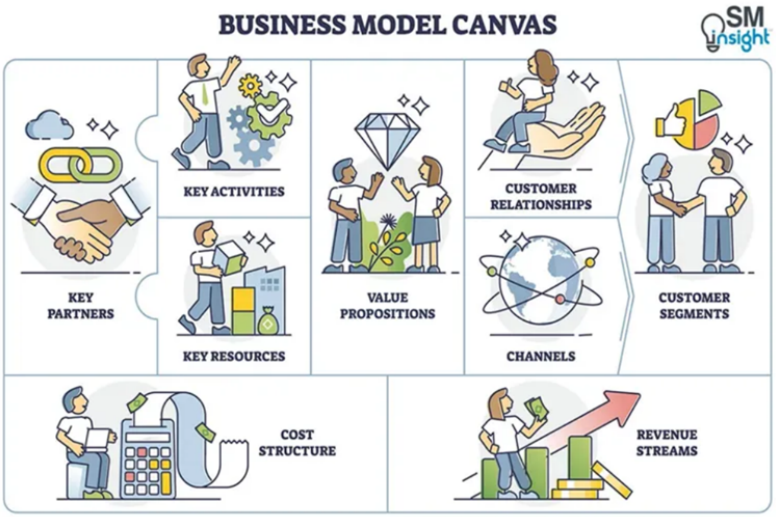


Figure 1: Schematic diagram of the Business Model Canvas (Source: Shutterstock; from https://strategicmanagementinsight.com/tools/business-model-canvas-bmc/)

The BMC framework aims to provide a holistic view of a business model, enabling entrepreneurs and businesses to visualize their business through a clear and concise overview. By analysing each component, the BMC helps identify key areas for improvement in efficiency and effectiveness. Specifically:

- **Customer Segments:** Who are your target customers?
- **Value Proposition:** What value do you deliver to customers?
- **Channels:** How do you reach your customers?
- **Customer Relationships:** How do you interact with customers?
- **Revenue Streams:** How do you generate revenue?
- **Key Resources:** What essential assets do you need?
- **Key Activities:** What core actions are crucial?
- **Key Partnerships:** Who are your key collaborators?
- **Cost Structure:** What are your major expenses?

Technically speaking, the BMC facilitates communication of the business model to investors, partners, and employees, while also serving as a valuable tool for brainstorming and developing new business models. In a nutshell, the BMC helps businesses understand and visualize their business model, identify areas for improvement, and communicate their strategy effectively.

Academically, the BMC has gained traction both as a pedagogical tool in business education (Joyce & Paquin, 2016) and as a practical framework in innovation and entrepreneurship research. Its design thinking approach makes it especially suited for early-stage ventures, social enterprises, and service-oriented sectors, where business models are still evolving and need iterative development (Gassmann, et al., 2014). Indeed, unlike traditional strategy tools like Porter's Five Forces—which emphasize competitive positioning and industry structure—the BMC focuses on the internal logic of value creation and delivery, making it more flexible in rapidly changing markets and non-traditional sectors (Teece, 2010). Moreover, its visual format fosters cross-functional collaboration and stakeholder engagement in business planning processes (Osterwalder et al., 2005). Despite its popularity, scholars have also critiqued the BMC for its limited ability to address dynamic changes over time or account for external environmental factors, leading to proposals for more adaptive or triple-layered versions of the canvas

that integrate sustainability and ecosystem perspectives (Joyce & Paquin, 2016; Lüdeke-Freund et al., 2016). Having said that, the BMC remains a widely used, adaptable framework for both research and practice. It is especially valuable when the goal is to design, analyse, or communicate a business model clearly and concisely, particularly in innovation-driven and service-based contexts.

2.2 Collecting information about business innovation - The interviews

2.2.1 Interview concept

The interviews, referred to as business or innovation dialogues, are designed as interactive and reflective conversations rather than traditional Q&A sessions. Interviewers not only gather insights but also guide participants to reflect on their strategic decisions and consider alternatives, promoting mutual learning. All interviews follow strict ethical standards: participants are fully informed about the objectives, consent is obtained, and confidentiality is ensured. The discussions are guided by clear goals, conducted in a neutral and open manner, and summarized anonymously for validation by the respondent. Recordings, when consented to, are used only internally and deleted after the interview report is finalized. Respondents are selected from a pre-agreed list of stakeholders, with a target of at least 30 interviews, maintaining a balance between public and private sector participants. While not geographically representative, the sample considers diversity in market maturity across and beyond the EU. Interviewers coordinate with other work packages to avoid duplication, using a stakeholder tracker, and send invitations that include a background information sheet, consent form, and guiding questions. Interviews generally last around 60 minutes and follow the project's established guidelines.

Each interview is structured using the elements of the Business Model Canvas (BMC), which serves as a practical framework to explore how services create, deliver, and capture value. As clearly described, the BMC framework supports discussion across elements such as the value proposition, key resources and activities, customer relationships, delivery channels, and revenue streams. Rather than focusing on full business model transformation, innovation often involves reconfiguring selected components to meet evolving user needs, integrate new technologies, or improve cost-effectiveness and resilience.

A central element shared with Task 3.1 is the focus on the value proposition, which reflects the core benefit climate services offer to their users. This may include improved efficacy and efficiency (such as better yield or resource use), risk and damage reduction, enhanced adaptive capacity and strategic planning, and monitoring of environmental or regulatory compliance. Overall, these interviews provide essential input for mapping innovation practices across climate service providers and contribute to the design of more sustainable and scalable business models.

The details of the interview protocol are described in Appendix 1 in full detail.

2.2.2 Extracting and condensing the information - the analysis concept

The interviews that followed the concept as described in Section 2.2.1 were recorded and transcribed. As a fraction of the interviews were conducted in the local language, the transcriptions had to be translated into English before a further structured analysis could be performed. The quality of the transcripts varied depending on the recording software used and the lingual performance of the actors. Thus, some adjustments of the output were required, in particular for interviews which had to be translated.

After finalising the adjustments to the transcription and (eventually required) translation, the interview data were analysed using a structured qualitative content analysis (Bauer, 2000), following a widely used six-step methodological approach:

1. Formulating research questions, hypotheses and problem's definition derived from theory and informing the selection/generation of interview material;
2. Defining the data corpus (the set of interview materials suitable for analysis), and defining the unit of analysis (i.e. the sentence or short paragraph) for consistent coding;
3. Developing the coding book to categorize text segments according to relevant themes and BMC elements;
4. Testing the reliability of the codes and revising the coding book to improve clarity and inter-coder reliability;
5. Systematic coding of interview segments using the codebook and thematic categories of the BMC elements, and set-up of a data file to support interpretation and potential statistical treatment;
6. Results' interpretation, by identifying key patterns, commonalities, and variations across interviews, and presentation of results aligned with the BMC framework.

The analysis was conducted using the qualitative data analysis software Qualcoder (Curtain, 2020), an open-source software available for different platforms. The software can be used to analyse text from different sources based on a predefined common "codebook". For this analysis the codebook was developed based on the BMC categories and predefined codes for each BMC element. In addition to the standard BMC elements a section addressing innovative methods and those contributing the transformative adaptation was included. The codebook (see Appendix 2) contains beside the BMC categories and the corresponding codes a short definition and description of the categories and descriptions for the codes were provided.

In addition, the Qualcoder software allows distinguishing between different cases (private or public provider), types (e.g. companies, projects or public institutions), and sectors). In the interview transcripts relevant text passages are marked according to the codes within the different categories. After finalising the coding of all transcripts reports and / or graphics can be generated by the software package. As the coding was performed by the partners individually, the final report was assembled centrally by CMCC. The reports obtained for each category were analysed and summarized thereafter. The results obtained by this procedure are discussed in Section 3.

3. Results

3.1 Overview on the interviews conducted for this study

In total 43 interviews were conducted for this study. The majority of them (32) are following the interview protocol as described in section 2.2.1 and Appendix 1. In addition, results of 11 interviews which were performed earlier in the CE2 project were considered as they provide valuable information for this study. The geographical distribution of the providers is shown in Figure 2. Besides providers in 10 European countries, 4 came from international companies based outside Europe and three were services provided through EU-funded projects.

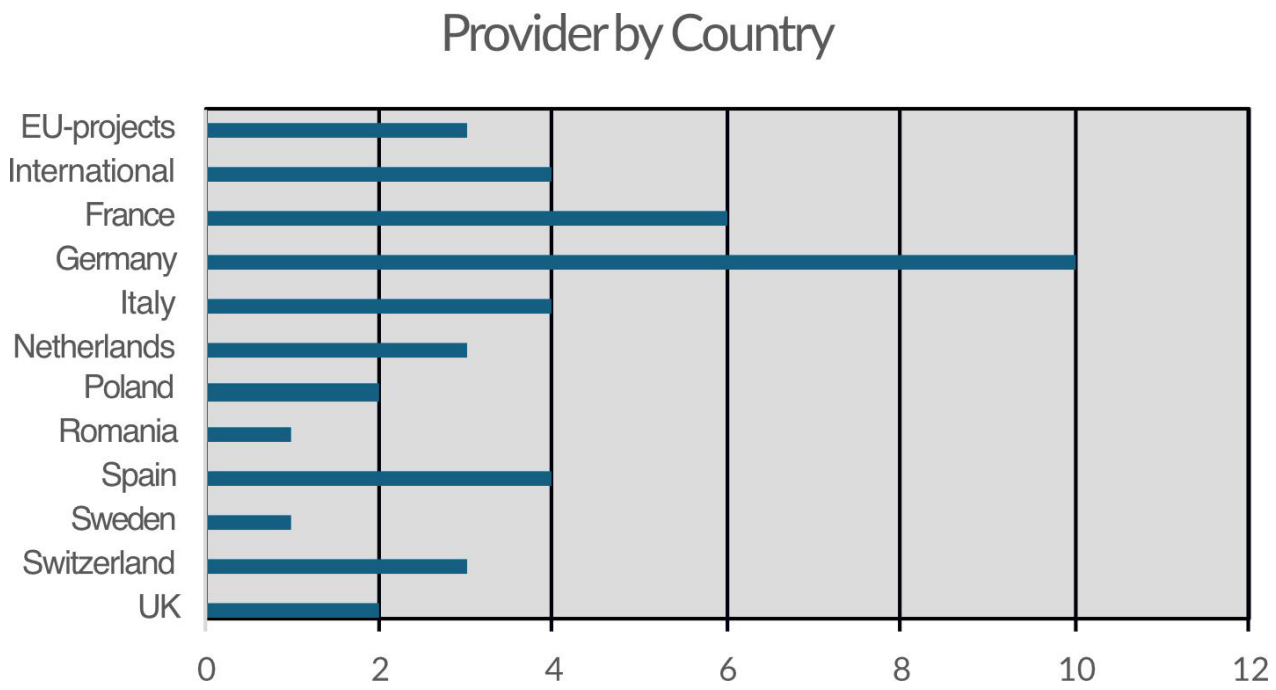


Figure 2: Geographical distribution of the providers interviewed for this study.

With respect to the function of the interviewees we distinguish between top level (e.g. CEO or director of a research institute), 2nd level (e.g. department head or senior scientist), 3rd level (e.g. sales manager or scientist) and a few that do not fit in these categories (e.g. public relations manager). Most of the interviewees are from the first two categories which ensures that they have a comprehensive overview on all aspects of the climate service (see Figure 3).

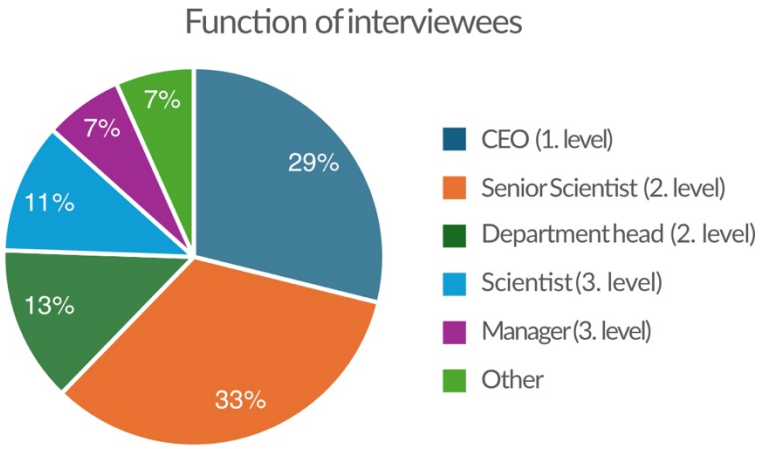


Figure 3: Function of the interviewees in this study

As envisaged in the planning for this deliverable, nearly two thirds of the interviews were conducted with private providers (58 %) (see Figure 4). This result is also reflected in the sectors covered by the climate services offered by the providers. Although most of the CS are not limited to one specific sector, many services within this study focus on climate risk assessment or more specifically on flood risks which is highly relevant for the finance and insurance sector but also on urban development, energy and industry (see Figure 5, see also subsection 3.2.1 for a more detailed analysis of the customer segments). Climate risk assessments are a typical domain of private providers either through individual consultancy or with standardised products based on different climate change scenarios to assess different climate risks (e.g. extreme temperature, precipitation and subsequent flooding, or storm impacts). On the other hand, applications for urban areas often include risk assessments caused by extreme heat or precipitation but also climate adaptation planning involving broader communities. Here public services play a stronger role, (e.g. through living labs or community engagement) as co-production and co-development require more resources. National Meteorological and Hydrological Services (NMHS) typically provide solutions applicable for multiple sectors and timescales, e.g. seasonal or long-range forecasts and climate change scenarios.

