# Policy implications and recommendations on promising business, resourcing, and Innovation for climate services

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# EXECUTIVE SUMMARY

This is the second report from the synthesizing work package 5. In this Deliverable, we discuss with what kind of **policies and measures obstacles regarding the uptake of climate services** can be resolved or at least alleviated, and what the roles of public and private sector can be in enhancing the uptake. The obstacles were identified and rated in terms of significance in the preceding Deliverable 5.1. In that same Deliverable were also mentioned preliminary propositions for policies and measures aimed at relieving or resolving the obstacles.

This Deliverable builds on the preceding project work by adding considerations on market conditions and resourcing options, and the consequent manoeuvring space left for choosing viable business models in given market and resourcing contexts. It just as well links these business model alternatives with the basic climate service product types used for describing main product-market segments (also used as quadrants to frame the discourse for initial offers. Important in this context is the notion of **policy mixes** (i.e. collections of instruments and measures), which underscores that separate policies and measures often need support form other measures and policies to become more effective, whereas also the judgement of the effectiveness of measures should be carried out in contexts of combined policies.

Furthermore, the report adds further realism by introducing **three different governance approaches** which are sketches of what can be typically found in the different EU Memer States, and within which climate service promoting policy packages will be operated. Policy mixes tuned to the governance approaches are subsequently assessed on their effectiveness within each governance approach. The three governance approaches, presented as three distinct scenarios, are 'state-centred', 'business-centred', and 'network-centred':

- The **state-centred-scenario** is driven by equity and safety concerns, and aims to ensure sufficient resilience across society, in all regions to the extent needed and deemed affordable. In this policy scenario can still be a lot of room for private climate service provision, but there will be a stronger inclination to public intervention.
- The **business-centred scenario** is based on a firm belief in the creativity of free markets, implying that this approach best enables a high innovation rate of climate services. Public climate services would largely be limited to basic data, services meant for citizens, and climate change scenarios.
- The **network-centred scenario** is driven by the notion adaptation and resilience are often best dealt with at regional and local level and benefiting from bottom-up initiatives, meaning that local actors (citizens, civic groupings, companies, regional collaborations, etc.) have a central role, even though facilitated by public facilities and/or support.

All three governance approaches policy packages can make a **significant difference in uptake**. Nevertheless, it seems that the network-centred approach tends to offer the best prospects for uptake, when accounting for the fact that the different goverance approaches can also slip into promoting also other agendas, alongside climate services promotion.

**Important policies and measures** relevant in all policy scenarios are:

1. **(Self-) regulation** on mandatory climate risk reporting, transparency, & accountability – at least for several sectors, such as financial sector, urban planning, critical infrastructure, and food supply
2. Enable, incite and support **collaboration** between different types of actors, notably also across the public – private divide, to engender learning and better needs based design and operation of climate services
3. When engaging in climate service development, especially public actors and public-private collaborations should adequately and timely **assess realistic and viable resourcing/business models** for the stage of regular climate service provision

4. **Standardisation**, such as of terms, product categories, and product ratings, and quality assurance which is also relevant to current and prospective users, should be pursued by the entire climate services sector
5. **Monitoring and ex-post evaluation** of climate services use and its effects, of which the results are public, with the aim to inform policy makers as well as providers and users, while inter alia also enabling to demonstrate the benefit generation capacity of different types of climate services for different types of users
6. Basic climate research aside, **innovation in climate services** should encompass user relevant aspects of service delivery, such as related to visualization, risk indicators integrated with the user's decision variables, collaborative mutual climate service development and delivery models, etc.

A **coherent and vigorous climate services policy package** can substantially lift the uptake of climate services, meaning that such a policy package can both precipitate the uptake and increase the share of the market potential that is realistically attainable.

Next to the above mentioned most crucial measures there is a **wide spectrum of innovation policy measures** for ministries, agencies, research institutes and private companies often aimed at embedding knowledge about climate services also in other disciplines as well as linking research and practice.

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## List of abbreviations

| | |
|---|---|
| ACC | Acclimatise group Ltd |
| AR5 | 5th Assessment Report (of the IPCC) |
| BC3 | Basque Centre for Climate Change |
| BOO | Build Own Operate |
| BOT | Build Operate Transfer |
| BPT | Build Pilot Transfer |
| C3S | Copernicus Climate Change Service |
| CCCA | Climate Change Centre Austria |
| CCIAV | Climate Change Impact, Adaptation, and Vulnerability |
| Climate KIC | Climate Knowledge and Innovation Community |
| CLIPS | Climate services supporting Public activities and Safety |
| CMCC | Centro Euro-Mediterraneo per I Cambiamenti Climatici |
| CO2 | Carbon dioxide |
| CS | Climate Service(s) |
| CSP | Climate Services Partnership |
| CTA | Constructive Technology Assessment |
| DG | Directorate-general |
| DRM | Disaster Risk Management |
| DRR | Disaster Risk Reduction |
| DWD | Deutsche Wetterdienst (German national met-office) |
| EC | European Commission |
| ECSP | European Climate Services Partnership |
| EEA | European Environment Agency |
| EIT | European Institute of Innovation and Technology |
| ERA4CS | European Research Area for Climate Services (operating under JPI-Climate) |
| ESA | European Space Agency |
| ESG | Environment, Social and Governance (the 3 domains of corporate sustainability) |
| ESGF | Earth System Grid Federation |
| EU | European Union |
| EUMETSAT | European Organisation for the Exploitation of Meteorological Satellites |
| FMI | Finnish Meteorological Institute |
| G8 | Group of Eight, forum of prime ministers or heads of state of Canada, France, Germany, Italy, Japan, (Russia) the United Kingdom, and the United States |
| G20 | Group of Twenty, international forum for the governments and central bank governors from 19 countries and the European Union |

| | |
|---|---|
| GDP | Gross Domestic Product |
| GERICS | Climate Service Center Germany |
| GFCS | Global Framework for Climate Services |
| H2020 | Horizon 2020 – research & innovation funding programme of the EU |
| IORP | Institutions for Occupational Retirement Provision (IORP II driective) |
| IPCC | Intergovernmental Panel on Climate Change |
| IPR | Intellectual Property Rights |
| ISO | International Organization for Standardization |
| JPI-Climate | Joint Programming Initiative "Connecting Climate Knowledge for Europe" |
| MARCO | Market Research for a Climate Services Observatory (EU-MACS twin project) |
| MDB | Multilateral Development Bank |
| MLP | Multi-layer perspective |
| NGO | Non-Governmental Organisation |
| NMHS | National Meteorological and Hydrological Services |
| NMS | National Meteorological Services |
| OECD | Organisation for Economic Cooperation and Development |
| PPC | Public-private cooperation |
| PPP | Public-private partnerships |
| PuPuP | Public-public partnerships |
| R&D | Research and development |
| RTD | Research and Technology Development |
| SDGs | Sustainable Development Goals (adopted by UN) |
| TFCD | Task Force on Climate-related Financial Disclosures |
| UNEP | United Nations Environment Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |
| VITO | Flemish Insitute for Technological Research |
| WCASP | World Climate Applications and Services Programme |
| WMO | World Meteorological Organisation |
| WTP | Willingnesg-to-Pay |
| W&CS | Weather and Climate Services |
| ZAMG | Central Institute of meteorology and geodynamics (Austrian Met-office) |

# 1 INTRODUCTION

To support further product development and effective widespread uptake of climate services, as a means to boost mitigation of and adaptation to climate change as well as capabilities to cope with climate variability, the European Commission has taken several actions in its current research programme Horizon 2020 (H2020). Essentially these actions follow from the logic to implement the European Research and Innovation Roadmap for Climate Services (cf. European Commission, 2015).

EU-MACS and its sister project MARCO deal with analysis of the climate services market. In addition, demonstration calls were launched on the added value of climate services for supposedly high value-added sectors with hitherto little uptake of climate services (SC5-01-2016-2017), while other actions focus more on networking activities interlinking to better connect relevant players (e.g. the ERA-NET for Climate Services (SC5-02-2015) and the project funded under the Coordination and Support Action (SC5-05b-2015) called Climateurope. Also many projects in the JPI Climate ERA4CS programme contribute to development of climate services, either for hitherto non-served themes and sectors or for appreciable improvement of existing climate services.

An extremely important sub-programme in H2020 is the COPERNICUS Climate Change Service (C3S) programme, which aims to compile a very comprehensive coherent and quality assured climate data set meant to support mitigation and adaptation planning, implementation and monitoring. In due course also coping capabilities of (current) climate variability are addressed.

*Key qeustions this report addresses:*

- What would be effective "**packages**" of instruments and measures under alternative (prevailing) policy paradigms?
- What are the **conditions** of the possibility that any policy option can actually be realised, in general, and these packages in different policy paradigms, in particular?
- To what extent objectives and instrumentation may change along the way, due to social **learning** processes?

In this framing, EU-MACS—European Market for Climate Services—will analyse market structures and drivers, obstacles and opportunities from scientific, technical, legal, ethical, governance and socioeconomic vantage points. The analysis is grounded in economic and social science embedded innovation theories on how service markets with public and private features can develop, and how innovations may succeed.

## 1.1 Scope and remit of this report

This report, which is Deliverable 5.2 of the H2020-funded project EU-MACS, identifies and explores the **policy implications** in the light of the Deliverable 5.1. It will also identify the existing policy trends, in particular those related to the three focal sectors, but also overarching policy trends. It develops viable policy options for a better matching of demand and supply in climate services in the focal sectors and in more general terms.

Deliverable 5.1 presented an **assessment of obstacles and mechanisms regarding the uptake** of climate services, both in terms of their interactions and in terms of significance-based prioritisation. Moreover, it identified **measures** (at sector level and at organisation level) and **policy instruments** that can be used to alleviate or resolve obstacles and improve effectiveness of mechanisms.

Deliverable 5.2 complements this viewpoint from a **mostly public policy perspective** and deals with three **key questions**:

- **Policy mixes:** What would be effective "packages" of instruments and measures under alternative (prevailing) policy paradigms?
- **Conditions for realisation:** What are the conditions of the possibility that any policy option can actually be realised, in general, and these "packages" in different policy paradigms, in particular?
- **Learning process:** To what extent objectives and instrumentation may change along the way, due to social learning processes?

## 1.2 Methodology

This deliverable has a **double task**: It, on the one hand, gathers the **policy relevant findings** from all previous work packages. On the other hand, the more **focused results from Deliverable D5.1** are also interpreted from a policy perspective. The report follows the logic of presenting the results first, while providing in the subsequent chapters the foundations for the results.

The **rationale** for this report is the following: *Firstly*, we analyse the overall and sector specific governance conditions and policies (chapter 6). *Secondly*, we discuss typical scenarios for service uptake (chapter 5) and also rate the effectiveness of instruments in different scenarios. *Thirdly*, we outline typical aspects of market conditions for climate services, including a discussion of business model alternatives, resourcing options, and the willingnesss to pay (chapter 4). *Fourthly*, we integrate the policy-related findings of Deliverable 5.1, which basically suggests a spectrum of policy instruments (chapter 3). *Fifthly*, we derive a set of policy implications from the analyses, which build the bridge to Deliverable 5.3 on policy options and which we have condensed to policy scenarios suggesting different policy mixes under different approaches to governance (chapter 2). Readers can nevertheless start from chapter 2 with the scenarios and find additional detail and underpinning in the subsequent chapters.

This deliverable is a **joint effort**, integrating contributions from all work packages, especially in chapters 2 and 6. Along a list of framing questions, the project partners have contributed findings. Their texts were integrated, and subsequently they have revised their integrated accounts in the context of the overall narrative of this deliverable. This was an iterative process, allowing for issues to emerge from the joint analyses and discussions about topics identified as key foci. This report also further elaborates on policy aspects and therefore uses a few key analyses already outlined in Deliverable 1.4. Precise references in the text help linking both reports, in case a reader wishes to revisit these aspects in the original context as well.

One limitation of this report consists in our **focus on three sectors**. However, since they were rather different, the synthesis also allowed us to gain some valuable insight into the spectrum of issues on a qualitative level (not indicating any frequencies or statistical correlations). Another limitation is due to the fact that in the sectors (WPs 2-4) we did not do policy analysis, but market and supply-demand matching analysis.

Another limitation refers to what we call a "**scenario**": this is meant to be a sketch of one possible configuration of a service use context, for probing through collective reasoning practice (deliberation). It a plausibilisation of a set of aspects that together help us to see how the combination of particular properties result in an overall picture that makes sense. These are not causal or deductive models, but deliberate constructions, based on empirical evidence, which are open to and actually supposed to trigger further sense-making by explicit reflection on elements and combinations of elements.

Even though a common effort the lead authors had typically leads for different chapters:

Ch. 1: jointly by Peter Stegmaier and Adriaan Perrels
Ch. 2: led by Peter Stegmaier, with significant contributions from Adriaan Perrels
Ch. 3: led by Peter Stegmaier, with some inputs from Adriaan Perrels
Ch. 4: led by Adriaan Perrels, with some inputs from Peter Stegmaier
Ch. 5: led by Adriaan Perrels, with some inputs from Peter Stegmaier
Ch. 6: led by Peter Stegmaier, with significant contributions by Robin Hamaker-Taylor, Atte Harjanne, Andrea Damm, Karoliina Pilli-Sihvola, Jörg Cortekar, Katja Lamich, Raffaele Giordano, and with some inputs from Adriaan Perrels
Ch. 7: led by Adriaan Perrels, with significant contributions from Peter Stegmaier
Annex 1-4: by Adriaan Perrels
Annex 5-6: by Peter Stegmaier

# 2 POLICY IMPLICATIONS

## 2.1 Climate services in a dynamic, uncertain world, and innovation attempts

Developing a new kind of services is inherently an adventure into the unknown. Service innovations, as all innovations, have an entrepreneurial character, combining vision, eagerness, and foolishness, since striving for the new or different is so full of risk and uncertainty, as innovations can always fail (Mazzucato 2013). **Uncertainty** characterises the world of policy and governance, too, especially regarding climate issues (cf. Chan et al. 2018; Nowotny 2015). Policy and governance can be seen as the conjunction of problem framings, policy negotiations, and politics with more or less shifting institutional arrangements and changing actor constellations (Kuhlmann et al. 2019). Whenever evidenced, significance suggests an opportunity to take a decision in a desired direction to open, and the opportunity is indeed taken, there are many occasions at which the made decision will again be reinterpreted, reused, or rebutted.

Climate services is making an offer to policy: to help making **better decisions with better intelligence** at hand, while in fact leaving policy, at the end of the day, with more uncertainties, since climate development cannot be predicted with absolute certainty, climate models are constantly called into questions or ignored from some actors (as fake or exaggerated), and whatever scenario climate intelligence suggests it can be used right in the opposite way as well (for prizing in more climate harm instead of less).

Whatever the specific policy conditions are—policy-making (Colebatch 2009) and governance (Bevir 2011; Bartolini 2011; Hoppe 2010; Benz 2007) are processes that are only boundedly rational and not linear. It takes competing rationalities, detours, side-developments, failures, and erratic changes of interests, drivers and circumstances to survive in policy and governance practice. Climate service innovation thus needs to be constant and longterm. And the only chance services with a strong basis in climatological intelligence might have against climate change denial or other forms of hesitation is to **win the framing game** (cf. Lakoff 2010; Rein/Schön 1993): framing whatever there is as an issue that can better be tackled *once the climate perspective is applied*.

## 2.2 Climate service fostering policy as process, condition, and result

In this Deliverable, we aim to bring together two aspects of policy assessment, being (1) comparing the **expected effectiveness** of alternative "packages" of instruments and measures, while assuming alternative policy regimes, and (2) the **modes and conditions** of approval and realization of a policy and its underlying regime (and the possible editing of it along the way).

> For **new policy areas**, such as climate services, the policy process is not yet crystallised, and therefore understanding of the interaction between aspired results and regime, on the one hand, and process, on the other hand, is important for the different actors. It is not only a matter of a not yet established policy frame and practices, but also of an emerging dynamic market in conjunction with several types of innovations emerging in different parts of the value network.

The first mentioned aspect refers to policy as an aspired state of affairs and to the so-called **policy regime** (cf. May/Jochim 2013) which defines the manoeuvring space that various instruments and measures[1] have, i.e., the first aspect is about results and conditions (basic principles) under which these results are to be achieved. The second aspect emphasizes that 'policy' is a **process** (cf. Kingdon 2011; Colebatch/Hoppe 2018), which strongly complements the first aspect that tends to suggest—if only for the purpose of evaluation of effectiveness—that a policy portfolio can be subject to ongoing negotiation efforts. For existing policy areas—say land use planning—we do know that there are formal policy cycles (Crabbé and Leroy 2008; Nijkamp

[1] For the possible interpretation differences between 'instruments' and 'measures' see section 3.1.

and Perrels 2014), on the one hand, referring to stepwise detailing in relation to delegation of responsibilities, and, on the other hand, to revision cycles, i.e., once in 12 years a new strategic plan is created, although building on the previous one. For other policy areas, e.g., concerning market regulation and distinction of public and private tasks, these cycles may be less clearly defined, but usually some kind of review process will exist. During the *process* of revision of existing or design of new policies the steps from concepts to concrete propositions and detailing may affect in all kinds of ways the originally imagined effectiveness or scope of the policy. Besides, especially in the EU, two structural characteristics have to be taken into account that are deeply linked to process and regime: the multiple tiers of governance (**multi-level governance**) and the **network character** of private and public actors' relations with at the same time defused and centralised elements of state authority (Hooghe/Marks 2003; Schakel et al. 2015).

For **new policy areas**, such as in this case on facilitation, promotion and public-private role division of climate services, the policy process is not yet crystallised and therefore understanding of the interaction between aspired results and regime, on the one hand, and process, on the other hand, is important for the different actors. It is not only a matter of a not yet established policy frame and practices, but also of an emerging dynamic market in conjunction with several types of innovations emerging in different parts of the value network. Especially, for new policy areas and new policy subjects, such as climate services fostering and climate service market ordering, the risk of change, uncertainty, steering crisis, legitimacy crisis, and failure is high (Jessop 2011), while existing policies are imperfectly applied to the new and new policies not yet matured enough. In this study, we approach the question under which circumstance a policy fostering climate services can be expected to be a realistic option in four regards: the basic governance conditions for climate service innovation (section 6), policy instruments (section 5), policy legitimacy in terms of policy acceptance and climate service sensitivity (section 4), as well as resourcing, business models, and market conditions (section 3). In the following, we integrate these four angles into three scenarios that follow different overarching policy rationales. Such rationales mean different balances of governance modes, institutional designs, problem perceptions, and solution failures.

## 2.3 Scenarios for climate service innovation policy

The following scenarios exhibit a **set of condensed insights** from the EU-MACS project into easy-to-grasp patterns (cf. Kuhlmann 2001; Rip 2011; Schot/Steinmueller 2018; Wainwright/Mann 2018). At the same time, they are open-minded and should be subject to alteration, whenever new insight requires it. If it is true that policy-makers should get interested in climate services, they have various rational and irrational ways of making policy choices. They may also follow frames that explain how they should see the world (Rein/Schön 1993). What we suggest is to consider both dimensions: the rationales and the frames, and develop a persuasive device that allows those addressed to see links to what they find reasonable (aims, objectives, utilities, logics, etc.) and real (framing, great policy narratives. etc.). All this necessarily is a business that can hardly be finished in this report, for this project's perspective is far too unspecific and not directly linked into actual policy-making. We can offer perspective as starting points for further refinement, though.

We have developed **three different scenarios** for the overall mix of policies and conditions under which a market for climate services can be further built and stimulated. The three scenarios use an EU level perspective and have the following main thrusts:

1. **State-centred—completeness & equity best guarantee for resilience**: In the broader policy focus (e.g., regarding resilience, policy leadership, sustainable economy, 20-20-20 targets, etc.), the attention for climate issues is considered pivotal, and the EU with its Member States has decided to use strategic climate intelligence as one reoccurring, and as soon as possible, obligatory element. Climate services are considered essential in supporting decision-making for the full spectrum of policies. Here, state is central, and the visible hand that fosters innovations embedding greatest uncertainty that only the state can make happen, EU actively procuring (development of) climate services and thereby setting EU wide examples;

2. **Business-centred—societal benefits through innovative thriving business**: there is a strong urge for an independent climate services market, supported by the and Member States by promoting development and provision of climate service by private providers in a free market. So, the bulk of the climate services is supposed to be commercially viable, apart from many upstream (basic) climate services, which remain public (and opend data) by their nature. In as far as public support for climate services promotion occurs it typically takes the form of temporary arrangements, aiming at rewarding trailblazers, who lower the risks for followers. Both EU and Member State would have more passive roles, apart from guarding the free market as well as supporting key innovations (which may need significant public support at initial stages);
3. **Network-centred—combine innovation & fairness in a bottom-up approach to welfare**: here, the best possible effect on welfare and well-being is the lead adage, and the state and public bodies help were market cannot guarantee sufficient use of climate intelligence through climate services; the EU continues public procurement of climate services innovations to stimulate climate services R&I. Here, a public-private-citizen networking rationale is followed; some local authorities, city networks, businesses, and citizen (NGO/SME) act as pioneers and trend setters, smartly linking the visible and invisible hands for innovation, investment, and practice integration.

These are the overall policy "boxes" in which we can sort alternatives regarding markets development, service formats, payment schemes, legal framework development, and many more. They represent three **basic economic and administrative approaches** relevant for policy making in general, but in this case applied to the enhancement of a climate services market. Each of these basic approaches has its advantages. It will depend on Member State and EU policy regimes what approach seems more appealing and feasible for a Member Country'. Furthermore, each of these sketched governance approaches are a kind of archetypes. Member States and the EU as awhole can decide blend policy scenarios. It remains to be seen to what extent harmonisation of relevant regulation would be necessary across Member States and to what extent different choices in Member States could live effectively side by side.

These are the main rationales (cf. Stone 2002; Enroth 2011; Jessop 2011; Bevir 2011b; Bevir/Rhodes 2011; Héritier/Rhodes 2011):

***First scenario rationale: state-centred***

In the scenario of climate focus made mandatory, climate intelligence is seen as a constituent element of policy decision-making in (selected or most) economic sectors and policy areas (assume, a "Climate Accountability & Risk Directive", e.g., would already have been adopted by the European Parliament). State is here seen as the only authoritative actor that is able to enforce sufficient action and oversee fairness. The state may also worry that market failures prevent adequate resilience, leading to GDP loss and more cost to the public sector. The climate services market vastly benefits from a broad array of duties to consider climate issues in many areas. Any separation of private and public climate services domains is not considered essential, although it may exist, to some extent, due to lobbying or EU legislation. In the background an important motivation for a leading role of (central) public authorities is ensuring sufficient resilience of the entire country and economy, and to realize the resilience in an equitable way.

***Second scenario rationale: business-centred***

In the business-oriented scenario, the handling of risks of climate change and variability is considered as far as market actors are willing to do so, whereas public sector motivation for support will be steered by expectations on new business growth and related key innovations (e.g., in observation and space technology, and supercomputing). Policy assumes here, that private actors can themselves best assess what is beneficial, provided information is reliable and accessible. Commercial provision of climate services is generally seen as highly preferable over public provision, but a part of the more basic climate services development will remain largely dependent on public funding, inter alia because of its links with key innovations. The climate services market is developing almost independent from state intervention, yet, with respect to quality assurance and standardisation public intervention (e.g., through

regulation at EU level) may be necessary to safeguard a level playing field and general service effectiveness. The separation of private and public climate services domains will be important to protect leading principles of this policy regime. An essential difference with the state-centred scenario is that the appropriate level of climate risk handling is much less guaranteed by public authorities, as market forces are *assumed* to steer towards an appropriate service level. Consequently, stipulations for publicly provided climate services will not go much beyond the upstream open data, complemented with climate information of typical general interest and/or supposed to be public due to international agreements (e.g., related to disaster risk reduction).