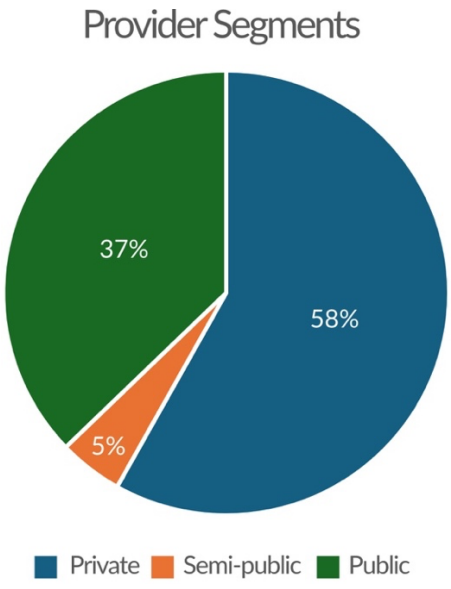


Figure 4: Provider segments

Figure 5: Major areas addressed by the climate services of this study.

Some providers offer their services mainly in their country (e.g. because their focus is specialized on national aspects or regulations or due to legal, administrative or language barriers). The geographical scope of the climate services in this study is illustrated in Figure 6.

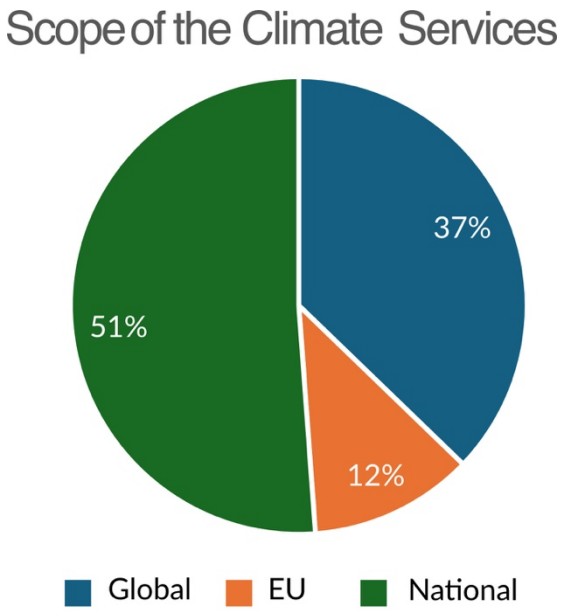
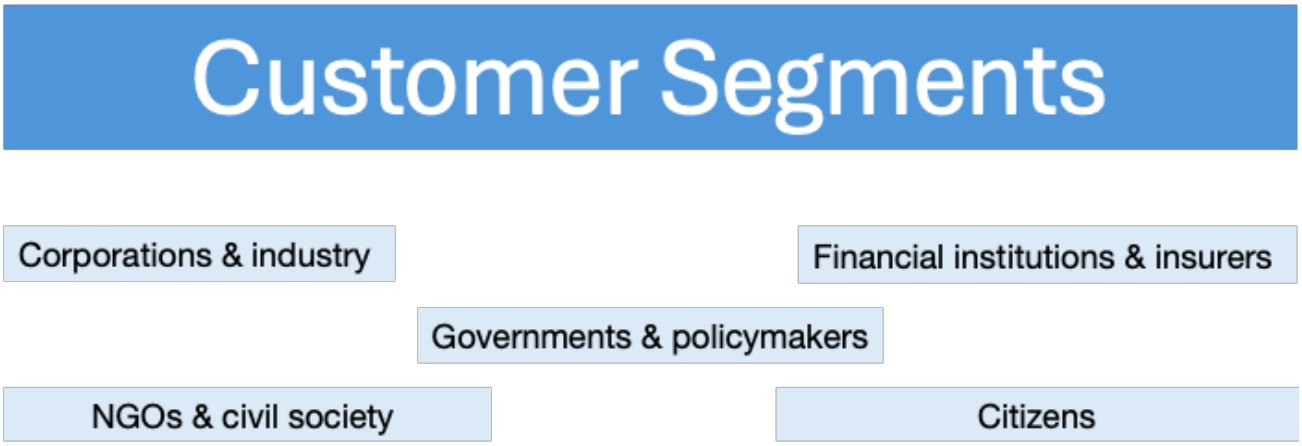


Figure 6: Scope of the CS in this study

In the following section the specific results according to the different BMC elements plus a section on innovation and transformational aspects are discussed and summarized.

3.2 Key findings according to the BMC elements

3.2.1 Customer Segments: Who are your target customers?



As customer segments we define groups of people or organizations based on characteristics such as demographics, behaviour, or needs. Customers can encompass e.g. *Corporations & industry*, *Financial institutions & insurers*, *Public institutions & policymakers*, *NGOs & civil society*. These segments can range from mass markets to niche markets, or even individualized customer bases.

- *"Citizens"*: While individuals impacted by climate variability can benefit from climate services, they are rarely directly targeted by service providers. However, homeowners can become users if the tools are tailored to their specific needs. In some cases, the general public and researchers can access climate data through websites.
- *"Corporations & Industry"*: Climate services (CS) providers primarily target the private and public sectors, which include a wide range of actors from large corporations to small companies, public authorities, and professional individuals. These sectors are affected by climate change at varying levels of maturity. Some of the most frequently mentioned sectors include:

    - **Insurance companies** and the **fintech** and **insurtech** markets
    - **Agriculture**
    - **Energy**, including Independent Renewable Energy Producers (IPPs) and renewable energy companies
    - **Infrastructure**, covering areas such as the building sector, especially in response to urban heat discomfort during summer, capital-intensive infrastructure operators, and airport operators
    - **Transportation**, which encompasses large shipping companies requiring medium-term forecasts for logistics and location-specific projections, as well as rail infrastructure
    - **Civil aviation**
    - **Consulting companies**, supporting corporate transitions, including technical engineering consultancies, Corporate Social Responsibility officers (especially for Corporate Sustainability Reporting Directive (CSRD) reporting), and risk managers (e.g., in insurance negotiations), driven by EU taxonomy regulation requirements

    - Other sectors mentioned less frequently include **industry**, **tourism**, and **heritage**. In the **public sector**, **regional water management agencies** and **water utility companies** were also noted as important stakeholders, along with **port authorities** (e.g., in Rotterdam).

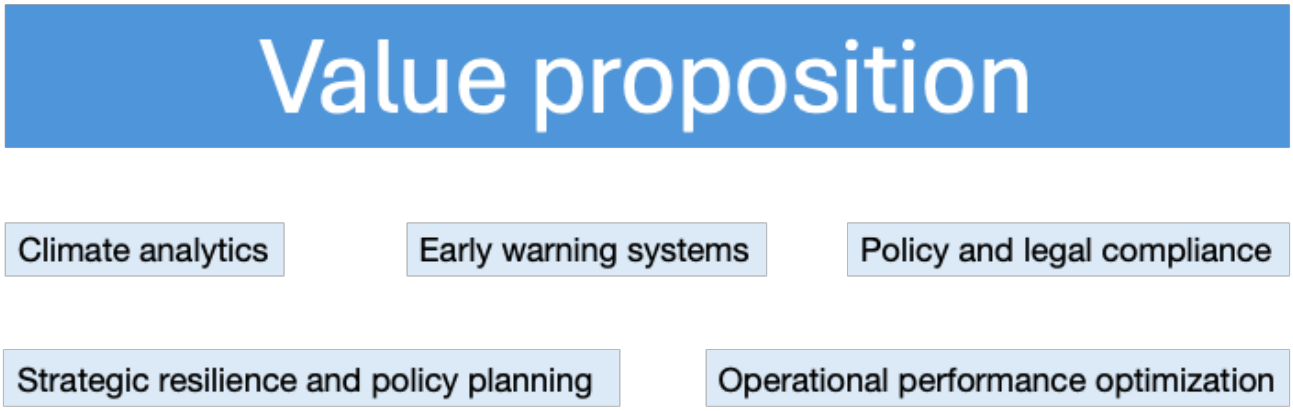
- *"Financial institutions and insurers"* are key customers for many climate services (CS) providers. One provider noted that approximately 60% of their revenue comes from working with banks, asset management firms, and private equity: "*I would say about 60% of our revenue is derived from work with banks, asset management, and private equity*." Some CS providers even develop specific products tailored for banks and primary insurers. Insurance companies are frequently cited as target customers, with one provider noting: "*As far as the insurance world is concerned, it is much more in the core business when it comes to catastrophe policies, i.e., policies that protect against events called systems*." Within the financial sector, the target profiles include risk departments in banks, and sometimes the credit departments, fund managers in private equity and real estate, as well as property investors and managers. One CS provider highlighted that real estate investors are among the primary users of their services.
- *"Governments & policymakers"*, including municipalities, civil protection agencies, regional authorities, cities, and metropolitan areas, are significant customers of climate services. For some service providers, the public sector, particularly civil protection and local authorities, is the priority. One provider mentioned, "*Currently, we are addressing a niche market, primarily supporting the public sector, civil protection and local authorities.*" Municipalities and national governments, especially in the Netherlands with its Delta Strategy, are key users, and the tools have been applied in multiple countries, including New Zealand and island states: "*The Dutch government is using it for the Delta strategy, and it's also been applied in many, many places around the world.*"
- *"Local authorities"*, particularly at the municipal level, are consistent users of climate services, often relying on daily information for emergency management and civil protection. For example, the city of Bucharest uses climate data for local development planning. In addition, federal authorities, environmental agencies, and research institutions are significant users who process climate data themselves, often for research or environmental reporting. Public authorities typically use climate services to optimise urban and regional planning based on climate analyses.
  However, some CS providers do not prioritise this customer segment: securing contracts in the public sector can be slow, as there are multiple layers of bureaucracy to navigate compared to the private sector. Some providers work indirectly with public administrations, partnering with companies that respond to city calls for environmental data services.

    - *"So let's say in terms of business strategy, we won 't go for the cities directly but eventually support someone that answers to the city calls around environmental data services, whatever they do, and support them with the data, we do it in partnership."*

- *"NGOs and civil society"*: While NGOs are not the primary target customer segment, civil protection agencies are a key focus. One provider mentioned supporting the civil protection services in Emilia-Romagna during a major crisis. Additionally, some organizations have special programmes aimed at educating the public, such as the climate school initiative by AXA Climate, designed to engage schools in climate action and awareness.
- "*Research institutes"* are not typically direct targets of climate service providers, but they often process publicly available data for their own research needs. This includes requests from doctoral theses or specific studies, such as those by agricultural or urban climatologists who require data

for yield calculation, water usage models, or urban climate assessments (e.g., heating and cooling requirements). These institutes often rely on climate data to support academic and scientific inquiries.

3.2.2 Value Proposition: What value do you deliver to customers?



The value proposition describes the added value a service or product provides to the client. For the purpose of the interviews conducted for this study, the value proposition was segmented into five general types:

a) *Climate analytics:* the service offers an advanced analysis of climate data to support informed decision-making.
b) *Early warning systems:* the service offers a system that provides timely alerts for extreme climate events and thus delivers value by protecting lives, assets, and infrastructure through early action.
c) *Policy and legal compliance advisory*: the service supports customers in meeting environmental and climate-related regulations and thus enables organizations to stay compliant and avoid legal or financial penalties.
d) *Operational performance optimization:* the service supports the improvement of operations using climate and weather insights and thus enhances efficiency and reduces risk in climate exposed sectors.
e) *Strategic resilience and policy planning:* The service supports long-term planning for climate adaptation and resilience and thus helps organizations and governments prepare for future climate scenarios.

Almost all interviewed CS providers add values from more than one of the above options to their clients. "*Strategic resilience and policy planning*" and "*Climate analytics*" are the most frequent types of value generation, followed by "*Policy and legal compliance advisory*" and "*Operational performance optimization*". "*Early warning systems*" are offered by only very few providers which could be attributed to the provider population of this study. Both, the private and public sectors, offer all types of value propositions. We found little difference in the value proposition between public and private providers, with the exception that private providers tend to offer "*policy and legal compliance advisory*" slightly

more often than public providers. Further, private providers frequently describe (parts of) their services with the term "*Risk assessment*", which is rarely the case for public providers. This could be an indication that public providers focus more on delivering data, that clients can further analyse themselves, while private providers more frequently offer the service of analysing the data for the purpose of the risk assessment.

Irrespective of the type of value proposition or provider category (public/private), providers frequently refer to the scientific reliability of the provided data as important aspect of the value they generate:

- *"High-quality, post-processed climate data from major datasets."*
- *"In order to maintain scientific rigour, there are researchers behind this project who are experts in the context of climate change."*
- *"One of the main services of [the provider] is providing high-quality, consistent data bases."*
- *"The service provider provides municipalities/communities with solid data foundations, as the data comes from a harmonized model chain, and the model data from several European institutes is checked and used."*
- *"All of our customers, virtually all of our customers ask us like how do you validate the stuff."*

A considerable number of providers state that their service translates climate data into useful information to clients:

- *"[…] processing the data and helping to contextualise it in the client's operation."*
- *"[…] the value is also to maximise the use of this information in real decision-making contexts."*
- *"[…] is a platform that was created with the goal of transforming climate data into usable information for different types of users […]"*
- *"If I had to generalise about the three industries we currently operate in, the first is having data that is tangible, usable."*

Further, in case providers mention that their services are sector-specific, the most frequently named sectors are urban planning and the financing/insurance/real estate sector. In case a spatial focus of the service is mentioned, the majority of services concentrate on the urban space. Providers do not only offer directly climate-related data, but they also offer information on hydrology, flood, heat-related information, drought, fire or landslides.

The services offered in the field of "*Strategic resilience and policy planning*" reach from development of climate pathways and strategy development over simulation of planning options to more specific services e.g. for drought management or irrigation planning:

- *"[…] climate resilience development pathway. So not only focusing on adaptation but also mitigation and sustainable development. This is the actual approach and then the pathways generator is a tool to actually visualise and generate pathways."*
- *"Our solution can support urban planners in designing new cities or urban regeneration plans."*
- *"[…] the value that is delivered to the specific user is basically to enable him to explore the different intervention […]."*

- *"So you can also see the effectiveness of adaptation interventions, and how that can reduce your impact or even your risk."*
- *"[…] not only it delivers information about the exposure to the compound flood hazard and risk, but also gives the interactive opportunity for the urban planners to implement some adaptation measures and then see, dynamically, what changes."*
- *"Especially 2022 was a particularly critical year for drought, and those are the times when the service is useful in terms of management, governance."*

Providers offering services in the field of "*Strategic resilience and policy planning*" as a climate service frequently point out, that they develop their services in line with client requirements:

- *"[…] strategy development that goes beyond the provision of data, thus processing the data and helping to contextualise it in the client's operations."*
- *"This is driven by user needs, meaning that existing users should provide ideas and, of course, the necessary funding to address them."*
- *"Now, I'm working the other way around, which is starting from the user, or trying to start from the user as much as possible, and only pick the methods relevant for the users, and the data and communications, […]."*
- *"[…] try to bring the scientific community on modelling towards more user-oriented evaluation of our models […]."*
- *"We have a platform, national platform providing specific data for different sectors tailored based on users' needs."*

When it comes to "*Climate analytics*", the interviewed providers clearly opt for seasonal and long-term forecasts over short-term forecasts. Further, providing climate information at a high spatial resolution is a frequently mentioned selling point.

- *"We deal with both seasonal forecasts and climate scenarios, we don't do weather."*
- *"seasonal forecasting mostly, […] up to even climate projections."*
- *"We have downscaling models for seasonal forecasts and scenarios based on machine learning that reaches up to 300 meters of resolution."*
- *"I know that today we have very high spatial granularity, which allows us to develop very accurate analyses."*
- *"Our unique selling point is the capability to deploy high-resolution datasets."*

With respect to category of "*Policy and legal compliance*", several providers mention the regulatory side as driver of need for CS:

- *"The ECB requires all banks in Europe to quantify the exposure of their credit portfolios to climate risk."*
- *"There is now a new market related to climate risk disclosure related to finance and investment."*

- *"For example, here in Italy, we have some regulation that requires municipalities to evaluate climate risk and hazards during the development of new urban plans. These regulations play a big role for our company because we are able to provide this data and service."*
- *"The specific pain point is the climate resilience strategy, which, according to European legislation, will be mandatory for all critical infrastructure from October 2024."*

In line with the regulatory need for supervision, transparency is mentioned as an important selling factor:

- *"There is a need for methodological transparency, and many of the providers in these private sectors lack transparency, so they provide output without explaining the drivers of a given risk on an asset. This creates problems when it comes to transparency and supervisory reporting."*
- *"[…] methodological transparency, which is very important for some industries, specifically in the banking world, which has to make these disclosures for regulatory reasons."*
- *"By using this tool it will be possible for that investor, or actually a data scientist at the investor, to gain more understanding in what the assumptions inside these models are […]"*

In the category of "*Operational performance optimization"*, risk assessment is a service offered by more than half of the providers, which is a significantly higher share compared to the totality of value proposition types:

- *"Qualitative risk changes under different climate scenarios."*
- *"Climate risk analyses according to the EU taxonomy"*
- *"The aim of the tool is to quantify the risk."*

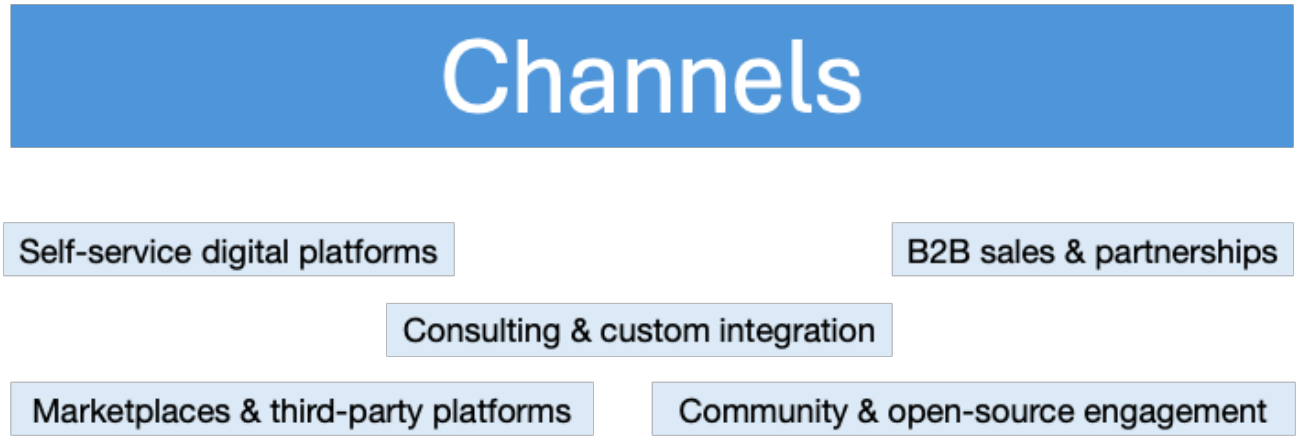
In general, risk assessment seems to be a focus rather of private providers, only very few public providers offer this kind of service.

Among the interviewed providers, "*Early warning systems"* are the less frequent value proposition type. One provider stated that he is reluctant to take the accountability for warnings:

- *"When you are issuing a warning, a flood warning, and something happens, like there is an impact, then one could be held accountable for something, right?"*

In summary, the value proposition of the CS covered by this study covers a broad range of application with "*Strategic resilience and policy planning*" and "*Climate analytics*" most frequently mentioned. Due to the fact that the study addressed primarily the private sector, value propositions like "*Early warning systems*" that require sustained operational services (e.g. through NMHS) are not mentioned that often.

3.2.3 Channels: How do you reach your customers?



Channels comprise methods and pathways to deliver its value proposition to customers. Channel management ensures that customers can access the company's services efficiently. Such delivery channels can be for instance *Self-service digital platforms*, *B2B sales*, *Consulting & custom integration*, *Digital marketplaces* or *Community & open-source engagement*.

The analysis of interviews reveals a range of channels through which climate service providers deliver their value propositions and reach end users. These delivery channels reflect strategic choices around facilitating uptake, scalability, and personalization. While some providers rely on a dominant approach, others combine multiple channels according to the nature of the service, users' profiles and their capabilities, and the provider business model and resource constraints.

The most widely used delivery channel is "*Self-service digital platforms*", including web portals, apps, or downloadable resources that allow users to directly access data, visualization and decision-support tools. These platforms support scalable, user-friendly and lightweight access to data, visualizations or decision-support tools. Providers emphasized the value of enabling users to access and interact with services independently and on demand, often via web portals or. One provider explained the typical model:

- *"When we are asked to build a service, we simply build it, we run it, and then we have the user interface, which is a website, and everything is disseminated there… providing a lot of data for free."*

However, the interviews also highlighted limitations when users lack the necessary expertise. Especially in early phases of service development and delivery, this channel is particularly suited to technically capable users. To extend their reach, providers stress the relevance of ensuring accessibility for diverse user groups in terms of expertise and maturity. As one noted:

- *"But clearly some skill is required to understand it. We have developed different levels: there is the more usable one and the more ad hoc one that, for example, only the hydraulic engineer…may understand… This is one of the challenges: trying to differentiate services based on different levels of expertise."*

Moreover, others pointed out the effort to broaden usability by improving intuitive design and functionalities:

- *"We've all built different types of visual applications, right, the maps, the charts, the graphs that you know like support. The idea was to integrate in the tool the outcomes from the heat maps so that the user can also enter and see… but it requires work on the functionalities and design."*

These examples illustrate both the potential and the challenges of self-service platforms. While they enable direct delivery, their effectiveness and scalability depend on intuitive design, differentiation by user maturity and improvements to usability and support.

"Consulting and custom integration" is another widely used channel, primarily among private providers offering bespoke services. This channel involves tailoring services to the client-specific needs and embedding services in operational workflows ensuring user-specific value delivery. One provider explained:

- *"We are a consulting company, we respond to customer requests individually and want to see exactly what the customer actually needs from us and doesn't just want to sell a standard product but really want to see how we can best help the customer."*

Another confirmed that such work *"requires some consultancy effort,"* reflecting on the relational nature of delivery rather than standardized products and transactions. This model varies in intensity from full-service integration to lighter handovers depending on the sustained dialogue, customer needs and infrastructure. In some cases, providers deliver only raw data and forecasts, leaving the clients to manage integration themselves *"We give them the raw data, weather data and forecasts… but there are no links other than that"*. Others described highly automated delivery and integration with clients' systems:

- *"We started out as API providers, integrating data flows into our customers' IT systems. This works very well for the banking and insurance sectors."*

These cases underline a delivery mode that is context-specific and often relational, rather than product-based. Furthermore, the delivery channel shapes also the potential for scale and improve the service via integration with customers computing resources:

- *"In addition, since we now also have the possibility of taking advantage of a lot of computing space through the supercomputer of the [omitted] region, and we could take advantage of this extra space.*

The consulting-based delivery is therefore framed as flexible and relational, bridging data provision with technical, organizational, and infrastructural realities of the client, and reflecting a delivery mode where value emerges via continuous adaptation and integration rather than standardization.

Third in prominence is "*Community and open-source engagement"*, that is, the collaborative sharing of tools, data and practices with communities to broaden service adoption, build trust and foster innovation. This approach is particularly frequent among research-based and public-sector providers and characterized by openness and mutual exchange contributing also to service development, optimization, and uptake, thereby supporting transparency, innovation and shared ownership. One provider describes this model *as "focusing on the open-access products, so using a knowledge-sharing approach"* reflecting a philosophy of public value of services. Other providers emphasized mutual relationships with trusted partnerships and exchanges with users who can engage with, build upon, and contribute to the service optimization and update with new data.

- *"Since we, operationally, do a quality check of the station data every day, the water boards are willing to give us their data because there is a mutual benefit... The exchange has always been free. The*

water boards give us agronomic information, maybe feedback with observed irrigation data, and we give them forecasts in return. All through project agreements, all free of charge based on a relationship of trust, of partnership."

- *"The tool can be updated every year once the E-OBS dataset [Ensembles Observation Dataset[1]] is updated by Copernicus… with E-OBS it is required that cities, local and regional weather stations, the governments, and others, can provide this information to Copernicus… they need to validate, etc. and this is how it is now."*

Such exchanges blur the boundary between delivery and co-production, forming part of an innovation ecosystem where feedback and data contributions from users improve the service quality and update.

"B2B sales and partnerships" were less frequently mentioned but remain relevant, particularly among providers operating in professional service markets (e.g., insurance, aviation, consulting). This channel includes long-term direct client relationships and collaboration with commercial partners often shaped by procurement structures as testified by a few interviewees:

- *"Customers like [omitted], who have told us you've done a phenomenal job in the past five years like serving us on climate projection needs. Can you help us with medium range forecasting like the season or sub seasonal?… because we would rather work with a one stop shop provider… because it's easier for us from a procurement and contracting standpoint."*

Others emphasized how new clients are often acquired through reputation.

- *"We have a website, obviously, but we're not a data provider."*
- *We're a consultant company. So people come to us because of previous services, because they heard from other companies that we provide the service, because someone in the company knows each other."*

In such a model, B2B delivery is not transactional but rooted in credibility and continuity through networks and visibility in professional ecosystems.

Finally, "*Marketplaces and third-party platforms"* were the least commonly mentioned channel but still noted as emerging tools for improving visibility and delivery. By acting as intermediaries, these platforms support services to increase reach and discoverability while helping users compare services. One provider noted these as spaces of mediated trust with credibility indicators and customer reviews:

- *"They have badges like 'verified provider'… ratings from clients. It's a classical thing to have in a marketplace."*

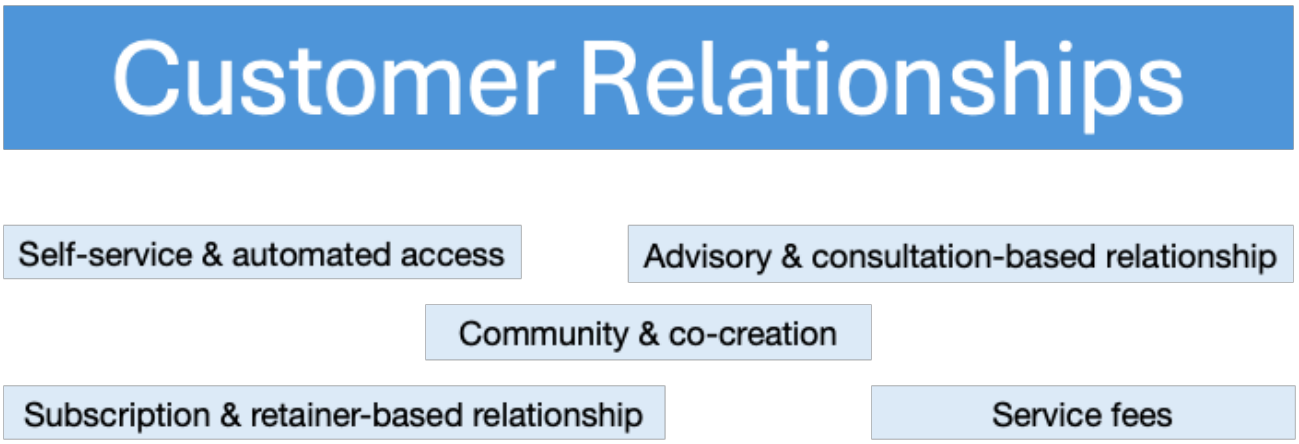
Others saw them primarily as promotional channels beyond existing networks and client bases: *"Those marketplaces give you visibility. Visibility and referencing."* References to large platforms like Amazon (AWS) were also mentioned, and while still supplementary in most cases, these channels may play a bigger role as climate services become more modular and digitally distributed.