***Third scenario rationale: network-centred***

In the third scenario, the EU and Member States play a networking role. Similar to the state central scenario, public authorities are motivated to ensure that a good climate resilience level is achieved. However, in contrast to that scenario, it is assumed that the best results can be achieved by devolving the initiative to regional and sectoral levels (i.e., connecting local risks with locally preferred solutions). In that sense, it has some of the entrepreneurial spirit of the business central scenario, but not confined to commercial actors only, instead extending also to NGO's, citizens and (local) public actors, often in collaborative settings (such as public-private partnerships). In turn, these multi-interest groupings are assumed to apply balanced improvement of welfare and well-being as the overarching criterion in their handling of climate risks and related use of climate services. Instead of separation, criteria for mutual participation in climate services are emerging. More complex issues might lead to the introduction of arbitrage mechanisms.

TABLE 1: EU-LEVEL POLICY SCENARIOS FOR CLIMATE SERVICE MARKET DEVELOPMENT (CORE ASPECTS)

| Scenarios / *Aspects* | **1: State-centred** | **2: Business-centred** | **3: Network-centred** |
|---|---|---|---|
| ***Core rationale*** | **State central, because**<br>A. State is seen as only authoritative actor able to enforce sufficient action and oversee fairness<br>B. State worries that market failures prevent adequate and equitable resilience, raising risks for welfare losses and extra public sector cost in the future<br>C. Climate intelligence as constituent element of policy decision-making in most, if not all, sectors (e.g., enforced by a "Climate Accountability & Risk Directive")<br>D. CS market vastly benefits from broad array of duties to consider climate issues<br>E. Separation of private and public CS domains not essential, yet may exist to some extent due to lobbying or EU legislation | **Market central, because**<br>A. Private actors can themselves best assess what is beneficial, provided information is reliable and accessible<br>B. Commercial provision is generally seen as preferable over public provision<br>C. Climate considered as far as market actors are willing to do so<br>D. Urge for commercially viable CS market; business interest in mind (e.g., CS support innovation in strategic high-tech industries or service sectors)<br>E. State intervention only when self-regulation is hard (e.g., international standards, quality assessment)<br>F. Separation of private and public CS domains as leading principle of this policy regime important to protect | **Pragmatic-conciliatory, because:**<br>A. Stakeholders are capable of assessing own benefits, while seeing benefits of collaboration, especially by region or sector<br>B. State defers initiative to stakeholders, but has important role in supporting & resourcing R&D, education, open data, etc.<br>C. Regionalization and sectorization cause new coherence challenges for the state; e.g., equity in results ≠ equity in resourcing; climate intelligence to some extent required to be considered in public & private policy<br>D. More local and citizen involvement may radically change innovation and its policy<br>E. New forms of collaboration (public/private; across scales, definitions of costs and benefits) may require new legislation<br>F. Citizen welfare and well-being orientation |

These are fundamental options, which have consequences one should be clear about. For this reason, we will now outline the three scenarios in **more detail**. The scenario discussion is divided into three dimensions: we start with the basic rationales, turn then to actors, and roles, shed light on general policy strategy, and finally complete the picture with assumptions on market prospects and general trends. Table 1 provides an overview of the three scenarios' core rationales.

When the *state is central* to organising the climate services market, we assume the EU would formulate **framework conditions and minimum requirements** for climate services (common data access principles, standardisation, quality assurance, some kind of minimum package of services to be covered, etc.), while greater parts of regulation may be national. The European Commission and a growing number of Member States remain or become significant funders of development and *notably also operation* of climate services, especially for the upstream and midstream stages of the climate services value chain, and in many cases also purchaser of common (basic) climate services. In the *business-centred scenario*, the EU would function as passive supporter, as a regulator setting only general frameworks. In the *network-centred scenario*, the EU would have the role of a facilitator, coordinator, and as regulator setting a minimum of detailed regulation, just enough ensure quality, persistence, and affordability of important climate services. The EU and some forerunner Member States would here be trend or pace setters together with some business pioneers. State and business would nudge the other to undertake extra efforts and be open to innovation in various different matters of concern. The state would be setting standards in a tentative way, making successful rules conditional after some trial & error period.

The **role of public policy** in the *state central scenario* is market and innovation policy, regulation, and regular procurement (e.g, a ministry 'buys' public provision of a collection of related climate services as public service contract). In the *business central scenario*, public policy limits itself to unlashing and protecting the market. In the *network-centred scenario*, public policy concentrates on catalytic procurement of climate services: changing innovation for public use (demonstrating that climate services can be used), not for meeting the agency mission need themselves (climate services for European Commission's own use).

Besides state and market, there is some kind of **community level** that interacts with and influences public and private bodies' activities. In the *first* case, we are talking about the municipal administrations alongside their citizens (in the councils, voluntary administration members in smaller towns and districts, etc.). They may feel pressure on public affairs (changing or increasing risk awareness) and decide to commission first pilots or urge for making more climate sensitive decision-making conditional (Hand/Williams 2019; Betsill/Bulkeley 2007; Betsill 2001). As a side effect, municipal administration and citizenry may want to be innovative or/and get a pioneer's image. In the *second* case, it might be rather the local business community (shop-owners, building firms, etc.) that feel a pressure on their businesses, leading them commissioning first pilot or requesting such from public hand. A local business community that sees advantage in being innovative or/and in a pioneering role, may thus even become policy entrepreneur judging the broader public community including the business community, as part of that local public, to become innovators. In the *third* case, the described impulses are likely to emerge from both sides: a municipality with its businesses and citizens may feel a pressure on the living environment and property, and thus commission a first pilot. Cities may develop 'city networks' at regional, national, or global level (cf. Covenant of Mayors on Climate & Energy[2], Mayors Climate Protection Center[3], etc.) to pursue climate policy agendas (cf. Hand/Williams 2019).

In the *business scenario*, established services companies (such as for engineering and accountancy consultancy), possibly some privatized sections from public agencies, and foremost newly established climate services expert companies are trying to create and expand their niches in the climate services market, greatly supported by a maximized array of free public data and shielded from risks of (disabled) public service competition. Notably in the downstream segments several sectors, such as insurance,

[2] www.climatealliance.org/activities/covenant-of-mayors.html [21 January 2019]
[3] www.usmayors.org/mayors-climate-protection-center [21 January 2019]

may develop or further expand (as internal innovators) the capacity to provide climate services to other companies and clients. Relevant standardisation bodies in this scenario may also be mostly private businesses or business collaborations. Business entrepreneurship is also possible in the *state central* and *network-centred* scenarios (whereby the latter will again be expressing an alleviated combination of the other two scenarios): public body pioneers, cities, regions, etc. may be selected or applying for pioneering, and develop their own commercialised spin-offs or professionalised standardisation products.

As we saw in the sectoral studies of this project (Damm et al. 2018: 43-66; Cortekar et al. 2017: 16-17; Larosa/Perrels 2017: 26; Hamaker et al. 2019), **intermediaries** often have the role of providing mediation, knowledge brokering, higher economic scale for climate service procurement, as well as in the representation of interest (vis-à-vis business partners, administrative surroundings, etc.). In the *state central scenario*, NGOs or companies are providing what public bodies can't do themselves or for the market, including climate services or frameworks for public-private partnerships/collaborations. Here, the emphasis may be put on cheap (affordable or cost-eficient) solutions for all those actors less motivated, but forced to act. There will remain a market for commercial seasonal climate services and for commercial climate consultancy, which is still larger than the curremt ones, but these will expand less than in the other scenarios due to public and third sector activity. In the *business central scenario*, companies may discover a broader market for climate services products originally cultivated for internal use only. Concentration of intermediary function may occur, where regulation or a highly dynamic market is absent. In the *network-centred scenario*, among other pragmatic combinations of the two previous scenarios, for instance, experts may discover a broader market for climate services products originally cultivated for public use only, inspiring individuals from public climate services developers and providers to become new business entrepreneurs. Public bodies may develop new public-private business models.

TABLE 2: EU-LEVEL POLICY SCENARIOS FOR CLIMATE SERVICE MARKET DEVELOPMENT (ACTORS AND ROLES)

| Scenarios / *Aspects* | **1: State-centred** | **2: Business-centred** | **3: Network-centred** |
|---|---|---|---|
| | | ***Actors and Roles*** | |
| ***Role of EU*** | – Regulator of details<br>– Significant CS funder, purchaser (mission orientation) | – Passive supporter<br>– Meta-regulator setting frameworks | – Facilitator, coordinator, meta-regulator after trial & error<br>– Trend or pace setter (mission orientation) |
| ***Role of EU MSs*** | – Regulator<br>– Significant funder (mission orientation) | – Passive supporter<br>– Meta-regulator (framework) | – Facilitator (allowing for/ exploring certain cooperative structures)<br>– Moderate funder (mission orientation |
| ***Market role*** | – Partial, where CS no public good<br>– Regulation (enforce use, minimum quality demands, certification) | – Maximized manoeuvring space for private CS<br>– Only basic climate data and service as public provision | – Market regulation guided by pragmatic societal benefit principles |
| ***Public policy role*** | – Regulation<br>– Regular procurement (public agency buys CS product off-the-shelf) | – Protect market<br>– Unlash the market | – Catalytic procurement (m): changing innovation for public use, not agency mission |
| ***Community level role*** | – Pressure on municipal administration, commissions first pilot | – Pressure on local business community, commissions first pilot | – Pressure on municipality incl. business and citizens (living environment and property), commission first pilot |
| ***Policy Entrepreneurs*** | – Municipal administration that wants to be innovative or/and get a pioneer's image | – Local business community that sees advantage in being innovative or/and in a pioneering role | – Municipality incl. citizens that want their community to be forerunner |

| | | | |
|---|---|---|---|
| ***Business entrepreneurs*** | – Public body pioneers; cities, regions, etc. selected or applying for pioneering<br>– Standardisation bodies | – New and established businesses see their opportunities increased by maximized free open data and limited public provision<br>– Maybe some privatization of public CS<br>– Business units that can afford CS<br>– Standardisation bodies | – Public body pioneers selected or applying for pioneering<br>– Business with public bodies<br>– Public body units able to afford CS<br>– Standardisation bodies |
| ***Role of intermediaries*** | – NGOs or companies providing what public bodies can't do themselves or for the market<br>– Public provision of CS and/or PPP<br>– Emphasis on cheap (cost efficient) solutions for all those actors less motivated, but forced to act<br>– Business limited or of public nature | – CS business entrepreneurs<br>– Companies that discover a market for CS products originally cultivated for internal use only<br>– Concentration may occur, where regulation absent | – Individuals from NHMSs as new CS business entrepreneurs<br>– Experts discovering a broader market for CS products originally cultivated for public use only<br>– Public bodies with new public-private business models |
| ***Governance of client-provider interaction*** | – Procedural rules<br>– Administrative handbook (quality definition) | – Quality assurance | – Procedural rules<br>– Administrative handbook<br>– Quality assurance |

The **interaction between clients and providers** may typically be governed differently in all three scenarios, where in the *first* the emphasis is on (setting of, monitoring compliance with) procedural rules through administrative handbooks (quality definition), whereas in the *second* quality assurance is a matter of soft and self-regulation among business partners, possibly supported by light state regulation not interfering too much with business interests. In the *third* case, we may see again a pragmatic combination of both. Table 3 provides an overview over the three scenarios for market policies, actors and their roles. Policy strategy is the next focus. As regards standardisation, the business-centred (self-imposed) regulation may become stricter than in the state-centred policy scenario, since in the latter one it would be more about user protection (which may regarded less an issue with a larger share of public climate services), whereas in the business-centred policy scenario level playing field and fair competition (both served by proper standardization) tend to be high rated characteristics.

State agencies in the *state central scenario* would be keen to further facilitate climate services application by strengthening **open source and data policies** in such a way that (mostly non-profit) pilot climate services would be enabled and with the help also of public bodies. Besides, public bodies could mediate between companies, NGOs, and other less specialised public bodies for facilitating climate services. In the *business central scenario*, climate services would rely on both for profit and non-profit brokering (the latter most likely from public bodies) as well as on intermediaries developing increasingly as business companies able to bring users and providers together, and as distributors. Climate services would be piloted as far as they are promising or showing to be profitable. In case of state absence in the resourcing and open data policies, either affordable business schemes or charities could play a key role in opening access to data and sources. In the *network-centred scenario*, the best of both approaches would be developed, most likely with a more public orientation on public wealth-related issues and with more business orientation for commercial climate services facilitation and brokering (Michaels 2009).