In conclusion, delivery channels in climate services are multi-layered and adaptive, reflecting the maturity of services, user technical capacity, and the institutional context in which providers operate.

[1] High-resolution gridded dataset of daily meteorological variables over Europe regularly updated through the Copernicus Climate Change Service (C3S) using validated data from national and local weather stations across Europe (https://cds.climate.copernicus.eu/datasets/insitu-gridded-observations-europe?tab=overview)

While self-service platforms offer extended reach, consulting and B2B remain critical for service deep integration and trust-based collaboration. Community-based and marketplace approaches provide complementary value — whether through expanded reach, legitimacy, or innovation.

3.2.4 Customer Relationships: How do you interact with customers?



Customer relationships are defined as groups of people or organizations based on characteristics such as demographics, behaviour, or needs. Direct as well as indirect customer relationships can exist such as automated decision support systems, custom-designed software or reports, or individual training modules. Segments can range from mass markets to niche markets, or even individualized customer bases. For the purposes of the interviews conducted for this study, the customer relationship category was segmented into a) *Advisory & consultation-based relationships*, b) *Community & co-creation*, c) *Self-service and automated access*, d) *Service fees* and e) *Subscription & retainer-based relationships*.

The nature and intensity of customer relationships in the field of climate services can be manifold and diverse depending on the nature of the service, the user's profile and capabilities of the provider. Private providers are per se user oriented as they depend on the revenue of their customers to finance their business. Nevertheless, as personnel resources are often associated with the highest costs (see subsection 3.2.9), the user-provider interaction through a co-development and co-production process will be somewhat different to services developed through publicly or project-funded activities. In the academic-driven part of the climate service market, a number of approaches for designing climate services with intensive provider-user interaction exist (*Villwock, 2023*). Through projects, new, innovative approaches can be tested to optimize provider-user interaction, e.g. through living labs or continuous feedback and evaluation processes.

Furthermore, depending on the characteristics of the CS, customer relationships can vary quite a bit. Advisory and consultation services individualized for specific customers require a more intense bilateral exchange than those designed for broader market segments that are based on self-service and automated processes which concentrate primarily on e-mail or hotline support for their products.

In general, the interviews supported these views. Responses concentrated mainly on three segments: *Advisory & consultation-based relationships*, *Community engagement and co-creation* and *Self-service and automated access*.

"Advisory & consultation-based customer relationships" in climate services are crucial for helping clients understand and adapt to climate risks. These relationships are characterized by personalized, ongoing support, active collaboration, and a consultative approach that emphasizes education and long-term value. By engaging with clients through workshops, feedback loops, and co-design processes, companies ensure that their services are tailored to meet specific needs, fostering trust and long-term partnerships. As the demand for climate adaptation solutions grows, these relationships will be key to ensuring that businesses can effectively support user needs. This segment is more prominent in the private sector.

- *"We don't just send the data like that and forget about the client. We say: anytime you have a question or doubt, we're open 24 hours, 7 days a week, whatever your question is, come back to us."*
- *"So we do risk engineering, onside assessments, that means a risk engineer really goes on site with rubber boots and looks at it and then sees if your emergency generator is in the basement and you're in a flood zone in a flood zone bad idea and then comes a list of risk improvements we call that and that and if this list is empty, because they've already done everything, then it's a top customer so the risk engineer gives a rating to the underwriter."*

Quite similar to the first category, "*Community engagement and co-creation"* play a central role in the customer relationship strategy of climate service providers. Providers emphasized that close collaboration, iterative refinement, and transparent communication are essential to build trust, enhance usability, and tailor services to user needs. This cooperative approach not only strengthens relationships but also supports more robust, context-specific, and user-informed solutions. In contrast to the consultation-based segment, co-creation aspects dominate more in the public sector.

- *"We also provide support to our customers because we consider our services to still be in a not super advanced version, so this is useful to give us the opportunity to learn and open up more possibilities. So we do a lot of interaction with customers, interaction with them and all the coordination part with them, we also organise meetings during the service delivery and collect any feedback."*
- *"Workshops with stakeholders, indeed surveys, so a lot of these types of interactions. So for example, what are your needs and those are often developed in workshops but it will vary across living labs, the mode of interaction."*

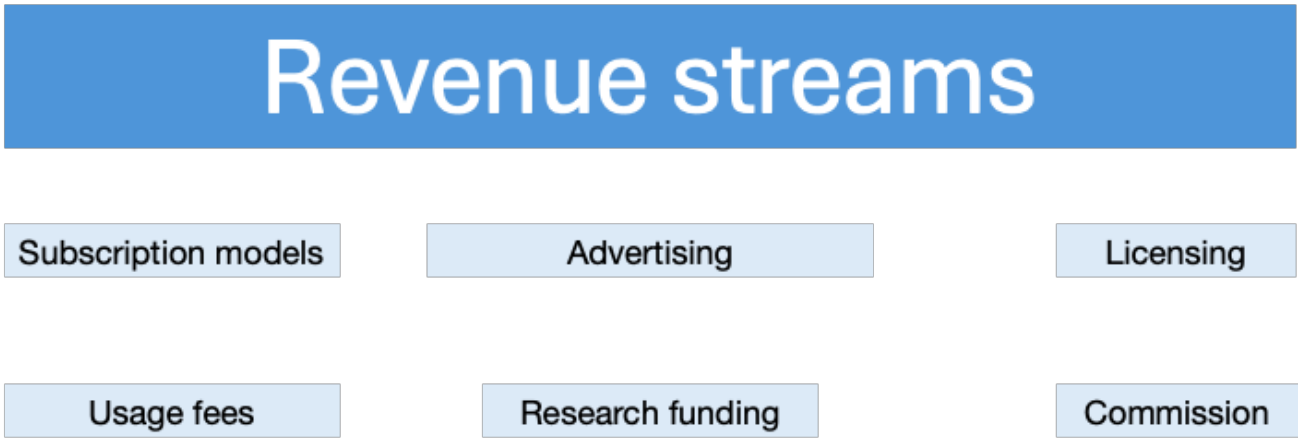
The answers to the integration of "*Self-service and automated access"* were more uneven across the responses by climate service providers. While some providers still prefer traditional, human-mediated interactions, others, especially tech-driven startups, are pushing toward automated systems.

- *"We already have personal contact with customers, which means that they know us, they write us an email or call us to say that they need something and then we have virtual conversations or meet live on site to see exactly what the customer needs from us."*
- *"In the developing phase they are clearly involved, whereas in a later stage, when they use the service autonomously, we may have exchanges because it may happen that they expected one thing and we developed another, and then we figure out together how to do it."*

In summary, depending on the strategy of the provider and the products offered, customer relationships vary in intensity and by channels used to interact with the users. Providers offering individual, pure consultancy-based products require continuous and intense interaction with users whereas web-based and more standardized products invest more time in direct user interaction during the design and planning phase for the service. Queries and quotations for subscribers of these services are typically handled by hotlines or web-based forms.

The future, a hybrid approach, combining user-friendly interfaces, automated data integration, and tiered service levels might be used to address the diverse capabilities and needs of the diverse user groups.

3.2.5 Revenue Streams: How do you generate revenue?



Revenue streams are defined as sources of income generated by the provider from its customers. Thus, how the company earns money from its services depends on the value proposition, pricing strategies, and customer preferences. Pathways for revenue streams investigated for this study are *Usage fees*, *Subscription models*, *Licensing*, *advertising*, *Commission* and *Research funding*.

With respect to revenue streams, public and private providers obviously differentiate. Public providers either receive funding for the design and operation of climate services primarily via *research or project funding* or through their institutional funding, e.g. operational National Hydrological and Meteorological Services (NMHS). The project funding plays a central role in sustaining and developing climate services across hybrid funding models combining governmental or institutional core funding, project-based grants (especially from the EU), and eventually consultancy work. These services can often provide data and / or products free of charge or are eventually applying just for a service fee to cover special requests. Some providers offer services for free to public and non-profit users but charge private / profit-based usage.

Some quotes related to this topic:

- *"As far as resources are concerned: the developments we manage to make are all within European projects."*

- *"Our long-term goal is to stay in the research and development projects to keep us updated and cover the development of new components and things like that."*
- *"All services provided by the XXX are publicly funded, and no fees are charged for the services."*

In academia, revenue can also be viewed differently as an increase in reputation if a service is successful which can finally lead to an increase of future (public or project) funding.

- *"We published a paper about explaining the service, and we actually called it in the title as a success story, and to me it means that the service is still running and is actually giving money, like profit, to the institute."*

As private providers normally have only limited access to public funds, their revenue has to be generated through "*Usage fees*", "*Subscription models*" or *"Licences*" depending on the type of service product and customer groups. These models offer diverse options for scalable and flexible revenue strategies tailored to data types, user needs, and client segments. Which payment model is applied clearly depends on the type of service. For web-based applications of Apps for mobile devices, subscriptions or licence fees are most common. Some providers offer multiple subscription levels, ranging from access to a single product to bundled services, with pricing influenced by factors such as resolution, volume, geographic extent, and type of hazard.

- *"You are moving to a subscription model for the portal: you use the portal as the preferred way to provide data, and then the user pays annually and downloads it."*

Pay-per-call or pay-per-download fees are particularly applied for APIs or high-demand sectors like finance and insurance, where users query climate risk information for specific assets. Also, spatial pricing (charge based on the activated area (e.g., per square kilometre)) is offered, e.g. when tools assess risks for different flood types.

- *"Regarding the pricing strategy, it's basically based on the extent of the activated area. We charge an activation fee for the first time you activate the service for a specific city, and then the user pays a cost per square kilometre. This also depends on how many tools and functionalities you want to activate."*

Unlike subscriptions (used for frequently updated services like seasonal forecasts), *licensing* applies to more static or project-specific datasets where the customer pays once for defined usage rights. Licensing also supports standalone software or tool access where each component or module can be licensed separately, allowing modular, flexible pricing. Licensing has grown in importance for some providers, increasing from around 10% to over 50% of revenue in some cases. Revenues from licenses are often used to finance further development of the licensed tools or instruments.

- *"When the data is delivered, you sign an annual license, not a subscription."*
- *"If they are climate projections it is a licence – because in the latter case you only sell them once."*

Services based on consultation activities with a large amount of user interaction (e.g. workshops, training, climate adaptation planning) typically generate their revenue by applying individual *usage fees* based on the project size and resources needed. Also, advanced services, like custom data transformations or risk monetization models, are billed separately based on the effort required to fulfil the task.

- *"Income is essentially generated through expert activities."*
- *"We sell hours of our consultancy."*

In summary, the revenue streams differ significantly between public and private providers. For private providers a sufficient revenue is essential for a sustainable operation of a service. Public providers rely either und long-term institutional funding or on project funding which limits a long-term perspective if services. Project funded services are often testing new innovative ideas or are developing prototype services which can only be maintained and sustained if long-term funding or an opportunity for commercialization can be allocated.

3.2.6 Key Resources: What essential assets do you need?

Key resources are assets the providers need in order to deliver their value proposition and sustain their business operations. The interviews conducted with climate service providers revealed some important implications in terms of key resources, one of the BMC blocks which was in turn analysed following five sub sections namely respectively i) *Data infrastructure & cloud computing* ii) *Scientific expertise & intellectual property* iii) *Regulatory & market knowledge* iv) *Strategic partnerships* and v) *Brand & trust*.

Regarding "*Data infrastructure & cloud computing*", the use of public and institutional datasets (e.g. Copernicus, ERA5, CMIP6, DRIAS) remains central in the development of climate services, complemented by internal historical records and, in some cases, data provided directly by clients or reinsurance partners. Most actors rely on a hybrid infrastructure: local servers or supercomputers (e.g. those from regional authorities or research institutions) are often used for core modelling, while cloud computing platforms like AWS are explored for flexibility, despite past technical difficulties. In-house APIs, lightweight front-end interfaces, and open-data portals enable efficient access to results, even if platforms are still being adapted to different user groups and usability levels. Despite interest in "as-a-service" models, full Software-as-a-Service (SaaS) integration is still under development. Broadly, there is a general consensus on the importance of aligning model complexity with available data resolution and managing uncertainty, particularly when projecting beyond 2050. Instead, the architecture of many services is evolving to support geospatial screening, risk quantification, and modular front-ends, offering tailored outputs for consultants, municipalities, and private actors engaged in reporting and adaptation planning.

- *"No, the data storage and processing are managed directly by us. We take advantage of our own supercomputer, and the data we use is often public data, available on C3S, or data that we develop as an institute, so climate simulations."*
- *"European data sets, we used the ERA 5 for precipitation, evaporation."*
- *"We also draw on existing data."*
- *"Regarding data, we naturally have public data that we include."*
- *"Making use of freely available climate data (e.g. CMIP data)."*

"Scientific expertise" is the backbone of climate service provision, integrating advanced knowledge from meteorology, hydrology, environmental engineering, and data science. Most providers operate in close connection with academia and research institutions, with around 80–90% of their activities rooted in research. This ensures access to state-of-the-art forecasts, high-resolution datasets, and proprietary or community-developed models. *Intellectual property* is also an important element. It includes custom-built water balance models, regional simulations, remote sensing integrations, and uncertainty assessments through multi-model ensembles. Many interviewees emphasized the value of internal expertise—scientists, engineers, data analysts, and communicators—who ensure methodological rigor and usability. Along this, climate services are developed in line with frameworks such as CLARA project or Copernicus and adhere to IPCC standards and transparent modelling practices. Skills in bias correction, scenario development, and operational forecasting (e.g. seasonal forecasts) are widespread. Despite challenges in documentation, much of the know-how is embedded in institutional memory and shared through ongoing research and dialogue. Overall, scientific integrity and intellectual independence remain core strategic assets for credibility and innovation.