The question of **quality assurance** will very much rely on the nature of the overall regulatory regime in the three scenarios. According to the pivotal role of state in the *first scenario*, we expect more emphasis here on hard rules and climate service quality experts being employed rather by public bodies, whereas in the second scenario the emergence of private soft rules as effort of self-regulation could be expected, to be applied by in-house consultants placed in participating or purchasing companies by climate service firms. In the third, scenario the combination of both would manifest in a publicly set framework further elaborated and applied by both consultants and public agents.

Regarding **fostering** specific policies, the state-central scenario entails purposeful, targeted innovation policy as well as the needs assessment of climate services by public authorities as supervision instances.

In the business central scenario, seeking of opportunities for climate service markets would already be a major step towards fostering, but also private supervision instances. In the third case, combinations of both public and private approaches, and more appropriately scaled to the region or sector, would create a specific supportive quality that might be either more targeted (solutions for specific problems that can better be achieved through public and private collaboration) or more cross-cutting scale effects (combining public and private interests in climate change intelligence). In all three scenarios, procurement of climate services is thinkable: in the first case, public procurement, in the second private procurement as part of long-term business relations ot outsourcing, and in the third pre-commercial procurement through either state or businesses or both, which basically means a nudging towards more climate service relevancy.

**Uptake** strategies and mechanisms would influence market chance more specifically. In the first scenario, e.g., through legislation working as enforcement of general or specific climate assessment duty, as well as through actually attending to such duty. A publicly installed and financed "observatory" could lens climate risks, climate services developments, and policy needs. In the second, corporate soft law setting a frame for own businesses or when corporations bring forward joint initiatives for entire sectors would stimulate uptake massively. Once uptake is decided, the whole range from occasional climate services market research by individual providers to in-house or outsourced market research would pave the way for more concrete uptake and economic justification as well. Making deals for climate services would be the most straight forward manner of uptake—basically, the uptake as such, by choice based on the perception of utility. Uptake in the third scenario would mean to consider catalytic procurement: publicly procuring climate services products on behalf of other actors in order to set an impulse that sooner or later will become more and more self-supporting. Occasional climate service market research by individual providers, public or private or together, may also be useful here. The market, policy, and climate risk observation may rather show in a collaborative format ("collaboratory"), merging the best of both worlds. A typical example for this scenario in terms of nudging would be something like "Climate-considered" labelling (à la eco-label).

Finally, **matching** strategies and mechanisms for the first scenario mean direct collaboration in making, providing or/and using climate services. Policies may span from formal criteria to practice and practical experience. The service may be for public bodies, state purposes, citizen use or linked with businesses. In the second case, we are speaking of customer relations which create practical experience and customer care to establish, stabilise, or change services relations; in other words: interactive quality management when users are in focus, or abstract quality assurance when providers pay less attention to users' own views. In this scenario, also public purchase order to equip administrations could be a form of matching (public) demand and (private) supply. Again, the third scenario combines both and may reach a particular quality through public-private (co-) production. Procurement would here be rather of adaptive nature: nudging towards more climate services relevancy (e.g., when a climate service product is incremental, aiming at adapting climate services to local, regional, national conditions.

Chapter 5 on policy instruments provides far more examples. Table 3 gives an overview of the policy aspects just outlined.

TABLE 3: EU-LEVEL POLICY SCENARIOS FOR CLIMATE SERVICE MARKET DEVELOPMENT (POLICY STRATEGY LEVEL)

| Scenarios / *Aspects* | **1: State-centred** | **2: Business-centred** | **3: Network-centred** |
|---|---|---|---|
| | | ***Policy Strategy*** | |
| ***Open source, open data policies*** | – Facilitate application of CS<br>– Piloting CS (rather non-profit with a few exceptions)<br>– Mediating for CS policies desired by CS community<br>– Intermediaries as companies, public bodies, or NGOs fulfilling state-set tasks | – Brokering of knowledge, products, and businesses like distributors<br>– Intermediaries as companies<br>– Piloting CS (rather for profit)<br>– Intermediaries as companies, NGOs (charities) compensating for state absence | – Facilitation and brokerage (distributors, mediators)<br>– Piloting CS (for/non-profit)<br>– Intermediaries as companies, public bodies, or NGOs |

| | | | |
|---|---|---|---|
| ***Quality assurance*** | – Public hard rules for CS data quality<br>– CS experts employed by public bodies | – In-house consultants placed by CS firms<br>– Private soft rules for CS data quality | – Public framework for CS data quality<br>– CS experts employed by public bodies; in-house consultants placed by CS firms |
| ***Fostering policies*** | – Needs assessment by public authorities<br>– CS innovation policy<br>– Direct public procurement | – Seeking market opportunities<br>– Corporate innovation policies<br>– Direct private procurement (out-sourcing): procurer = user | – Combination of public and private assessment<br>– Combination of private and corporate innovation policies<br>– Pre-commercial procurement: nudging towards more CS relevancy |
| ***Uptake policies*** | – Legislation: as enforcement of general climate assessment duty<br>– CS Observatory<br>– Attend to duty | – Corporate soft law<br>– Occasional CS market research by individual providers<br>– In-house or outsourced market research<br>– Making a deal<br>– CS choice by utility perception | – Occasional CS market research by individual providers<br>– CS Collaboratory<br>– Catalytic procurement: publicly procuring CS products on behalf of other actors |
| ***Matching policies*** | – Collaboration<br>– Formal criteria, practical experience<br>– Public CS production | – Customer relations, practical experience<br>– Public purchase order to equip administrations<br>– Customer care<br>– Quality management | – Customer relations, formal criteria, practical experience<br>– Public CS (co-) production<br>– Collaborative quality management<br>– Adaptive procurement: nudging towards more CS relevancy |

Finally, we consider market and overall prospects in relation to our three scenarios. What would be the typical growth scenario for each of the three models? The **market prospects on EU- and Member State level** in the *state central scenario* assume steady growth until full compliance, then more or less stable, given the fact that climate intelligence as is indeed seen as indispensable constituent element of policy. Growing economy and changing population can still cause some degree of growth (or shrink). Yet, technical and organisational development may cause the unit-cost of climate services to go down, implying that service volume may show continued growth whereas the transaction (or production) value of the provided services would show a decrease. A domestic focus is also assumed, as the task of implementing climate focus in all EU-level policy areas is big enough a task. On national level, the EU framework is binding. In the *business central scenario*, by contrast, the search for new market shares and markets is essential. Although more regulatory obligation for climate-sensitive management and decision-making may provide extra chances for business, climate service providers prefer an independent climate service market, giving them more freedom to develop and expand free of binding rules obligated to public welfare. Voluntary is also the extent to which Member States embrace the climate services. The market is therefore rather volatile. It will maybe start growing slowly, but then breakthrough and saturation are expected. Nationally, focus is on scale effects in small markets with fewer bigger players or bigger markets with more players. The deviating development between volume and value is also possible in this scenario. In the *network-centred scenario*, steep growth until full compliance, then rather modest growth is expected. Of course, business and public climate services seek additional opportunities, but at the same time try to appreciate and make the best out of public regulation and promotion of increasing climate intelligence obligation and climate services as part of broad sustainability policy. Just as well, the deviating development between volume and value, owing to decreasing unit-cost, is also possible in this scenario. EU sets frameworks, while there is also a high degree of voluntary uptake of climate services, as regulation will only be strengthened when the free market play doesn't lead to desired use intensity and scale effects.

Regarding **non-EU markets**, in the *state central scenario*, we assume the EU will promote climate sensitive policy using climate services as source of strategic intelligence as export good to public and private actors in non-EU countries. In cases, where the EU has an interest in inciting neighbour or partner countries towards more careful consideration of climate impacts, it may try to define the attention for climate change and climate services solutions as conditions for political/economic collaboration. In the *business*

*central scenario*, climate services will also be promoted as export good, in particular when coinciding with market expansion possibilities of (other) key innovations, such as regarding observation and satellite technologies. Apart from public support for export stimulation, private climate service providers will obviously seek for export markets themselves. In the *network-centred scenario*, the bottom-up emphasis and the probable frequent occurrence of public-private partnerships may offer a good knowledge and skill base for twinning projects and capacity building projects with less developed non-EU countries. Yet, also more conventional export of climate services may flourish in this scenario.

Regarding the **political-economic climate** in the *state central scenario*, we assume an EU-wide sense of urgency for climate-protective measures leading to a broad consent over relevance of using climate intelligence in decision-making supported by climate services, on EU- and Member State level. This tendency is rather stable, as there is also consent about the fact that there is climate change pressure on the economy and public infrastructure. Actors also rely on regulatory spill-over effects through state-set obligations to pursue climate risk handling and transparency in all sectors. In the *business central scenario*, the EU Member States can't find consensus over the extent that the EU and Member States should intervene in the provision of climate services. It may be expected however that some willingness to fund basic infrastructure and basic climate data generation will remain. Some successful climate service providers may get large and multinational actors in this scenario, for example by means of integration with other consultancy services, and thereby possibly leaving a modest role for national met-offices. There is even growing climate change denial in increasingly populist/neo-nationalist political discourse. In the *network-centred scenario*, it may be expected that regulation on climate risk handling and transparency in all sectors will be similar as in the state led scenario, even though in the network-centred scenario a higher share of self-regulation in sectors and regions may be expected. On the other hand, similar to the business led scenario there is more space for entrepreneurship, albeit in this case entrepreneurship is more led by 'common good' and the thrill of (own) initiative as such, rather than by profit maximization. In general, across all three scenarios, one cannot rule out the possibility that climate skeptic or opportunistic ideas and/or internationally smallest common denominators would gain much more influence in EU and many Member States' policy making, which may well lead to significant reduction of the effectiveness of climate policies, including promotion of climate services. In section 5.5 where policy packages are rated on effectiveness, such a grave reduction in effective policy effort is however not assumed. Instead, next to supposedly best attainable packages per scenario alternatives are formulated in which other policy goals bias the original best attainable packages.

**Technological prospects** in the *state central scenario* depend greatly on state-side investment into observational and computational infrastructure, and capabilities of NHMSs and public agencies with large climate change sensitive assets, as well as in GovTech that is able to integrate climate data, intelligence, and service offers into its system. Some countries authorities may even be digitalisation pioneers, but for state infrastructure to become broadly digital on all levels, there is still a long way to go. In the *business central scenario*, novel market interaction approaches such as by FinTechs and InsurTechs[4] as well as increasing uptake of climate services-related functionalities into existing business management instruments boost climate services as much as decreasing costs through technically mediated services marketing, provision, and sector-/association-level use of climate services. In the *network-centred scenario*, both governance and market technological innovations are creating combined scale effects. One could expect more innovation in organisational structures in the network-centred policy scenario. Businesses and network-centred scenarios express the chance that where state lacks behind, corporate, urban, civic actors from private and public backgrounds push for innovative approaches to digital practice and infrastructure (digitalisation), visualisation (e.g., Google's 'Climate Engine', 'Google Earth Outreach'), and block chain (cf. Stegmaier/Visscher 2017). The scenario assumption is that alongside such

[4] FinTechs are platform banks developed by "non-banking companies targeting the most profitable parts of the banking value chain" (Dietz et al. 2017), striving at creating their own internet-based market places combining retail, finance services, chat-service, high tech interface experience, efficient consumer and product data exploitation, based on exceptional technological capabilities and novel business models. The same applies to insurance-related platform businesses (InsurTechs). Cf. Stegmaier/Visscher (2017: 34); Hermann (2007).

innovations, service innovations instigating the usefulness of climate intelligence could profit in terms of availableness and usability. In the network-centred scenario, there is also the element of sharing: cloud-based services for free may both challenge and fuel both public and private service models based on more restricted pricing and access policies (e.g., the GDELT project).