- *"So all funding goes to research or let's say 80–90% is research. So, definitely, there's a lot of thinking around how to market your product and also the research… we are rooted in the world of research."*
- *"Our key partner is XXX. The service is essentially made up of three pillars: the first is the seasonal forecasts, calibrated for northern Italy, the second is the modelling, i.e. our water balance model, and the third key pillar is the remote sensing data."*
- *"…but build them ourselves and therefore don't have any black box models, but we really know every little screw in our flood model and can adjust it ourselves."*

"Market knowledge" in this context is fundamental. Navigating between scientific innovation and market applicability indeed remains still a central challenge for climate service providers. Many actors operate at the interface between research and real-world implementation, often struggling to balance R&D with commercialization and scalable delivery models. While the academic world focuses on long-term projections and methodological advancements, end-users—especially in sectors like urban planning or agriculture—require short-term, actionable insights. In this view, regulatory frameworks are increasingly influencing market dynamics: in Italy, for instance, new urban planning laws require municipalities to assess climate risks, creating a demand for climate data services. Despite this growing demand, many providers admit to lacking business-oriented infrastructures, such as automated subscription models or scalable B2B platforms. Business development often depends on ad hoc offers and person-to-person sales, highlighting a knowledge gap in market strategy and digital commercialization. The fragmented nature of the sector, with many small companies and research-based actors, limits

acquisition opportunities and promotes collaboration over consolidation. Overall, regulatory incentives are opening new market pathways, but a stronger alignment between scientific capacity and operational business models is still needed.

- *"For me, it's always a key question how to balance the research part and this kind of marketing part… this balance between this kind of research and development versus how do you apply this and how do you indeed make business cases for applications."*
- *"…we have no experience on that and it's what you were saying about this different type of subscription. Because this model of business is not in our institute's core DNA… we don't have this type of business, operationalised…"*
- *"Here in Italy, we have some regulations that require municipalities to evaluate climate risk and hazards during the development of new urban plans. These regulations play a big role for our company because we are able to provide this data and service."*

In this regard, "*Strategic partnerships"* are a core and crucial component in the development and delivery of climate services, enabling access to specialized expertise, computing infrastructure, and new markets. From the interview, collaborations generally span from public institutions (e.g., UNESCO, regional authorities) to scientific entities (such as, ESA) and private actors, especially in the software and finance sectors. Co-creation with clients, joint development projects, and shared infrastructure (e.g., supercomputers, digital twin platforms) are underlined as common strategies. While large companies are harder to engage, productive networks often emerge through events, EU-funded projects or collaborations with SMEs, which represent key strategic channels which foster in turn innovation, scale-up opportunities, and sectoral integrations.

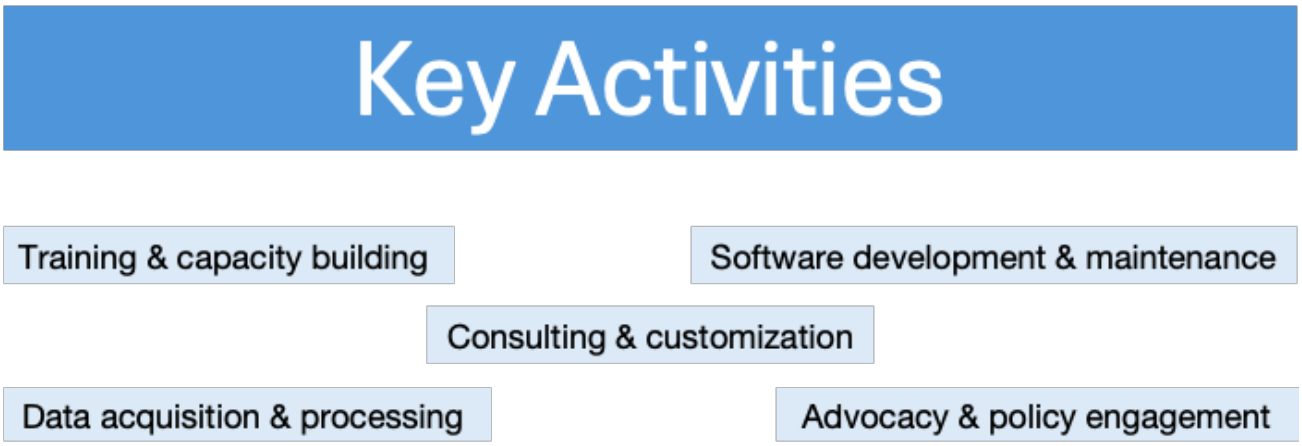
- *"We have a partnership with Jupiter Intelligence for climate data. And we're constantly looking for partnerships…"*
- *"I think the network is quite an important resource as well, that we have as a company. The network we built through acquisitions of companies, through partnerships, through client relationships."*
- *"We always try to contact large companies, but it's really difficult… Whereas with small and medium-sized companies it's easier, thanks also to the various events that are organised for these types of companies, so then you get to know each other."*

Having said that, above all, *"Trust and credibility"* are widely recognized as foundational assets among climate service providers. Many institutions have built strong user relationships over time, grounded in scientific integrity, transparency, and consistent engagement. While branding efforts may be fragmented—such as between EU projects or institutional labels—clients often remain loyal due to familiarity with products, ease of use, and the availability of direct communication. Operational excellence, like routine quality control of meteorological data, further reinforces trust, encouraging data-sharing partnerships based on reciprocity rather than monetary exchange. Finally, the long-standing reputation and collaborative ethos of providers serve as powerful differentiators in a competitive and evolving climate services market.

- *"I think the engagement with the users is something that has been built for many years now… Trust is something quite powerful."*
- *"You operate upon core principles: scientific integrity, comprehensive coverage, reliability and trust, which is really nice and highly appreciated."*

- *"...we, operationally, do a quality check of the station data every day... the exchange has always been free... All through project agreements, all free of charge based on a relationship of trust, of partnership.*

3.2.7 Key Activities: What core actions are crucial?



Under **Key activities** we summarize the most important tasks and processes the company (must) perform to create and deliver its value proposition, i.e. a climate service. This can comprise a) *Advocacy & policy engagement*, b) *Software (model) development & maintenance*, c) *Data acquisition & processing*, d) *Consulting & customization (co-production)*, and e) *Training and capacity building*.

Amongst the interviewed providers there is a large variety of activities that they conduct to create their climate services. "*Software (model) development & maintenance*" to generate climate information are key and crucial activities for climate services. Public providers like NMHS and research institutes typically operate their own climate models, collecting observational data and conducting short-to-medium range forecasts and/or climate projections. This requires a lot of effort on continuous model development and maintenance as well as data processing and research activities to provide up-to-date climate information. In addition (large) private providers often use their own models for downscaling to regional or local scales based on the above mentioned publicly available climate change scenarios calculations from General Circulation Models (GCMs). In addition to the climate information non-climate models are used, e.g. to calculate flood risk or heat impact on local scale (resolution up to few metres scale).

- *"A key resource are the self-developed model tools, such as water balance models for xxx and neighbouring catchment areas, which allow statements about water balance variables and water levels."*

The category "*Data acquisition & processing*" is an important backbone of climate services. By combining global and regional datasets (such as CMIP-6 / IPCC scenarios, CORDEX data, or C3S products) with local knowledge and applying advanced processing techniques, climate service providers deliver tailored, high-quality information that enables businesses and governments to make informed decisions in the face of climate change. For many providers, in particular from the private sector who are not operating complex climate models on their own, data services serve as background information for their own analysis and product design.

- *"Core business is climate data analytics, i.e. translating climate data into something that can be useful for your users, and then you also get into risk management, consulting and recently also artificial intelligence and data science."*
- *"Apart from running dynamic numerical models, for the rest we have all the processes: data downloading, bias adjustment, risk calculation, energy models, hydrological models, we have also built a basin model for water management."*

"Consulting and customization" activities are essential and high-value activities for many climate service providers. These efforts are resource-intensive, as they have a strong focus on customer interaction, training, and specific customer support tailored to the user needs but crucial for creating user-relevant, actionable outputs. As such, they shape how climate services are packaged, delivered, and monetized, as the interviews revealed, often taking precedence over purely automated or self-service offerings.

- *"We have the whole consulting part, because at the end of the day the difficulty of doing a platform is also to have something that is scalable but that is detailed enough: I often hear from our customers that they need a service that is tailored to their reality, that is customised, consultative."*
- *"In the end, the product is standardized but, again, being B2B, the large company will never be satisfied with the product you have developed; it will want customisations, so then we go and implement the customisations."*

Closely related, "*Training and capacity building"* or educational activities are on one hand needed for the staff of service providers on new data, methods and products and are on the other hand an elementary part of customer interaction to train users of CS on the product, inform about data quality, uncertainties and limitations, etc. Without such appropriate training, products can be misunderstood and lead to maladaptation. Adequate, information, education and training are an elementary part for successful transformation towards climate resilient societies as this requires a well-established knowledge and acceptance of measures needed to adapt and / or mitigate to climate change (see also subsection 3.2.10)

- *"Comprehensive training programmes to succeed in the sustainable transition, through an online learning experience, covering 8 different professions in 8 different languages. Over 6 million employees have been trained on environmental issues through 40+ hours of digital content, helping them adapt their skills and guide their companies through the transition."*

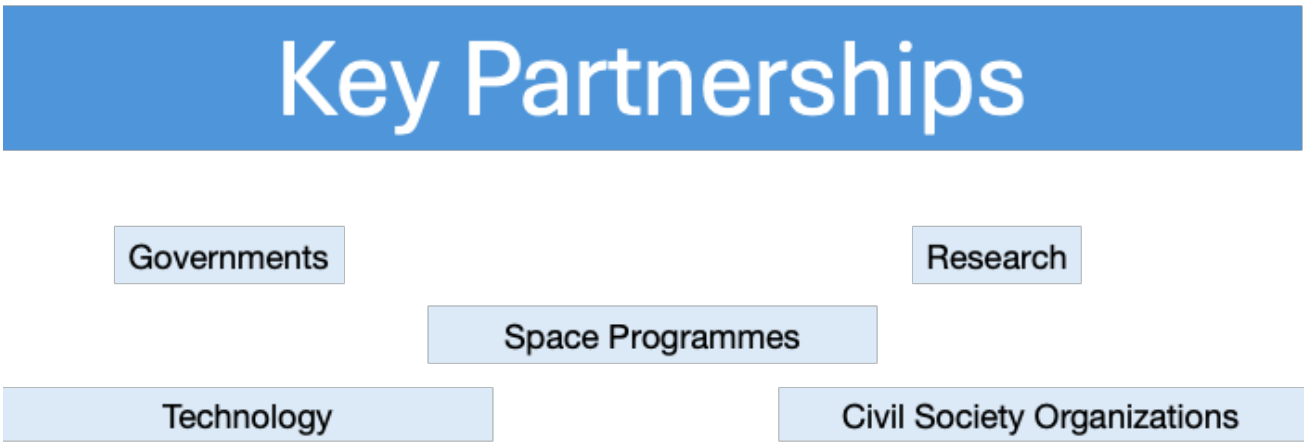
"Advocacy & policy engagement" related statements were not often mentioned in the interviews. This reflects somehow that the majority of the talks were conducted with providers from the private sector. Typically, *Advocacy & policy engagement* is a strength of research driven public institutions such as NMHS or other governmental bodies. They provide advice to policymakers on different levels (e.g. regional, national or EU). Although it is for most of them not a core activity, for example policy briefs or participation in advisory groups and committees plays an important role for strategic planning for overarching research topics, funding lines and political directions (e.g. climate adaptation planning).

- *"xxx is intensive consulting with federal and state bodies."*
- *"In an international river basin commission (specifically the International Committee for the Protection of the Rhine), the xxx has taken a leading role in drafting scenario reports by a group of experts, working together with colleagues from different states and neighbouring countries."*

Finally, beyond the customer-related activities, administrative (back-office) processes such as finance and personnel are required regardless whether the provider is based on public or private funding. As in the area of public providers, proposal writing and scientific publications are important cornerstones for successful and sustained performance, in the private sector acquisition of new customers through e.g. product advertisement or sales representatives are elementary to successfully operate their business.

- *"You need to sell the project, so that's a key activity. You need to win projects, and you need to write proposals. So the pursuit phase is an activity. And then you need to carry out the project in the project team. And then you need to deliver and administer the projects. So, that are the key activities within the project phase, I think."*

3.2.8 Key Partnerships: Who are your key collaborators?



By **Key partnerships**, we refer to collaboration with external organizations or entities that help the company achieve its goals and deliver its value proposition. Partnerships can include data suppliers, technology distributors, joint ventures, or alliances with other businesses. Key partnerships were recognised as a fundamental element in the business model canvas for all interviewees, both public and private, as they rarely operate alone in the climate services market. Strategic collaborations, as a matter of fact, help the interviewed partners reach areas they couldn't access on their own, increasing their capacity to provide comprehensive and useful services to their customers and users.