TABLE 4: EU-LEVEL POLICY SCENARIOS FOR CLIMATE SERVICE MARKET DEVELOPMENT (PROSPECTS AND TRENDS)

| Scenarios / Aspects | 1: State-centred | 2: Business-centred | 3: Network-centred |
|---|---|---|---|
| ***Market Prospects and General Trends*** | | | |
| ***CS market prospect: EU*** | – Steady growth until full compliance, then static<br>– Home focus<br>– Climate intelligence as indispensable constituent element of policy | – Volatile; maybe slow growth, then breakthrough and saturation<br>– Search for new markets<br>– Urge for independent CS market | – Steep growth until full compliance, then rather flat growth<br>– Seeking additional opportunities<br>– Promotion of CS as part of broad sustainability policy |
| ***CS market prospect: nationally*** | – Binding EU frameworks for MSs | – Focus on scale effects in small markets with fewer bigger players or bigger markets with more players<br>– Voluntary action by MSs | – Binding EU frameworks for MSs<br>– Voluntary action by MSs |
| ***CS market prospect: non-EU*** | – CS advertised as means for good government<br>– Promotion of CS as export good to non-EU governments<br>– Defining attention for climate change and CS solutions as conditions for political/economic collaboration | – Promotion of CS as export good<br>– CS advertised as means for good business management<br>– Promotion of CS as export good to non-EU public bodies/governments | – Promotion of CS as part of climate sustainability diplomacy (e.g., in developmental policy)<br>– Promotion of CS as export good |
| ***Political-economic climate*** | – Reliance on regulatory spill-over effects<br>– EU-wide sense of urgency<br>– induced by climate change pressure<br>– EU MSs consent over relevance of CS | – EU MSs can't find consensus over relevance of CS<br>– EU-wide CC denial<br>– EU-wide financial crisis<br>– EU disintegrates | – EU-wide acknowledgement of climate change<br>– EU MSs consent over relevance of CS |
| ***Technological prospects*** | – Governance infrastructure (GovTech)<br>– Digitalisation | – Platform capitalism (FinTech, InsurTech)<br>– Digitalisation, visualisation, block chain | – Platform capitalism (FinTech, InsurTech)<br>– Governance infrastructure (GovTech)<br>– Digitalisation, visualisation, block chain |

In this case, scenarios 1 and 2 are two opposite extremes on a continuum, while scenario 3 is a more balanced configuration, yet with an own dimension regarding scale sensitivity, devolution of initiative and responsibility, and high flexinbility in collaborative forms. In reality, all three directions are in principle possible, however these specific accounts will rather be like **approximations of possible situations**: in more specific, more local or limited contexts, the one or the other extreme may even be realistic—be it as discourse about how climate service business should ideally look like (from a particular point of view), be it as really existing special cases. For instance, one could say climate services itself as mandatory seems unlikely and, in many sectors, unnecessary. Instead, making quality assurance for providers and users (practically) mandatory is probably feasible. In order to probe the potentials of mandatory climate services, we draw the picture of a strong determination by state authority. This is partially in response to the often-expressed hope that regulation will boost service request.

**Policies**, in some way or another related to climate services, **vary a lot across Europe**. While on a technical level, many elements may overlap or look similar, there are still rather particular institutional arrangements, legitimation patterns, and political rationales that differ. This is also dependent on actual public, scientific, and political discourse and political culture. The EU often sets a framework, regulates an issue to some detail, and leaves it to Members States to appropriate the rules according to the

political, economic, legal, and societal context. In the light of the material and theoretical chapters below on governance conditions, resourcing, and policy sensitivity, the scenarios can be applied with attention to doability, acceptability (Deuten et al. 2007), and the readiness to try some policy for climate services even if a country's wealth level (a company's available budget), political (managerial) choices, and the facts of life wouldn't make it easy. In fact, there are countries in which the situation is perceived as having only very limited budget for climate services-related policy and not much climate data sources available. For them, finding sources for creating the data needed is of the essence. State can play a big role inshaping and creating climate services markets, which goes beyond the mere correcting of market failure. The network-centred option, by contrast, is to capture those moments where a combination of actors on various levels (not just central state or big corporation alone) may better be equipped with inspiration and motivation to give climate intelligence and services a chance (not necessarily meaning that responsibility is shifted from state to individuals totally or principally).

The scenarios can also be used to work through **different possibilities** where a business-central option is considered most viable. Think of a country with a strong emphasis on market economy to which the second scenario may apply broadly, on the one hand, or of a country where state plays a strong role, but in fact can't provide much of a basis for all that is needed for climate services leaving their developments to market forces and business that develops the services they find useful. The third scenario might apply then to a country of the latter kind, but in which it is policy to cooperate with stronger, interested businesses, e.g., in the energy, agricultural, or transport sector for creating the foundation for climate services and for their uptake. When state is strong, there might be more public company activity which can push climate services, while in another case of a string state and MetOffice there more room given to corporate and citizen initiatives.

The above table can, firstly, be used as a means to structure different configurations and their properties, and, secondly, as a source for drawing thought provoking, integrated images of policy alternatives. In the following, we sketch the scenarios in three dense descriptions. These scenarios are a suggestion we have developed in the light of our project findings, through an internal workshop and a collective writing effort. The scenarios are in principle **open to modification**: If needed, users discussing this table and the narrative should think about which factors could also be varied and how both accounts could be changed in such a way that they make sense of the modified scenarios.

# 3 POLICY INSTRUMENTS TO DRIVE CLIMATE SERVICE INNOVATION

In this chapter, we will briefly unfold a **holistic perspective on policy instruments** in more general terms, aiming at outlining the current trends in European innovation and market policy. We will also introduce a more detailed overview of policy instruments, which could be useful to stimulate climate service market innovation. The emphasis is on innovation, but that also includes ensuring adequate market introduction and appropriate changes so as to adapt from development to provision mode. This chapter shall give cues for comparison and selection.

## 3.1 Innovation systems view and the trend towards policy mixes

The OECD Oslo Manual suggests to see an **innovation** as "*a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products and processes and that has been made to potential users (product) or brought into use by the unit (process)*" (OECD 2018). Similarly, we consider a market as a kind of medium that has a set of properties, guiding generation of transactions and allocation of value, and—for given conditions—favouring some business models over others and inviting or enabling some innovations more pertinently than others. These characteristics interact with each other through various economic, legal, social and technical processes, which together engender changes in the property set. Sooner or later, markets evolve into a crucially different set of properties or may even dissolve into larger entities (e.g., the greater part of the CS market may dissolve into a broader consultancy market). Technical, regulatory and social innovations play an important role in the evolution of markets, sometimes through gradual generic technology adoptions, sometimes through swift changes in markets shares of lead companies.

> We want to suggest refraining from thinking in terms of 'linear innovation' (from basic research to applied to commercial and market innovations) or the 'pipeline model' (public money to be pumped into public research would lead to industry valorising directly from innovations).
> Instead of just addressing market failure, we suggest including governance and system failures as well, thus taking a more **holistic** (systemic) view on innovation and market development.

Innovation as a task for policy[5] can be tackled from various angles, such as economics, policy studies, sociology, science and technology studies, and legal studies. In this project, we have chosen an integrative viewpoint, linking some of the best hints for climate service innovation from all these angles, which is 'science, technology, innovation and research studies' (STIR), with a large body of literature and an ever-growing scholarly community (cf. Nelson/Winter 1977; Mowery/Rosenberg 1979; Dosi 1982; Lundvall, 1992; von Hippel 1998; Porter 1990; Smits/Kuhlmann 2004; Arnold et al. 2004; Smits et al. 2010; cf. Romer 1993). From a market-oriented point view, innovation policy "*refers to the translation of knowledge into new commercial applications*" (Boekholt 2010: 334). The emphasis of this chapter is on policy instruments that, as far as we can see from our project results, are key to providing the conditions under which climate services and their market can be (further) developed, established, and stabilised. The instruments we want to feature here have in common that they are not only supply-side driven, but also integrate the user side. We want to **suggest refraining from thinking in terms of 'linear innovation'** (from basic research to applied to commercial and market innovations) or the 'pipeline model' (public money to be pumped into public research would lead to industry valorising directly

[5] In the literature, policies and measures are often used interchangeably. In this case, a '**policy**' refers to the de facto opening up and closing down of the spectrum of policy alternatives, aiming at identifying and pursuing a strategy. **Policy-making** regards (a) public matters that require attention and how they are being defined ('problems'), (b) proposals for change and producing solutions ('policy' in the narrow sense), and (c) making choices and decisions ('politics') as a 'window of opportunity' occurs (Kingdon 2011). By '**measure**', on the other hand, we mean an action, ruling, guideline, or investment implemented by a public or private organization or sector agency. A '**policy instrument**' here is understood as a "measure or programme that aims to change the behaviour and actions of the actors involved in the whole process from generating new ideas into innovative market introductions and solutions" (Boekholt 2010: 334).

from innovations), as results of generating knowledge are often uncertain and indivisible, and lots of knowledge remains a (quasi-) public good (can't be appropriated). Instead of just addressing market failure, we suggest to include governance and system failures as well, thus taking a more holistic (systemic) view on innovation and market development.

A simple categorisation of **public policy instruments** encompasses (1) regulatory, (2) economic and financial, and (3) soft instruments—also referred to as the "sticks", the "carrots", and the "sermons" of policy instruments (Borrás/Edquist 2013: 1515-6). A more comprehensive overview of instruments in European innovation context links bottom-up and top-down approaches, experimentation in unusual context and with novel targets, through careful design. In particular, we find more generic R&D and thematic or sectoral policies, linkage and communication policies, regulatory, financial/fiscal policies, and human resources policies, as well as meta-policies (intermediary activities and organisations, the Open Method of Coordination). This has been referred to as "*fourth generation of innovation policies*" after "*the linear model, the chain-linked model and the innovation systems approaches*" (Boekholt 2010: 351).

**Policy mixes** gain importance enormously (e.g., IPCC AR5 WG2), while the specific combination and design of a mixed policy depends on the area, aims, and conditions of a policy: "*A policy mix can be defined as the combination of policy instruments, which interact to influence the quantity and quality of R&D investments in public and private sectors*" (Boekholt 2010: 353). It is important to realize that modern policy design often means that several instruments are built together into a compound policy package (policy mix). For example, obligations to make adaptation plans and/or comprehensive risk management plans could be combined with minimum standards on the information used, whereas both may also function as prerequisite for eligibility for support funding or public procurement. Or a performance dependent feebate programme, e.g., related to progress in climate service uptake. These instruments and others are presented and assessed in sections 5.3 – 5.5.

## 3.2 Detailed overview on innovation policy instruments supporting climate service development and market

In the following, we distinguish more generic R&D and thematic or sectoral policies, linkage and communication policies, regulatory, financial/fiscal policies, and human resources policies, as well as meta-policies (framework setting, intermediary activities and organisations (cf. Boekholt 2010). We only include instruments that promise to help **innovating** the climate services market in general (besides product and process innovation), such as addressing the issues of (a) identifying potential markets and (b) serving chosen markets better (Johne 1999), while not ignoring the need to think about innovating the ways business is done (Kjellberg et al. 2015), as far as this can be an issue for public innovation policy.

A mix of instruments offers the chance to better tackle more **complex challenges** than single target instruments or simple punctual efforts would do. The risk is, however, that the governance (see chapter 6 of this report) of either the targeted policy area or the innovation system itself is too compartmentalised due to (a) lack of coordination between agencies and ministries, (b) a missing comprehensive strategy, as well as (c) to overly self-sufficiently focusing on one sector only. Furthermore, despite the best intentions and assumed complementarity, instruments may easily overlap in ways that reduce effectiveness (Nissinen et al. 2014), and hence both their design and the governance of their operation require coordination. Lack of this coordination, often means that synergies between adjacent policy domains will not be generated (Boekholt 2010: 352). Ensuring "'*framework conditions' conducive to innovation*" (ibid.) could be of utmost importance for most players in the field of climate services across sectors and institutional boundaries. Governance thus needs to be able to **handle change**, to **coordinate** between differing areas in which climate services could be useful (cross-/multi-sectoral view), to coordinate between and **attune** differing economic and societal goals (ecology, economy, local, national, global challenges), to **integrate** different knowledges (climate- and not climate-related) and knowledge creation (climate services as multi-perspectival) (cf. Boekholt 2010: 353). If all this would be insufficiently developed, the governance part in climate market building would risk failure.

In Table 5, we show the most relevant **generic** innovation policy instruments[6] for climate service market building and stabilisation. Since climate services, in our three focal sectors in particular, are still largely a niche phenomenon, in many cases far from maturation, and in some cases well developed, but not ubiquitous, we are talking about innovation which means both the building of services and of a market for them. Often, these service and market innovations can neither be easily separated—they go hand in hand, as a new service is co-produced with (potential) users ready to explore that new product and with what they can achieve with it once it is available and working. Nor can we realistically look only at one side, public or private policy, since, firstly, it is often in the nature of climate services that they combine public and private ingredients and collaboration, and, secondly, public and private agencies will in many cases be involved (either as providers, purveyors, or/and users).