The most common type of partnership is undoubtedly with the "*Research*" sector. Collaborations with universities and research institutions are among the most widespread, as they allow both private companies and public organisations to access new knowledge, models, and methodologies, helping them stay at the forefront of global developments. Many of these partnerships, particularly within the European context, take place through EU-funded projects. As one SME stated: *"Our long-term goal is to stay involved in research and development projects to keep us updated and support the development of new components and similar innovations."* For companies focused on consultancy, key research partnerships are often with institutions that can translate data into actionable information: "*we're constantly looking for partnerships, especially on the software and data provider side, because that's not our core business. So if anyone can help us focus by providing us with high-quality data that we can trust, that's something we're always looking for.*"

Along the same lines, several "*Space programmes"* were identified by interviewees as crucial enablers for delivering their value propositions. In particular, Copernicus was the most frequently mentioned program, as it is regarded as a highly valuable initiative for compiling a comprehensive, standardized data foundation at the European level, which can then be used for national and regional applications. Copernicus primarily acts as a data provider, offering satellite-based Earth observation data that most climate service providers rely on. Other key partners mentioned include major space agencies such as ESA and NASA. Like many research institutions, these agencies often engage in collaboration through European-funded projects. One interviewee recalled: "*there was an ESA project a few years ago that was very interesting to create intercontinental collaborations, so between Europe and outside Europe, and it gave us a network that we still have and are working on today"*.

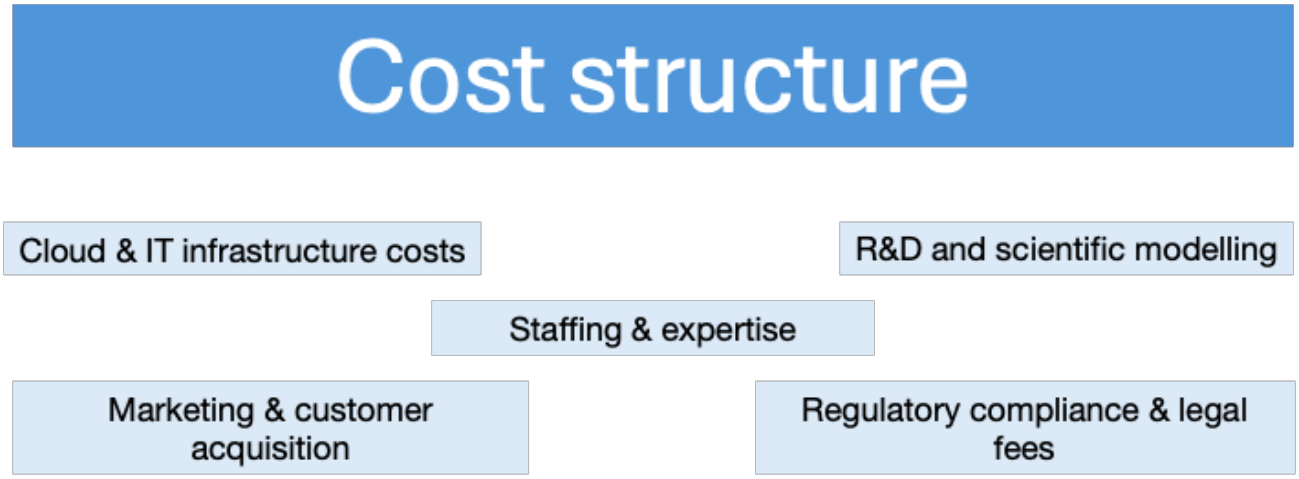
Regarding partnerships with "*Governments"*, the majority of interviewees reported partnerships with government-funded bodies and national hydro-meteorological institutes, which play a crucial role in providing data or co-developing services. In contrast, municipalities and regional governments were rarely mentioned as direct partners in service co-development. As one participant noted: *"So let's say in terms of business strategy, we won't go for the cities directly but eventually support someone that answers to the city calls around environmental data services, whatever they do, and support them with the data, we do it in partnership."* Trust and long-term relationships were also highlighted as essential for establishing partnerships, particularly with the public sector. As one interviewee put it: *"In the Netherlands, we have a long history, so we're involved in public projects and are frequently invited to participate in public tenders. In other countries, the situation might be different."*

In addition to building relationships with organizations and institutions, several interviewees expressed varying needs for relying on external providers for technological support. While larger institutions tend to manage data internally ("*This is in our plans. The idea is to move to the cloud, but currently we manage everything through our own storage; this is also more cost-effective for us")*, it was more common to hear about the use of external services such as Amazon Web Services (AWS) for data storage.

Finally, "*Civil society organizations"* were the least frequently mentioned type of partner. Among the few references, international organizations such as the Red Cross and the IPCC were cited.

It is also important to note that, despite instances of competition, rivalries, and acquisitions, both public and private actors often mentioned actively collaborating with other businesses. These collaborations contribute to the creation of a dynamic ecosystem, a network of private sector actors working together. As stated by one interviewee: "*The network we built through acquisitions of companies, through partnerships, through client relationships. That's a very important learning. We're natural to partner with a lot of companies so we're building an ecosystem of companies together with many others.*"

3.2.9 Cost Structure: What are your major expenses?



Costs for a climate service encompasses all the expenses incurred by the company to operate its business model. Expenses can comprise a) *Cloud & IT infrastructure costs (data & modelling)*, b) *Staffing & expertise*, c) *R&D and scientific modelling*, d) *Marketing & customer acquisition*, or e) *Regulatory compliance & legal fees*.

With respect to costs, most providers of climate services indicate two major cost blocks that stand out: personnel and operational costs.

Costs for *"Staffing & expertise"* are often very high as developing climate services (modelling, data analysis, application developments), documentation and interaction with customers (co-production and consulting) requires qualified personnel and also time. This is valid for both, private as well as public providers. This correlates also with the outcome of the customer relationship part where the importance of close collaboration and interactions with users was emphasized by many interviewees.

On the other hand, in particular private providers have to keep a positive balance of revenue vs. costs (i.e. run their business profitable), thus, these providers are trying to use their personnel as efficiently as possible.

With respect to future developments, AI methods might reduce labour-intensive tasks, e.g. documentation of products, programming assistance, etc. Some examples are provided in the following subsection.

Some quotes from individual interviews related to personnel costs:

- *"We wanted to hire people, more specialized people on machine learning and it's obviously very difficult because they're very much popular on the market and people pay them a lot of money."*
- *"Almost entirely personnel. I'd say 90% personnel and 10% infrastructure. We are trying to be more economical in our use of resources."*
- *"The largest share so far is still the personnel performance from the team."*
- *"Exactly, staff and our offices - those are actually the cost items."*
- *"First of all personnel costs, which account for 70% of the company's costs."*

The second cost block that stood out from the interviews were operational costs, for "*Cloud & IT infrastructure"* such as computational costs (modelling), data storage and handling. Although many service providers use freely available data from public sources (e.g. Copernicus data store, CMIP analyses etc.), they either operate their own model approaches to downscale information to the local level that customers need, or they buy products from external service providers. Some providers are trying to reduce such operational costs by outsourcing expensive computational operations to external providers. Applying AI methods also requires additional computational resources which might shift the cost structure from personnel to operational / computational costs in the future.

Some quotes from individual interviews with respect to operational costs:

- *"We've entered an era of high-resolution data and vast quantities, which has become very expensive to produce and maintain, especially when major organisations like C3S are archiving data anyway."*
- *"So operationalise means that there is a virtual machine focused on that, which is able to provide this service to several users at the same time. So you need a good virtual machine, that is secure, that is offering these, that is running 24/7, and is able to do this by itself. So the machine is one of the costs."*
- *"If they (i.e. customers) ask for the large domain data extraction for a specific period of interest, then this comes with a cost, and the cost is not from the fact that they are buying the data, it's more like to cover internal expenses for someone to go in and do the data extraction. For the models as well, the code of the model is also open, it's open source, but the setup of the model is not open source, because there's been quite some repurposing of the data."*
- *"We have a gigantic compute bill to do the downscaling, the debiasing and to store the stuff."*

Another strategy that was mentioned is to provide users with (licenced) models that they operate on their own which reduces computational costs on one hand and provides revenue through licencing:

- *"We're shifting towards providing the models, with the users running them, while we offer support for maintenance or upon request. We still handle computational costs, doing so on demand. While some of our models still run operationally, I think the trend of us maintaining fully running models is decreasing."*

Closely connected to both previous topics are costs generated by "*R&D and scientific modelling"*. They often require sustained investment in tools, computation, and expert time, thus are somehow also covered under staff and operational costs. Although many providers are using results from publicly available model simulations, data analysis, downscaling or adaptation to user needs requires a substantial amount of scientific expertise and computational resources.

While not the largest cost category, "*Regulatory compliance"*, legal considerations, and intellectual property management are important hidden costs in climate services. These affect how services are structured, priced, and delivered. Providers are increasingly adapting their business models to mitigate legal risks, ensure data transparency, and remain commercially viable in a shifting regulatory landscape.

Other cost factors can comprise "*Marketing and customer acquisition*", nevertheless, interviewees, if at all, put this in a secondary row. It can be argued that due to the special situation of the climate service market, advertisement and marketing does not (yet) play that crucial role as in other businesses. Providers often either have a regional or thematic focus, are known or are competing on proposal driven

level (e.g. publicly funded projects). Exceptions might be the financial & insurance sector where globally operating commercial players are competing. Nevertheless, with respect to the overall cost structure this topic did not play a dominant role in the interviews.

- *"We do have some expenses in marketing (not too much marketing) – should be improved, mainly for staff, organising events, not a dedicated line to improve our projects."*
- *"Only limited investment in marketing and communication (not a dedicated budget line)."*

3.2.10 Innovation potential and contributions to transformation

In this subsection we summarize findings related to questions on innovation and transformation which are beyond the classical BMC model approach but could provide valuable information about future roadmaps and plans for climate services.

1. **Innovation potential**

Interviewees were asked about their views on innovative developments of their climate services or in the field of climate services in general. This could encompass new methods (e.g. AI, digital twins, machine learning), new products or other innovative ideas that from their perspective could develop in the near future. Special emphasis was put on the role and usage of AI-based methods and products.

Answers from interviewees differ substantially reflecting a higher innovation potential in start-up's, SME's and project-based services. The answers to actual (or future) use of AI concepts document that this is a dynamic and fast emerging field. Responses range from: '*no, this is not interesting at all and not feasible*' to '*we already apply AI-based methods in our service products, and we see a high potential for future products'*. Applications range from chat-bots facilitating documentation and user-support to products which are already entirely based on AI-technology. By using AI-methods climate forecasts and projections could be improved, processes optimized, and personnel-intensive tasks reduced.

However, not all providers have already unravelled the potential of such innovative methods ("*AI thing is not as fundamental as you might assume it is from a core innovation standpoint", "I am not aware that we really use AI or operate a lot in this area*"). Although the current interview series is not representative, there is a tendency that innovation in the field of climate services is stronger from start-ups and SME's and publicly funded projects than from larger, well-established providers.

Furthermore, in particular for larger providers not all interviewees might have a full overview about all activities related to the climate services they offer (e.g. it makes a difference if you talk to somebody in the sales department or the R&D group).

Some quotes from individual interviews with respect to innovation.

- *"Our entire product is based on artificial intelligence. So our projection models are not physical simulation models but different types of AI models, depending on the type of risk and the type of variable measured". … "Based on the risk and the type of risk, we develop a model that is capable of quantifying the risk, which is an AI model." (private)*

- *"It was interesting to see that one of our competitors introduced a chatbot into their platform, thus integrating the AI part." (private)*
- *"We exploit spatial climate and similar data with AI-based and hydrodynamics models." (private)*
- *"In my opinion, when one works so much in an academic context, one runs the risk of losing sight of the market and the end users need short-term solutions as opposed to decadal predictions for example." (private)*
- *"We got support from Amazon to do that because they want their clients to use the resources. It's their interest to have their machines running and they wanted to promote machine learning. So they actually sponsored us by financing a consulting company to help us implement machine learning on AWS." (private)*
- *"We've done some work … behind the scenes and basically having AI bots that support our customer queries so that instead of reading 200 pages of documentation, you have an LLM (large language model) that's already pre-trained on our documentation and becomes the agent that you interact with when you need answers to your questions." (private)*
- *"The possibility to work within the context of EU-funded research projects is a main driver for our innovation." (private)*
- *"Regulation and standards are a major driver of innovation, and they can significantly boost the demand for innovative tools". (private)*
- *"Everybody's using 'digital twin' because it's modern. We used to call it the 'coupled model' and 'social hydrologic model' in the past. Now it's 'digital twin,' raising expectations." (public)*
- *"For instance, CEMS[2] is working a lot with cutting-edge methodologies, tools, data, and so on, so we could have access to this information, trying to improve both the science and also the operational services at the national scale." (public)*

2. Transformation:

In the interviews the topic "*contributions of climate services to / for transformation*" was often not addressed explicitly as it is somehow an overarching view on climate service activities and their impact on societies. Thus, conclusions can mostly be drawn integrating knowledge from different elements of the BMC such as value proposition, key activities and customer segments and customer relationships.

Thus, are at present or in future climate services supporting transformational adaptation processes towards a climate resilient society? What is needed for such a goal beyond providing projections for future climate change? In general, these questions can only be addressed by services that have long-term perspectives. Thus, climate services that are providing seasonal predictions do not have the long-term focus needed for transformational processes.