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The **risk** is, however, that the governance of either the targeted policy area or the innovation system itself is too compartmentalised due to (a) lack of coordination, (b) a missing comprehensive strategy, or (c) to overly self-sufficiently focusing on one sector only.
Instruments may easily overlap in ways that reduce effectiveness. Hence, both their design and the governance of their operation require **coordination**.

**Institutional funding for climate service-related R&D in the public sector** could nourish the build-up of more dedicated departments and chairs in climatology and climate service at public universities and equally dedicated research departments in private organisations. At universities, interested corporations (e.g., from financial and tourism sectors) could offer endowment for climate services professorships. Such initiatives may be purely created by the university itself, but could also be the response to national R&D programmes. Furthermore, it can also be mixed public-private initiatives, as, for example, some sectors may be concerned about the future supply of competent exerts in this expanding field. **Competitive grants** are usually issued by the EU Horizon 2020 programme, national ministries, and could also go via the Belmont Forum (with a closer connection to application). From the private side, this can be matched by private commitments to programmes or projects.

Two examples of support for **R&D infrastructures** would be the state-side established Copernicus programme working with public and private partners, where basis and applied research foci are combined, while private side could invest into setting up hubs as infrastructure for service intermediaries. Hubs could connect service products, providers, and users (Oasis Hub), as well as data or software exchange infrastructure (Climate Data Store[7], or a more climate service specific kind of GitHub[8]). Supporting climate service hub structures as well as platform business models by R&D and supportive regulatory frameworks should also have a market innovation effect, as uptake and matching of demand/supply are facilitated. The Climate-KIC[9] can also be considered a R&D infrastructure. All these could in future be translated into more specific geographical, sectoral, and business environments, since the overarching infrastructures are already available.

**Centres of excellence**, as a public climate research centre in countries without yet much other knowledge basis or a public climate service research centre, e.g., Joanneum Research (JR)[10], could boost climate services with a high concentration of multi-disciplinary expertise as well. Private (corporate or sector association) climate (service) research centrecan second the public centres efforts, or even better be able to build bridges into private sector businesses—both in terms of more direct connections to private companies and suitable legal grounds for direct valorisation of new services.

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[6] Adopted from Boekholt (2010: 354)
[7] https://cds.climate.copernicus.eu/#!/home [15 January 2019]
[8] https://github.com/ [15 January 2019]
[9] www.climate-kic.org/ [15 January 2019]
[10] www.joanneum.at/life/ [15 January 2019]. JR is owned by public authorities (ownership structure: 80,75% province of Styria, 14,25% province of Carinthia, 5% province of Burgenland) and we receive an annual basic funding (but 80 % - 90 % is still project based funding).

**Generic R&D policies for private sector** through **institutional funding**[11] could, for instance, be (a) block funding (discretionary funding for organisations rather than individuals) for firms or (b) private venture capital, like R&D oriented start-up grants both on public and private basis. **Competitive grants**[12] (project-based funding connected to research performance) involving private sector developers are basically the same as for public sector, even more so as they increasingly entail public-private collaboration. Private grants (foundations, charities, etc.) generically addressing the private sector may be interesting for corporations wanting to launch matching funds for public grants thereby setting specific business-oriented impulses. The same goes for loans. Private funding will have strings attached, i.e., loans or participating capital in exchange for, e.g., first use rights or exclusive IPR. This may be complemented by **R&D-friendly procurement** by public hand for private providers, by joint procurement (stimulating and exploring public private partnerships/collaboration), and by classical public service contracts on climate services. With regards to business policies, this could be paralleled by joint procurement with high private stakes and by private users procuring climate services from private (or public, mixed) providers. Differences between practices and legal limitations of public and private procurement needs to be further explored (cf. Arlbjørn/Vagn Freytag 2012), with regards to climate services in particular.

TABLE 5: TYPOLOGY OF GENERIC INNOVATION POLICY INSTRUMENTS

| Main category | Types of instruments | Public policies | Business policies |
|---|---|---|---|
| **Generic R&D policy (public sector)** | Discretionary institutional funding for R&D activities (e.g., block funding for universities and research centres) | - University *climate* research department /chairs<br>- University *climate service* research department/chairs | - Private (corporate or sector association) *climate* research department<br>- Private *climate service* research department<br>- Endowed professorships on CS |
| | Competitive R&D project grants | - H2020<br>- National ministries<br>- Belmont Forum | - Private contract project orders |
| | Support for R&D infrastructures | - C3S | - Hubs for knowledge or innovation |
| | Selective support for centres of excellence | - Public *climate* research centre<br>- Public *climate service* research centre; e.g., at Joanneum Research | - Private (corporate or sector association) *climate* research centre<br>- Private *climate service* research centre |
| **Generic R&D policy (private sector)** | Discretionary institutional funding for R&D (e.g., block funding for firms) | - CS start-up subsidies | - Parallel to public ones, subsidies on business association level<br>- Private venture capital scheme for CS start-ups |
| | Competitive R&D project grants | - H2020 | - Private matching of public grants |
| | Competitive R&D loans | - CS start-up or innovation loans | - Private matching of public loans |
| | R&D-friendly procurement | - By public hand for private providers<br>- Joint procurement (PPP, PPC)<br>- Public service contracts on CS | - By private users for private (or public, mixed) providers<br>- Joint procurement (PPP, PPC) |

Boekholt (2010: 356) describes a number of **pros and cons** for generic and thematic/sectoral innovation policies. **Generic policies** allow for a wider distribution of impulses than more thematic/sectoral policies, where there is a risk of 'betting on the wrong horse'. Generic policies, being less selective, leave more freedom to the market for choosing the best or most promising innovation results. They also

[11] Cf. www.innovationpolicyplatform.org/content/block-funding [21 January 2019]
[12] Cf. www.innovationpolicyplatform.org/content/competitive-research-grants [21 January 2019]

make national or EU-wide approaches to climate services less prone to fluctuations in the market and irritations external to the climate service world. **Thematic/sectoral policies**, in turn, risk lock-ins in given structures that might no longer be competitive, while government or corporate resources invested may not be sufficient really to make change happen. Thematic/sectoral foci can also be blurred by vested interests from industry, government, or other actors. At the end of the day, the necessary process of diversification could thus at some point be hampered and the market distorted. We therefore recommend looking into thematic/sectoral policies with some caution and mention them in the same breath with linkage and communication policies. Both can absorb exaggerated thematic/sectoral foci. The concern how to position a new policy field is a recurrent theme in environmental economics and policy research and empirics. There is an oscillating tension to choose for integrated approaches (as element of existing policies) or for developing own pillars (Eckersley 1999). A truly mature policy field eventually manages to exploit both options.

In Table 6, we show the most relevant innovation instruments regarding thematic and sectoral policies.[13] In existing domains with affinity to high-tech (just as climatology and climate services are often rooted in high-tech and high science), thematic/sectoral policies would typically support climate service **development for highly developed parts of the state and the economy**, or as a business policy, business sector, or problem specific support for climate service development with more commercial focus. In the same line, there could be support for business area specific or comparative evaluation of climate services, e.g., on business association level or in areas undergoing more radical changes, where careful attention is required. EU and national tenders could evaluate existing and novel climate service tools also from a public policy perspective. In areas with low or medium-tech orientation, one could think of knock-on financing for administrative and business sectors without much connection to climatology, climate services, or science, or of pilots for hesitant or economically less powerful areas (geographically, administratively, commercially). The same can again be mirrored into business policy. Selective R&D support schemes for specific societal issues could be addressed through dedicated public schemes regarding Sustainable Development Goals (SDGs), Grand Challenges, etc. from public and business points of view.

TABLE 6: TYPOLOGY OF INNOVATION POLICY INSTRUMENTS REGARDING THEMATIC AND SECTORAL FOCI

| Main category | Types of instruments | Public policies | Business policies |
|---|---|---|---|
| **Thematic/ sectoral policy** | Selective (collaborative) R&D support schemes for existing sectors/ technology domains with high-tech affinity | - EU and national support for sector or problem specific support for CS development for highly developed parts of the state and the economy<br>- EU and national tenders evaluating CS tools | - Business sector or problem specific support for CS development<br>- Support for area specific or comparative evaluation of CS tools (e.g., on business association level or in areas undergoing radical changes) |
| | Selective R&D support schemes for sectors with low- and medium-tech orientation | - Knock-on financing for administrative & business sectors without much connection to climatology, climate services, or science in general<br>- Pilots for hesitant or economically less powerful areas (geographically, administratively, commercially)<br>- Organisational development for efficient CS uptake in public administration | - Knock-on financing in business sectors without much interest in/connection to climatology, climate services, or science in general<br>- Pilots for hesitant or economically less powerful areas (geographically, administratively, commercially)<br>- Organisational development for efficient CS uptake in business |

[13] Adopted from Boekholt (2010: 354)

| | | | |
|---|---|---|---|
| | Selective R&D support schemes for specific societal issues | - Dedicated public schemes addressing SDGs, Grand Challenges, etc. | - Dedicated business schemes addressing SDGs, Grand Challenges, etc. from business points of view |

**Linkage policy** would emphasise **collaboration** on climate services as one primary goal, provided there is an indication for serious climate services needs and benefits. The EU Horizon 2020 programme and Belmont Forum projects have such a feature. Horizon 2020 and JPI ERA4CS[14] climate projects piloting new climate services or also links with JPI Urban[15] and JPI Oceans[16] are areas of climate service market development, in which collaboration could be considered essential. The development of more tailored collaboration could also be used for areas, which alone are often not ready or economically strong enough to venture or invest into climate services, yet connected—think of the potential nexus between tourism, rural development, urban and village planning, agriculture, landscape and water management, and transport/traffic infrastructure, and finance services in sparsely populated areas. The same could work also in the form of corporate partnerships or in organisational development with regards to climate service uptake, where, e.g., one SME or smaller city can't afford much innovation, but in collaboration with others well. Think of introducing climate service trials also in EU Interreg[17] and LIFE+[18] programmes (in the latter this is already happening to some extent, at least). This can also apply to **cluster and regional growth pole policies**, or regional innovation, in general, e.g., regarding climate services product development on local business or administration level. Growth pole is a concept from regional economics, which does not mean certain instruments in particular, but can be a reason to address certain types of support only to certain regions. Climate services development would often be minute element in a growth pole inspired policy.

**Technology platforms** & similar 'stakeholder programming' actions could consist in development grants for climate service tools linking key climate intelligence needs across the sectors of urban, tourism, and finance, or with other fitting sectors in order to reach scale effects. However, next to, or perhaps even in place of, giving grants key seems to be regulatory and administrative enablement of such collaborative climate service generation and use. Start-up support seems quite useful, but when such clusters get their act together and productive, it is usally expected they are able to get funding from constituent bodies and/or (end) users.

At several occasions during the study, stakeholders have told that quite some climate services tend to be too academic, notably when provided by public research institutes. **University-business** and **university-administration linkage mechanisms** (e.g., liaison offices or intermediaries dedicated to translating scientific findings into practice or to liaising practitioners creating business operable versions). In conjunction with such liaisons a sequential business model (Build Pilot Transfer, or BPT), linking climate service development with subsequent regular climate service provision could be explored. Comparable models (Build Operate Transfer, BOT, and Build Own Operate, BOO) have been used for realizing public infrastructure of which the funding and/or realization is—at least initially—private.

Similarly, schemes to support the connection between policy, business, and climate service experts by, e.g., **subsidising networking between business, experts, & policy-makers** would be helpful (local or regional "climate for policy and business forum", for instance). When successful in the longer run, such fora could bring forth 'communities of practice'. They would need funding, a structure and legitimation to start and to run organisations like the Climate-KICs on more specific levels of practice. Business could participate with matching funds and slightly elevated sharing in lieu of competitive attitude. The Climate-KIC model could be used, e.g., on regional level in order to produce very targeted climate services for a major region with lots of needs. There is no reason why such regional KICs couldn't be linked to

[14] www.jpi-climate.eu/ERA4CS [15 January 2019]
[15] https://jpi-urbaneurope.eu/ [15 January 2019]
[16] www.jpi-oceans.eu/ [15 January 2019]
[17] www.interregeurope.eu/ [15 January 2019]
[18] http://ec.europa.eu/environment/life/funding/lifeplus.htm [15 January 2019]

the central KIC. Or, instead, more of a liaison organisation between domains (climate and health, or climate and finance, or climate/biodiversity/agriculture/food chain) could be needed.

Another policy instrument are support schemes for **spin-offs** regarding know-how and logistics in climate services. In EU-MACS we saw quite a few examples, like the business mentoring of UnternehmerTUM, in this case addressing climate services, or personal mentoring is also thinkable. Such mentoring could also be cast as an enhanced form of a 'first mover subsidy' mentioned in sections 4.4 and 4.5. Public administration could engage in public-private collaborations on service design and infrastructure, as, e.g., GERICS[19], Joanneum Research, publicly funded or offsprings initiated by the public sector, now partially self-sustaining and having more business leeway in later stages of innovation valorisation. Joanneum Research is owned by three provinces of Austria (Styria, Carinthia, Burgenland) and receives an annual basic funding (but is for the greater part dependent on project based funding). Service design labs, e.g., with a Living Lab or Constructive Innovation Assessment approach, would be another suitable format.

Finally, one of the newest policies is to directly **involve citizens or consumers** in the production, evaluation, or provision of climate services. In fact, there are some existing Citizen Science initiatives, Public science-based initiatives, such as Climateprediction.net, Weather@home[20], and the CLIPS project[21] of FMI, exploring crowd sourced (sub)seasonal climate services in Finland. In business, it would mean to involve consumers/users through prosumer activities informing commercial climate services or schemes for payed user involvement in climate service development or localised climate data gathering. Probably regulation needs to be developed on citizen science data ownership, access, feedback, and rewards. A public citizen science infrastructure could make it easier to involve citizens in R&D, with differentiated rules, e.g., if R&D has (also) private purposes (think of some medical studies). Table 7 refers to linkage policy for fostering climate services.

TABLE 7: TYPOLOGY OF INNOVATION POLICY INSTRUMENTS REGARDING LINKAGE

| Main category | Types of instruments | Public policies | Business policies |
|---|---|---|---|
| **Linkage policy** | Collaborative R&D programmes without thematic focus | - Development of collaboration in areas not ready or economically not strong enough to venture or invest into CS, yet connected | - Strategic corporate partnerships |
| | Technology platforms & similar 'stakeholder programming' actions | - Development grants for CS tools linking key climate intelligence needs across the sectors of urban, tourism, and finance, or with other fitting sectors | - Development schemes for CS tools linking key climate intelligence needs across the sectors of urban, tourism, and finance, or with other fitting sectors |
| | Cluster and regional growth pole policies | - CS product development at local business level | - CS product development at local business level |
| | Support for university-industry linkage mechanisms (e.g., university liaison offices) | - Scheme for linking climate research with regional/local administration and innovation centres | - Scheme for linking climate research with regional/local business and innovation centres |
| | Support for bridging gaps between policy, business, and CS experts | - Subsidising networking between business, experts, & policy-makers | - Sponsoring networking between business, experts, & policy-makers |
| | Developing communities of practice | - Fund, start, and run more specific Climate-KICs | - Participation in Climate-KIC with matching funds and sharing attitude |

[19] www.climate-service-center.de/ [15 January 2019]
[20] www.climateprediction.net/weatherathome/ [15 January 2019]
[21] Cf. http://clips.fmi.fi/?lang=en [14 December 2018]

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|---|---|---|---|
| | Support schemes for spin-offs (know-how, logistics) | - Public-private collaboration on design infrastructure, e.g., Joanneum Research | - Business mentoring, e.g., UnternehmerTUM or personal mentoring<br>- Service design labs, e.g. with Living Lab approach |
| | Citizen Science initiatives | - Public science-based initiatives, e.g. Climateprediction.net, Weather@home<br>- Participatory observation pilots & feedback (CLIPS) | - Pro-sumer activities informing commercial climate services<br>- Schemes for payed user involvement in CS development or localised climate data gathering<br>- Citizen involvement as part of user experience and/or rebate/ award system |

**Communication instruments** are used as policies on their own, but quite often also as supporting element of a financial incentive or obligation. The more obvious types of instruments are awareness campaigns (to inform target groups about existence or risks and related remedies) and schemes to raise skills (training, education). Next to learning by single actors, also social learning (i.e., awareness and mentality change of a whole sector) can be promoted by means of networking and associating actors, e.g., in 'communities of practice', to exchange experiences among peers. The other two informational instruments are—potentially—more interventionist than the aforementioned information instruments, and attempt to raise the transparency and informedness of the considered market segment at a more fundamental level. Quality standards can significantly reduce uncertainty among potential users (see Larosa and Perrels 2017 (EU-MACS D1.2)), if a reliable, credible, understandable and widely accepted system can be created. This means for example that competing standards are counterproductive. In terms of communication **(self-) regulation**, there could be codes of conduct on what/how to communicate in terms of climate services and closely related subjects; especially regading standardisation in terminology, classifications, and quality assurance. **Brokerage** can of course not only be reduced to communication, yet, builds enormously on communication (infrastructure, events, training, personnel and knowledge exchange). **Campaigns** could advertise weather or/and climate services specifically, e.g. in packages, or highlight best practice examples.

Data openness is a crucial pre-condition for climate service R&D and market building. The notion of communication is here stretched towards relatively open flow of data and information. Open access of data can have different effects, depending on how it is exactly implemented. Good and affordable access to basic climate information and data, to information relevant for quite generally applicable damage reduction, and to widely used tools and models for societal impact assessment purposes generally enable much larger benefits as compared to poorly accessible or expensive versions of such services. Moreover, the cost of developing and maintaining such services is usually moderate, especially at national or European level. Cost cutting cooperation and data sharing is to be encouraged. However, if open and free-of-charge data principles are applied much more generally, the public budget limitations may after all slow down the development and provision of climate services, whereas the notion that all climate services ought to be free would also hamper development of commercial service products. Table 8 lists the mentioned categories and examples for communication policies.

TABLE 8: TYPOLOGY OF INNOVATION POLICY INSTRUMENTS REGARDING COMMUNICATION

| Main category | Types of instruments | Public policies | Business policies |
|---|---|---|---|
| **Communication policy** | Public and sectoral CS communication | - Climate communication fund involving public bodies & others | - Climate communication fund involving mostly businesses |
| | Stimulating brokerage | - Promoting/supporting brokerage services (e.g., start-up subsidy) | - Promoting/supporting brokerage services (e.g., start-up VF) |
| | Campaigns | - W&CS marketing packages<br>- CS best practice programmes | - W&CS marketing packages<br>- CS best practice programmes |

| | | | |
|---|---|---|---|
| | (Self-) regulation of CS communication | - Codes of conduct<br>- Standardisation in terminology, classification, quality assessment, etc. | - Codes of conduct<br>- Standardisation in terminology, classification, quality assessment, etc. |
| | Data openness | - Open source<br>- Open access<br>- Affordable access<br>- Cost-cutting cooperation<br>- Data sharing | - Open source<br>- Open access<br>- Affordable access<br>- Cost-cutting cooperation<br>- Data sharing |

Through **public administration sector reform** public risks assessment procedures or even law making stimulates using climate intelligence can develop quite some effect. Business can profit when able to deliver tailored intelligence. Law making or private soft regulation can in parallel or alone also lead to innovative tackling of business problems using climate intelligence. **Reformed IPR regulation** may lead to more ambitious open data policies both in private and public sectors. Adopted support schemes may help to secure IPRs. **Accountability and disclosure requirements** have proven to be useful to raise sensitivity for climate and environmental issues, e.g., in finance services (cf. examples in section 6 below; cf. TCDF 2017a, b). They can entail regulated climate proofing (including attention for the resilience level), assessments of societal and ecological risks, minimum standards for climate service products, and ethical guidelines for climate service provision. Transparency on climate risks and adequate (annual) reporting on it, based on quality assured data, is one of the key building blocks for engendering a market for climate services. As such, accountability and disclosure measures may promote/necessitate innovations is some domains, as, e.g., in finance, TCFD, Climate risk disclosure laws, the Carbon Disclosure Project may become triggers for more interest in climate intelligence and thus dedicated services (cf. ch. 6 below; see also D2.1), however they could perceived less as innovation measures.

On the other hand, if not well-embedded in actual **administrative and business culture** (formal procedures, informal practices, mind sets, etc.), an obligation may stipulate use of climate services as such, but that might in practice prove less effective as it will be hard to deny actors minimized (token) efforts. Instead, obligations regarding the use of quality-assured climate services and obligations to be transparent on risk exposures (and be accountable where applicable) can in fact leverage much larger implied sanctions on inadequate or minimal use of climate services. With respect to quality obligations the state should, however, in due course take care in the realm of information instruments a credible quality standard system is developed, applied and communicated. Also, in this case private sectors can decide to impose self-regulation. In case of complex sectors, with concomitant complex prescriptive schemes, it might be wiser for the state to allow the sector to self-regulate. In that case, there should be provisions that the scheme proves to produce the desired results and allows for some kind of external review and for sanctions for poor performance (as has been fairly usual in voluntary agreements for energy efficiency; Chidiak 1999; Rezessy et al. 2014). In Table 9, we show the most relevant kinds of regulatory policy instruments.[22]

TABLE 9: TYPOLOGY OF REGULATORY INNOVATION POLICY INSTRUMENTS

| Main category | Types of instruments | Public policies | Business policies |
|---|---|---|---|
| **Regulatory policy** | Reform of public administration sector | - Innovation of public risk assessment procedures<br>- Law-making | - Innovative private soft/self-regulation and standards |
| | Reform of IPR regulations | - More ambitious & realistic open data policy (open source, access)<br>- Support schemes to help secure IPR | - More ambitious & realistic open data policy (open source, access)<br>- Support schemes to help secure IPR |

[22] Adopted from Boekholt (2010: 354)

| | | | |
|---|---|---|---|
| | Accountability and disclosure requirements | - Regulated climate proofing (incl. resilience level)<br>- Societal and environmental risk assessments<br>- Setting minimum standards for CS products and use<br>- (General) ethical guidelines for CS provision | - Sectoral guidelines & standards (such as endeavoured in the TFCD process)<br>- Setting minimum standards for CS products and use<br>- Business ethical guidelines for CS provision |

Whereas obligations generally require at least some action and evidence, **financial incentives** usually leave leeway for the extent and rigour of the response to the incentive. **Research grants** were already mentioned earlier, but innovation and uptake related financial instruments would in this case in particular mean *conditional funding* or *rewarding* of new climate services, i.e. *performance based public-service contracting*. For example, public actors that score above average in developing and launching climate services that prove to have demand, could be rewarded with larger development support for a next round of climate service development (see also business model no. 3 in Table 14 in ch. 4). Depending on the policy scenario backdrop (cf. ch. 2), this rewarding mechanism could be coupled to promotion from the PPP. Rewards could also be translated into the realm of public agencies, e.g., when successful climate service integration would lead to compensation of X% of the costs for their development. Alternatively, credit guarantees or interest support for climate service-related investments could be applicable, although this would be just a small measure, which in principle may already be allowable under current instruments, but would need more advertising for this purpose. Risk capital for public bodies is not contradiction, but means, for instance, PPPs[23], public sector banks, support for public institutions (e.g., municipalities) for infrastructure projects[24], or the promotion of territorial and local associations/governments, e.g., in tourism, as well as of „risk capital" in terms of matching funds only available for a public body when sucessfully developing/having developed/using some climate intelligence scheme. For example, financing organizations specifically meant for the public sector show an increased interest in ensuring that public investments are climate proof (Hamaker-Taylor et al. 2018 (EU-MACS D.21); cf. ch. 6, below). For social enterprises, there are also new venture capital schemes for both for-profit and for non-profit organisations.[25]