- *"Resources are limited, in the sense that they have an end, a certain amount of resources each year, and I have to decide how to allocate them. If I want to make an impact, I have to find a way to use the 80-20 rule: where can I spend 20 to get 80? So these tools must be able to optimise capital utilisation, prioritising the most vulnerable areas and creating projects that can withstand events*

[2] Copernicus Emergency Management Service

that may occur at that point, not with the intensity we see today but with the intensity we will see in 20-30 years, because these are very important infrastructure projects that may take years to build and then have to last at least 50 years. So where to go in the long-term. And all this can be done if I have a solid database behind me that tells me where these events could happen, how strong they could be, and therefore the whole basis of adaptation is the efficient allocation of financial resources to protect us from these events in the future." (private)

Risk assessments, typical products from private providers for the insurance and financial sectors, have different time horizons, depending on the assets of their customers. Here, for real estates and long-living infrastructure (e.g. buildings, railroad systems, etc.) developments for next decades are important. Therefore, risk assessments for such assets are often accompanied by recommendations for adaptation and mitigation (e.g. protect or relocate infrastructure against climate hazards, reduction energy demand or sustainable / renewable energy supply). Efforts in these areas are driven from the provider as well as the user side. Providers, e.g. insurance companies, are facing higher financial losses due to extreme weather and users are facing, if at all possible, higher rates for their insurance. Thus, by applying appropriate adaptation measures a win-win situation can be achieved for providers and users of climate services.

- *"So we do risk engineering, onside assessments, that means a risk engineer really goes on site with rubber boots and looks at it and then sees if your emergency generator is in the basement and you're in a flood zone in a flood zone bad idea and then comes a list of risk improvements we call that and that and if this list is empty, because they've already done everything, then it's a top customer so the risk engineer gives a rating to the underwriter." (private)*

Climate services for the urban and health sectors are addressing more the general public or society at large. How can we protect human health against climate extremes, what measures to implement to make urban environments more resilient to extreme conditions (e.g. flooding, water & heat stress, sea level rise)? This requires not only protection of assets (e.g. dikes, water reservoirs) but also changes in urban development (e.g. greening of cities areas) and societal behaviour (e.g. sustainable use of resources and renewable energies, sustainable mobility concepts, etc.). Information, education and training can play an important role to enlarge the acceptance and willingness to adapt and transform to a more climate resilient society.

Quoting a provider from the insurance sector:

- *"Comprehensive training programmes to succeed in the sustainable transition, through an online learning experience, covering 8 different professions in 8 different languages. Over 6 million employees have been trained on environmental issues through 40+ hours of digital content, helping them adapt their skills and guide their companies through the transition." (private)*

One interviewee addressed the topic explicitly:

- *"So, on the one hand, we have a more methodological approach, and I have further extended the methodology of this pathway into a climate resilience development pathway. So not only focusing on adaptation but also mitigation and sustainable development." (public)*

Another interviewee pointed towards limitations in this context:

- *"But the fact that there is no socio-economic assessment during the co-creation phase, I think that creates a gap between the service and the communication of the added value, which leads further to no uptake conditions." (public)*

In summary, in some aspects climate services explored in this study support transformational processes. This is in particular valid for services with a long-term perspective, e.g. risk assessments or climate adaptation planning and those that directly interact with societal relevant groups e.g. through training, events or other stakeholder engagement with the general public.

4. Discussion & Conclusions

4.1 General findings

The interviews with a broad range of climate service providers from the public and private sector following the classical approach of a commercial business model set-up (Osterwalder & Pigneur (2010)) has provided valuable insights in the business innovation and development of the climate service market.

Although there is a backbone of existing CSs that serve legal requirements such as climate adaptation plans, ESG[3] reporting or risk assessments for (financial) assets, the market of CSs is still developing dynamically and rapidly implementing new and innovative ideas and concepts. This is either done through publicly funded projects where new ideas and concepts for CSs are developed and tested in close interaction with designated users but as well by private providers who are competing with other companies to obtain higher market share and profit. Thus, innovation activities can have different goals: either to develop new ideas and products but also to make products more efficient, profitable and successful. The latter elements might be more typical for the private sector nevertheless, the development of innovative products e.g. such as AI-based applications is primarily driven by the private sector as there the reaction to new technologies is faster than through publicly funded activities. In the public sector, the interaction with the users, the co-design and co-production process is typically more intense, including feedback loops and evaluations. Products developed by public providers are often more experimental which supports the implementation of innovative ideas and concepts (e.g. interactive decision support systems, participatory concepts, etc.). In contrast to private providers, time constraints are often less tight and the upscaling or transferability of services is often limited due to funding issues. In general, a commercialization of CS developed by public providers by spin-offs is possible but not very common. Beside innovative ideas and products a successful commercialization of a CS requires good business management and financial backups.

The BMC approach by Osterwalder & Pigneur (2010) aims to create a profitable business which addresses not necessarily needs for sustainable and equitable climate services for climate adaptation and a climate resilient transformation. Thus, do present climate services within this study address such approaches towards transformational adaptation or are there innovative methods and business models which are currently being developed to support this challenge? If not, how to achieve this goal? In the

[3] Environmental, Social, Governance

following we are discussing these questions by revisiting the approach by Cools et al. (2024), see Table 1, Section 1.1.).

The first category suggested by Cools et al. (2024) is the "**scope**" or ability of services to affect and influence an entire system (*system-wide effects*). For example, global players like large insurance companies are influencing with their risk assessment service the global markets. Services like Copernicus, global data stores or research institutions or NMHS operating global climate models have system-wide impacts. Not all services are *scalable*, in particular those based on public research funds have limited options to maintain, scale and transfer their services for other applications whereas private services will always try to develop products which are applicable and useable for a broad range of customers.

In the category "**depth**", Cools et al. (2024) suggested the following characteristics: *path-shifting*, *restructuring*, *innovative* and *addressing root-causes*. The services investigated in this study in particular address two of the above-mentioned criteria: *restructuring* and *innovative*. As discussed in section 3.2.10 various new innovative approaches are currently being explored with the goal of better products with higher accuracy and faster delivery (e.g. machine learning of AI-supported processes). Risk assessments as for instance performed by the insurance sector are often leading to restructuring / rethinking by the customers as the providers put pressure on them if exposures to climate risks are not reduced by appropriate adaptation measures. This could be changes in production processes, protection or a relocation of production sites or other assets.

In the category "**impacts**", changes in *beliefs and attitudes* and *governance* are mentioned by Cools et al. (2024). Here different stakeholder groups are addressed, from political decision makers to the general public. Services that are reaching out to these user groups are primarily provided by the public sector. Close interaction and co-production processes (e.g. living labs) or those involving democratic decision-making processes (e.g. through public participation) can lead to societal transformation. Development of climate adaptation plans can be seen as a first step, but ultimately the implementation and acceptance of measures suggested through the planning process leads to the envisaged long-term impact.

The long-term perspective is covered by the "**temporality**" category, Cools et al. (2024) describing this with the characteristics "*Persistent*", "*Long-term vision*", "*Future benefits*", and "*Dynamic*". Thus, the long-term perspective of CSs supports societal transformation but do the services which participated in this study have such a long reach? Some of them do, others not. For example, typical time horizons in the financial and insurance sector are often focussing on the next 5-10 years at maximum. Longer time scales are addressed for instance in planning of infrastructure (e.g. buildings, roads, railway tracks) or in forestry. Services addressing these sectors are using various climate projections and have to address uncertainties. In particular, CSs provided by NMHS, research institutes and re-insurance companies are often supporting these long-term time horizons with their products. They also take historical data (learn from past experiences) into account. In addition, services which are supporting adaptation planning for cities / regions also support transformational processes on longer timescales.

Finally, the category "**inclusivity**" aims for services which provide *equitable*, *synergetic* or *SDG-aligned* products. Here products from public providers have a clear advantage to commercial products from private companies.

In summary, many CSs investigated in this study address to some extent aspects relevant for transformational adaptation. Nevertheless, there is no coherent and fully established approach or mechanism to implement adaptation measures leading to the transformation to a climate resilient society. Furthermore, in particular for private providers of CSs this is not their primary focus. Some examples of public providers using innovative methods pave the way. One example which supports this process are living labs e.g. as implemented in the I-CISK project. Through intensive stakeholder interaction and dialogues, CS can support a transformation to a climate resilient society. Jabłoński (2023) proposed a change in the set-up business models to address overall climate benefits and values offered, which can include climate risk, green technologies, and carbon footprint in the value chain. This approach integrates aspects of adaptation and mitigation, a concept that could contribute to successful transformational adaptation.

4.2 Recommendations and Guidance

What conclusions can be drawn from this study with special emphasis on how CS can be improved to address transformational adaptation towards a climate resilient society? In the following section we provide a reflection on this topic structured along the four components of CSs identified by Climateurope2: Decision context, Ecosystem of actors, Knowledge systems, Delivery mode and evaluation (Doblas-Reyes et al., 2024, Baldissera Pacchetti, & St.Clair, 2023).

1. Scope of the CS addressing transformational adaptation (relates to the **Decision context**)
   The decision context is a key starting element in the development process of a CS. Questions which have to be addressed are for example: "*Who are the designated users of the CS? What kind of information are they requesting or what do they need to establish mechanisms beyond the adaptation to a climate risk, i.e. to establish a behavioural change in the long-term? What other factors influence their decisions and are competing with climate adaptation and mitigation efforts?*" For almost all CSs investigated in this study, the decision context plays a fundamental role to plan and to develop the service, regardless of whether the service is created by a private or public provider. This can be derived from the answers to customer relationships and value proposition. In the area of customer relationship, the "*Advisory & consultation-based relationships*" and "*Community engagement and co-creation*" are the most frequently named categories. For these approaches and methods, the knowledge of the decision context is key to deliver information that support transformational changes through value propositions like "*Strategic resilience and policy planning*" and "*Policy and legal compliance advisory*" which were often mentioned.
   - Thus, transformational adaptation can only be successful if the climate services which aim to support this process address all relevant aspects of the context such as user needs and other factors that influence decision making into account.

2. Addressing an audience suitable for transformational adaptation (related to the **Ecosystem of actors**)
   Relevant questions to be addressed with respect to the ecosystem of actors are: "*Who are the actors? How to reach out to them and how to establish an efficient dialogue? How to accomplish mutual understanding*?" As societal transformation requires a broad acceptance of change processes and measures applied, what are successful communication methods that can convince a majority of the stakeholders to accept and implement them? As mentioned before, here the

interviews showed a strong emphasis on close customer relationships either through *Advisory & consultation-based activities* or *Community engagement and co-creation*. Both play a central role in the customer relationship strategy of climate service providers. Providers emphasized that close collaboration, iterative refinement, and transparent communication are essential to build trust, enhance usability, and tailor services to user needs.

- Thus, intense customer relationships through a continuous co-development, co-creation and co-implementation process including feedback and evaluation (see below) can ensure that the CS supports transformational processes.

3. Product design addressing transformational aspects in an appropriate way (related to **Knowledge systems**)
   Ideally, a successful product which is paving the way for societal transformation should be easy to understand and use and it should provide positive achievements in a short period of time. This is a major issue with respect to transformational changes which a) require time to be implemented and b) in case of climate change show positive impact of established measures and methods only on the long-term. Thus, either (financial) investments or (social) engagement will only pay-off in the long-term far beyond typical planning horizons of human beings. In this sense, successful CSs for transformational changes have to provide "quick-win" pathways that provide a positive return on the short-term but have a positive (climate) effect on the long-term. This can be financial benefits by achieving lower insurance fees by applying adaptation measures to assets or improving the quality of life by greening of the city or social by gaining reputation by establishing a climate resilient lifestyle. Thus, the CS product has to be closely connected to the context and the actors to reach a good and long-lasting impact. Some of the CSs of this study support pathways as described above, either through financial or social benefits by implementing adaptation measures.
   - In addition to the context and actor related factors (see the first two items), a CS product that supports transformational processes has to have a long-term perspective but also needs short-term goals as planning horizons and user perspectives are mostly on short timescales.

4. Delivering the product in the right way at the right time to the right audience to accomplish the envisaged impact. To improve products feedback loops and evaluations are included. (related to **Delivery mode and evaluation**)
   The success of the transformation also depends on whether you can reach your customers with the information they need at the appropriate time. The monitoring whether and how the product is received and what kind of impact is generated is an important instrument to readjust and improve a service according to the feedback and evaluation results. A transformational adaptation requires long-term perspectives, continuous feedback and evaluation but also innovation to be successful. The interviews conducted in this study provided limited insides to these aspects as they reflect only the provider side. Nevertheless, the importance of customer feedback and the emphasis on close co-production and customer interaction gives hints that providers have a high interest to receive customer feedback to improve and optimize their products.
   - Continuous feedback processes and evaluation procedures are helpful to improve CS products in particular on longer timescales needed for transformational processes.

In summary, climate services explored in this study at least partly support transformational processes. This is in particular valid for services with a long-term perspective, e.g. risk assessments for long-living assets or climate adaptation planning and those that directly interact with (societal relevant) user groups. Nevertheless, the BMC approach by Osterwalder & Pigneur (2010) used in this study aims preferably to create a profitable business which addresses not necessarily needs for sustainable and equitable climate services for climate adaptation and a climate resilient transformation. Thus, a business model for transformational adaptation needs to take additional factors into account. Some recommendations could be made along the 4 components of climate services as defined by Climateurope2.

4.3 Outlook

This report is the second deliverable of Task 3.2 on Business Innovation. With this study we have tested the theory of business models as discussed in the first deliverable of this task based on the Business Model Canvas in a large set of qualitative semi-structured interviews with a broad suite of climate services providers with strong emphasis on the private sector. This approach provided in-depth insides to many aspects of design, production and application of CSs. In addition, the study provided valuable hints of new, innovative methods which are needed for aspects of climate adaptation towards a climate resilient society. In order to support the transformative processes CS products are needed to accomplish that CSs have to be designed appropriately. The last deliverable of this task D3.6 “Technical briefs and taxonomy of sustainable business model innovation” (M48) will therefore focus on the needs for CSs to fulfil this goal.

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Appendix 1: Interview protocol

1. Purpose of the protocol

This protocol outlines the workflow and process applied during the interviews conducted under the Climateurope2 task T3.2: Business Innovation. The protocol specifically refers to the interviews that will inform Deliverable D34. This deliverable/report examines the (business innovation) practices and strategies employed by climate service providers—both private and public—to ensure the sustainability of their services and to justify the introduction of new offerings. This protocol builds upon and complements the **project's guidelines** on conducting interviews and contacting respondents (see additional details in the following text).

2. Introduction to the Interviews

- **As a research method**. The primary method for gathering insights into business innovation practices and strategies is through interviews—referred to as **business or innovation dialogues**—conducted between team members (interviewers) and service providers (interviewees or respondents). Unlike standard interviews, these dialogues are designed as **bilateral exchanges**. Interviewers not only collect information about the reasoning and motivations behind the business innovation choices of service providers but also guide respondents to reflect on their decisions. Throughout the dialogues, respondents are encouraged to consider alternative approaches and are introduced to relevant developments in the field with which they may be unfamiliar or have limited awareness. This approach fosters deeper insights and mutual learning.
- **General principles**. The interviews are carefully planned, and the interviewers are aware of their ethical responsibilities. The interview objectives must be clear and well-structured to guide the discussion effectively. Respondents must be fully informed about the purpose of the study, their rights, and how the information will be used, ensuring consent is obtained beforehand. Anonymity and confidentiality are respected to protect participants' privacy. The interview setting should be comfortable and conducive to open dialogue, avoiding any form of bias or leading questions. Interviewers actively listen, allowing participants to express their views freely while maintaining neutrality. After the interview, proper documentation and secure storage of data are ensured. The team is fully transparent about the results, reporting the views, perspectives, and insights accurately and fairly, while upholding the integrity of the research.

3. Conduct of Interviews

3.1 Process

- **selection of respondents**. Respondents are selected from a previously agreed list and in alignment with the agreed division of work. The minimum sample size of respondents (30) will be revised throughout the implementation of Task T3.2, with the possibility of gradually increasing the sample size within the limits of available resources. A balance between the public and private sectors will be ensured, with the guiding target set at a ratio of 1:2,

meaning at least one-third of the interviews will target the public sector, while two-thirds will focus on the private sector.

  - Geographic balance is not the primary focus of this research, as the aim is to gather information about employed practices and their combinations. However, considering that regulatory conditions may differ across countries and regions, potentially creating competitive advantages for advanced business innovation practices, a balance between advanced and lagging economies within the European Union and beyond should be maintained.

  - While the research scope is not limited to the European Union, most respondents will likely be recruited from Europe for practical reasons.

  - The main recruitment mechanism involves leveraging the pool of participants managed by WP6, specifically those engaged in project activities, to identify and contact potential respondents. The list of the interviewees includes the project's common case studies and considers any changes to their composition.

- **approaching the respondents**. Before approaching the respondents, the interviews check the database of past and planed interactions with the stakeholders (see also the tracker) and inform the colleagues from other WPs about the intention to establish and follow up on the previously established contacts. The invitation to the interview is shared by email including the information sheet with the scope of the interview, guiding questions and expected results. The Project's **Guide to interviews** are fully respected. An informed consent form is collected from the respondents before or after the interview.
- **conducting the interview.** The interview typically lasts approximately 60 minutes and, with the respondent's consent, is recorded for internal reference purposes. The recording will not be shared, either internally or externally, and will be securely deleted once the interview report is finalized. A summary of the interview, anonymized to protect the respondent's identity, will be shared with them afterward, allowing for the correction of any inaccuracies or misunderstandings.
  1. The interview is guided by business model framework using the *Business Model Canvas* (BMC) and the innovation areas outlined therein. BCM consists of a visual framework that simplifies the process of designing, describing, and challenging business models. It consists of nine building blocks: 1) the value proposition, representing the unique value a company offers through its products or services; 2) key resources, 3) key activities, and 4) key partners, which outline how the company creates and delivers the value proposition; 5) customer segments, 6) channels, and 7) customer relations, which describe how the product or service is delivered to users and how relationships with customers are managed; and finally, 8) the revenue stream and 9) cost structure, detailing the ways in which the company generates revenue, charges costs, and ensures the financial viability of its operations.
  2. BMC serves as a guide for business innovation, helping to reconfigure key components to ensure alignment with user needs and evolving market conditions. Business innovation doesn't necessarily require creating an entirely new framework - it often involves refining specific elements of the value network, such as the value proposition, delivery, and capture mechanisms. These *'value strategies*' help address challenges like low demand, competition, and market changes, while also enabling businesses to tap into new

opportunities driven by evolving preferences, technology, and regulations. Business innovation can also focus on enhancing organizational structure, fostering in-house expertise, and building strategic networks. The ambition behind innovation drives the depth of exploration.

3. The interviews require that the **expert interviewer holds a deep understanding of climate services and the various options available for providers to innovate their businesses**. These options may include leveraging technological advancements, optimizing analytical workflows, forming partnerships with other entities, or restructuring costs and revenue streams. Deliverable D3.2 offers valuable insights into these choices.
4. Value proposition is the central element shared with the task T3.1. A categorization of the value proposition should be pursued in collaboration across both tasks of the WP3. Initial set of the value proposition may include but are not limited to

    — improved **efficacy** (ability to produce a desired or intended outcome) and **efficiency** (how well resources - time, money, energy, etc. - are used to achieve a desired outcome); e.g. increase agricultural yield, water and energy savings by more efficient application and planning, etc.,

    — **avoid or reduce damage and losses** (e.g. from extreme climate events and/or business interruptions,

    — build **resilience** to shocks, boosting coping or adaptive capacity, and **strategic planning capabilities** (e.g. DRR and climate adaptation, transformation and transition strategies),

    — monitor and continuously analyse critical (e.g. environmental, economic) conditions or compliance with regulatory or otherwise defined standards and targets (including sustainability)

Appendix 2: Codebook for Qualcoder data analysis

Category	Definition	Description	Code	Description of codes
Value proposition, or customer value	Unique value a company offers to users	Customer value of climate services can comprise e.g. climate forecasts and analytics, early warning systems, policy and legal compliance advisory, operational performance optimization, or strategic processes for resilience.	Climate analytics	Advanced analysis of climate data to support informed decision-making.
			Early warning systems	Systems that provide timely alerts for extreme climate events. Deliver value by protecting lives, assets, and infrastructure through early action.
			Policy and legal compliance	Support customers in meeting environmental and climate-related regulations. Enables organizations to stay compliant and avoid legal or financial penalties.
			Operational performance optimization	Improving operations using climate and weather insights. Enhances efficiency and reduces risk in climate exposed sectors
			Strategic resilience and policy planning	Long-term planning support for climate adaptation and resilience. Helps organizations and governments prepare for future climate scenarios.
Key resources	Assets the providers need to deliver its value proposition and sustain its business operations.	Providers assets can comprise infrastructure for modelling and data analysis, scientific expertise & intellectual property (patents, brands), strategic partnerships, market knowledge or financial resources.	Data infrastructure & cloud computing	Technological systems for storing, processing, and accessing climate data; Essential for delivering scalable, real-time climate insights and services.
			Scientific expertise & intellectual property	Knowledge, models, and tools developed by climate scientists and institutions; Forms the core of reliable, high-value climate service offerings.
			Regulatory & market knowledge	Understanding of policy frameworks and climate-related market dynamics; Supports tailored services aligned with user needs and legal requirements.
			Strategic partnerships	Partnership with research bodies, tech firms, or public institutions to expand capabilities, access to data, and delivery channels for climate services
			Brand & trust	Reputation for scientific accuracy, reliability, and ethical standards; Builds user confidence, crucial for

Category	Definition	Description	Code	Description of codes
				adoption of climate-sensitive solutions.
Key activities	The most important tasks and processes the company (must) perform to create and deliver its value proposition.	Key activities to create and deliver a CS comprise software (model) development & maintenance, data acquisition & processing, consulting & customization (co-production), marketing, and customer support	Software (model) development & maintenance	Designing and updating climate models and digital platforms; enables delivery of tailored, scientifically robust climate insights.
			Data acquisition & processing	Collecting, cleaning, and transforming climate data into usable formats; Fundamental for generating accurate, actionable climate information.
			Consulting & customization (co-production)	Collaboratively developing solutions with users based on specific needs; Ensures relevance and usability of climate services in real-world contexts.
			Training & capacity building	Educating users to understand and apply climate information effectively; Empowers stakeholders to make climate-informed decisions independently.
			Advocacy & policy engagement	Influencing policies and raising awareness about climate risks and services; Helps integrate climate services into broader decision-making frameworks.
Key partners	External organizations or entities that help the company achieve its goals and deliver its value proposition.	Partnerships can include suppliers (data), distributors (technology), joint ventures, or alliances with other businesses.	Governments	Public institutions at local, national, or international levels who provide funding, policy support, and access to users for climate services.
			Space programs	Organizations managing satellites and Earth observation systems, supply critical climate and environmental data for service development.
			Research	Universities and scientific institutes conducting climate studies; contribute knowledge, models, and innovation essential to service accuracy.
			Technology	
			CSO (Civil Society Organizations)	NGOs and advocacy groups engaging with communities and stakeholders; Help reach end-users, co-produce solutions, and build climate awareness
Customer segments	Groups of people or		Corporations & industry	Businesses across sectors like energy, agriculture, or logistics; Use

Category	Definition	Description	Code	Description of codes
	organizations based on characteristics such as demographics, behaviour, or needs. Segments can range from mass markets to niche markets, or even individualized customer bases	Customers can encompass e.g. corporations & industry, financial institutions & insurers, public institutions & policymakers, NGOs & civil society.		climate services to reduce risks, optimize operations, and plan investments.
			Financial institutions & insurers	Banks, investors, and insurance companies which rely on climate data for risk assessment, portfolio management, and underwriting.
			Governments & policymakers	Public agencies responsible for regulation, planning, and public safety; use services for policy design, disaster preparedness, and climate adaptation.
			NGOs & civil society	Organizations advocating for communities and the environment; Apply climate information in local resilience projects and awareness campaigns.
			Citizens	Individuals and households affected by climate variability and change; Benefit from accessible, actionable information for daily and long-term decisions.
Channels	Methods and pathways to deliver its value proposition to customers. Channel management ensures that customers can access the company's services efficiently.	Delivery channels can be for instance self-service digital platforms, B2B sales, consulting & custom integration, digital marketplaces or community & open-source engagement	Self-service digital platforms	Web portals or apps where users access data and tools directly; Allow scalable, user-friendly delivery of climate services on demand.
			B2B sales & partnerships	Direct business relationships and long-term service agreements; Facilitate tailored climate solutions and integration into client operations.
			Consulting & custom integration	One-on-one services and technical integration into client systems; Ensure high customization and alignment with specific user workflows.
			Marketplaces & third-party platforms	External platforms offering climate tools or data-as-a-service; Expand reach by tapping into existing digital ecosystems and client bases.
			Community & open-source engagement	Collaborative sharing of tools, data, and practices with communities; Builds trust, encourages innovation, and broadens service adoption.
Customer relationships	Type of interaction the provider establishes	Direct as well as indirect customer relationships can exist such as automated	Advisory & consultation-based relationship	Personalized guidance tailored to client needs and decisions; Builds trust and ensures high relevance of climate solutions.

Category	Definition	Description	Code	Description of codes
	with customer segments. E.g. automated self-service to personalized assistance and community building.	decision support systems, custom-designed software or reports, individual training modules	Self-service & automated access	Clients independently access tools and data via digital interfaces; Enables scalability while maintaining usability and efficiency.
			Community & co-creation	Engagement through collaboration, feedback, and shared development; Fosters user ownership, innovation, and long-term commitment.
			Subscription & retainer-based relationship	Ongoing access to services through regular payments. Ensures predictable revenue and continuous service delivery.
			Service fees	Clients pay per use, project, or transaction. Offers flexibility and aligns cost with actual service consumption.
Revenue streams	Sources of income generated by the provider from its customers. How the company earns money from its services. Depend on the value proposition, pricing strategies, and customer preferences	Examples for revenue streams are subscription models, licensing, advertising, usage fees, commission but also research funding	Subscription models	Recurring payments for continuous access to data, tools, or services; Provides stable, predictable income and supports long-term client engagement.
			Licensing	Fees for the right to use proprietary models, data, or software; Monetizes intellectual property while enabling external application.
			Advertising	Revenue from displaying third-party promotions on platforms which can subsidize free services, especially in public-facing digital tools.
			Usage fees	Charges based on data volume, API calls, or number of reports; Aligns pricing with actual service consumption, ideal for on-demand access.
			Commission	Earnings from facilitating transactions between third parties; Applicable in platforms or marketplaces for climate-related services or tools.
			Research funding	Grants and contracts from public or private funders; Supports R&D and service innovation, often tied to public-good objectives.
Cost structure	All the expenses incurred by	Expenses can comprise IT infrastructure costs (data & model-	Cloud & IT infrastructure costs	Expenses for data storage, processing, and platform maintenance; Fundamental to ensure reliable, scalable climate service delivery.

Category	Definition	Description	Code	Description of codes
	the company to operate its business model	ling), staffing & expertise, marketing & customer acquisition, or regulatory compliance & legal fees	R&D and scientific modelling	Investment in developing and updating climate models and tools. Core cost to maintain scientific accuracy and innovation
			Staffing & expertise	Salaries for scientists, developers, consultants, and support teams. Essential human capital driving service quality and customization.
			Marketing & customer acquisition	Costs to promote services and attract new clients or partners. Critical for growth and market penetration.
			Regulatory compliance & legal fees	Expenses related to meeting legal requirements and intellectual property protection. Ensures lawful operation and safeguards organizational assets.
Innovation			Transformational adaptation recommendation	Innovative ideas that should be taken in consideration regarding transformational adaptation
			Innovative methods	