**Performance-based R&D support** for passing climate service innovations to market could be reward user-minded climate services developers in conjunction with PPP frameworks. In the business realm, PPP frameworks could be offered as a kind of outsourcing of the risky parts of R&D. Allowing for performance-based public service contracts could offer prospect when development work starts; it could be applied when pilot is ending and successful, as prospect when development work starts (parties should fulfil various criteria). Reward-based crowdfunding is currently growing (Kraus et al. 2016; Roma et al. 2017). With the aid of **financial incentives**, public and private users' and providers' entry costs could be lowered (start-up subsidy) or they get a resourcing guarantee for providing a public service (public service contracts) or prospective users may receive support for acquainting with climate services through a climate communication fund. **Public service contracts** are typically applied to services which are deemed indispensable from a societal point of view, and which cannot be (entirely) funded from user fees. These usually require precise specification of the minimum quantity and quality of annually delivered services, and thereby require performance monitoring. Public service contracts have often a contract period of 4 to 7 years, after which a new (updated) contract is issued for competitive bids. Financial incentives can also be devised within a private sector, e.g., by establishing a common fund from which promotion of networking, brokerage, etc. can be funded. Such private (sectoral) support schemes are often based on some kind of annual offer competition (or ex-post award competition), thereby introducing 'best practice' policy elements in the private initiative. An alternative are revolving funds,

[23] Cf. www.gccapitalideas.com/2018/09/10/closing-the-gap-public-sector-risk-financing-solutions-increase-community-resiliency-gcmc-commentary/ [22 January 2019]
[24] Cf. www.kfw.de/inlandsfoerderung/Öffentliche-Einrichtungen/index-3.html [22 January 2019]
[25] Cf. www.die-stiftung.de/praxis-projekte/risikokapital-fuer-sozialunternehmen-33617/ [22 January 2019]

meaning that sooner or later the beneficiary has to return the principal wholly or partly. These private sector (sectoral) schemes may also receive support from the public sector. In Table 10 we show the most relevant kinds of instruments for fiscal and financial innovation policy.[26]

TABLE 10: TYPOLOGY OF FISCAL/FINANCIAL INNOVATION POLICY INSTRUMENTS

| Main category | Types of instruments | Public policies | Business policies |
|---|---|---|---|
| **Financial and fiscal policy** | Improving leverage of performance (Risk capital for R&D measures) | - Reward public bodies when more than X% of their portfolio supports *successful* CS development | - Credit guarantees or interest support for CS related investments<br>- Reward, e.g., venture capital firms when more than X% of their portfolio supports *successful* CS development |
| | Past innovation to market performance-based R&D support | - Reward user minded CS developers in conjunction with PPP frameworks | - Offer PPP frameworks as a kind of outsourcing of the risky parts of RD |
| | Allow for performance-based public service contracts | - Offered as prospect when development work starts; apply when pilot is ending & successful (various criteria should be fulfilled) | - Offered as prospect when development work starts; apply when pilot is ending & successful (various criteria should be fulfilled) |

Climate service development depends on more than data, pricing, and rules. Without appropriate **human resources** there is no chance for a public or private actor to get very far or keep development and implementation costs low. Even if R&D or service provision are outsourced, at least a liaison agent must be available at the user side who is capable and capacitated to deal with the climate intelligence in a suitable manner. **Subsidies for hiring personnel** with climate service expertise and capability/capacity able to bridge between climate service and organisation tasks. This may entail tax incentives, employment incentives, and facilitation for foreign personnel with climate service expertise, even immigration policies for expert personnel. Such combination of R&F and employment policies is a means for smaller countries that cannot (yet) provide enough experts themselves or even education for future experts. In relation to attracting extremely talented researchers, there may be grants or subsidies for academic institutes to attract international (rising) star researchers. This is, on the one hand, reinforcement of the academic base of climate services, and, on the other hand, bringing in experts that could directly provide service expertise. On the **educational** side, climatology and climate services could be made more attractive for pupils, students, and graduates, e.g., by offering climate sensitising and climate services explaining projects to educational contexts, including vocational training. Climate service education could be better included into curricula, e.g., attention for climate change, its impacts, adaptation and vulnerability, as part of education for a whole variety of sector-relevant professions and of business education. In Table 11, we show the most relevant kinds of instruments regarding human resources policy.[27]

TABLE 11: TYPOLOGY OF INNOVATION POLICY INSTRUMENTS REGARDING HUMAN RESOURCES

| Main category | Types of instruments | Public policies | Business policies |
|---|---|---|---|
| **Human resources policy** | Subsidies for hiring personnel | - Subsidies for hiring personnel with CS expertise, capability, capacity to bridge between CS and organisation tasks | - Subsidies for hiring personnel with CS expertise, capability, capacity to bridge between CS and organisation tasks |

[26] Adopted from Boekholt (2010: 354)
[27] Adopted from Boekholt (2010: 354)

| | | | |
|---|---|---|---|
| | | - Employment incentives & facilitation for foreign personnel with CS expertise<br>- Immigration policies for CS personnel | - Tax incentives, employment incentives, and facilitation for foreign personnel with CS expertise<br>- Immigration policies for CS personnel |
| | Efforts to make climatology and CS more attractive for pupils, students, & graduates | - Offer climate sensitising & CS explaining projects to educational contexts | - Offer climate sensitising & CS explaining projects to vocational training contexts |
| | Including CS education in curricula | - CCIAV as part of education for a whole variety of sector-relevant professions | - CCIAV as part of business education |

Finally, some and meta-level instruments for innovation should be mentioned that could be used to build and advance climate service innovations and markets. Firstly, supporting or establishing **intermediary** activities and organisations could happen in the form of **expert centres** for bridging climatological and other areas', scientific and citizen gaps (e.g., a 'Centre for Climate and Society'), **advisory councils** as public bodies (e.g., à la the Dutch Council for Environment and infrastructure), or more generic councils for strategic climate intelligence (on local, regional, national, or EU level). This could also include a climate service **festival**, or a climate service **fair** (for business or/and public administration). Secondly, the prominent approaches of (a) **public procurement of innovation** (PPI) should be mentioned, e.g., offering innovation action grants that link to R&D of novel or better elaborated climate service formats with business participation (Edquist et al. 2015; see also ch. 6); and (b) mission orientation in R&D policy (mission-oriented policy, MOP), an approach differentiating "*between public policies that target the development of specific technologies in line with governmental goals ('missions') and those that aim for the institutional development of a system of innovation*" (Mazzucato/Penna 2015a: 9; Mazzucato/Penna 2015b). It has been observed that mission-oriented investments tend to be used when it comes to security-led issues such as military, energy and renewables, health, food. Both approaches actually entail hybrid mixes of policies. The strategic question for policy fostering climate services is whether and how PPI and MOP could be further developed in support of climate service innovation and market building.

The considered policy instruments in Tables 5-11 are supposed to tackle one or more of the obstacles and mechanisms for uptake of climate services and/or promote more pertinently innovation of climate services. Yet, the admissible way to tackle obstacles will depend on the **overall policy scenario environment** in which these are supposed to operate. For example, public service contracts for publicly produced climate services is of limited relevance in a policy environment in which maximum space for private provision is aspired, but is quite relevant in both other policy scenario environments. Or if, e.g., on national level fiscal discipline is low, tax incentives may have only limited effect; if, e.g., corporate taxation is very high, additional climate-related taxes will very likely meet heavy political resistance (Boekholt 2010: 355).

This overview can only stimulate the necessary intensive struggle for innovative approaches to service innovation a world of change: where innovation, are polycentric, build on advertising or social media, and also come from emerging economies (Haar/Ernst 2016)—not just from the most sophisticated, tailored, or Eurocentric climatology and climate service.

# 4 RESOURCING, BUSINESS MODELS, AND MARKET CONDITIONS

## 4.1 Introduction

Resourcing, business models and market conditions are distinct but nevertheless closely related **concepts**. Market conditions, such as the degree of competition, and the effort needed for newcomers to enter the market, can be seen as an overarching framework within which economic agents, in this case climate service providers, have to operate. Also, aspects as economies of scale and scope, which are relevant for at least a part of the climate services can be seen as market conditions, which tend to favour incumbents over newcomers and larger over smaller organisations.

The **market conditions** can be seen as the overall frame within which business models and related resourcing options have to function properly. So, not every **business model** is viable in every market, but usually there is at least some choice, provided the business model is 'edited' to the circumstances. The options for **resourcing** depend on the business model and vice versa. However, resourcing can also be understood broader than funding, examples are the availability or access to knowledge and skills, and several forms of sharing data and other information. In some collaborative forms of climate services provision both provider(s) and user(s) can bring in information, data and expertise thereby blurring traditional resourcing set-ups. Furthermore, we learned that the use of climate services often requires more resources than their acquisition, hence resourcing should also have an eye for the user side.

> The **market conditions** can be seen as the overall frame within which business models and related re-sourcing options have to function properly. So, not every business model is viable in every market, but usually there is at least some choice, provided the business model is 'edited' to the circumstances.

Given the above described largely nested structure of these three concepts, the chapter starts with market conditions, followed by business models and concluding the discussion with a review of resourcing options also in the light of evolving needs, both at the provider and user side. Next to desk research and input from preceding Deliverables (especially D5.1; Perrels 2018), a set of interviews was conducted with senior representatives of mostly public climate service providers on how climate service development was framed, and how the pathway from idea to actual regular service looks like, what the **main drivers in the process** are, etc. The questionnaire and the interviewees are presented in Annex 2.

## 4.2 Market conditions for climate services

The **market conditions for key public climate service providers** in the upstream and midstream segments have arguably a large influence on how the rest of the market can unfold. Upstream, where observation data and climate model output are processed and a significant part of the work requires high levels of (hard to commercialize) expertise, public actors dominate kind of naturally. Usually the national met-office (NM(H)S) is the key actor, in some countries to a varying extent complemented by other (semi-) public organisations. These complements have often to do with hydrological issues. So far, Germany (GERICS) and Italy (CMCC) are the only two EU countries where a separate (public) climate service centre operates. The character and organisational structure of these two centres is not the same. CMCC has still a quite strong R&D character and climate service provision is a consequence of the R&D. For GERICS regular climate service provision is a much more pertinent objective, even though R&D is also a part of the work. Furthermore, the market regulation and funding conditions under which these two operate is quite different. Given the flurry of climate services development projects in Europe more institutes may acquire positions comparable to GERICS or CMCC, for example VITO and BC3 among others shows such signs, both are regional, referring to Flanders and Basque Country respectively.

Generally, in Germany, as well as the Netherlands and Spain, and to some extent Norway, designated **providers of public services** are supposed to stay out of markets in which private providers are active, apart from designated market segments for which a public service contract is in force (such as for weather services for aviation). In many other countries this separation is not pursued so strictly as in the

aforementioned ones (Table 12 below), but in practice also in many of these countries national met-offices (NM(H)S) earn only some income from charged services, including climate services. In some Central- and Eastern European countries, NMHS are more clearly incited to seek for income from charged services as a means to supplement the basic budget.

TABLE 12: APPROXIMATE SITUATION FOR OPEN DATA AND MARKET SEGREGATION POLICIES REGARDING CLIMATE SERVICES FOR SELECTED COUNTRIES

| Open data policy | public-private segregration | separate public CS centre exists, but also CS role for NMS | separate public CS centre exists, but minor role for NMS | no separate public CS centre; CS from N(H)MS & NHS | no separate public CS centre; CS from N(H)MS and other (semi) public org. |
|---|---|---|---|---|---|
| strong | strong(er) | Germany | | Norway | Netherlands* |
| | | | | | Spain* |
| | weak(er) | | | Sweden | UK* |
| | | | | France | |
| | | | | Finland* | |
| | | | | Ireland | |
| weak(er) | strong(er) | | | | |
| | weak(er) | | Italy | Latvia | Greece* |
| | | | | Lithuania | |
| | | | | Denmark* | |
| | | | | Austria | Belgium* |
| | | | | Portugal | |

**Legend**: Belgium: Flemish Institute of Technology (VITO) - urban climate; Denmark: Geological Survey of Greenland and Denmark (GEUS) – flood risks & ground water; Finland: Finnish Environment Institute - flood centre, in cooperation with FMI; Greece: National Observatory of Athens – IERSD; Netherlands: Deltares, Rijkswaterstaat; Spain: Barcelona Supercomputer Centre (BSC); United Kingdom: Flood Centre (DEFRA); Highlighted cells denote countries where interviewees reside.

The **market division in public and private domains** is a complement of the policy to maximize access and re-use of public data '(open data policy'). Open public data, meaning easily accessible and low or no-charge data, is seen as a prerequisite for enabling innovative services based on such data. The division of the market is meant to protect private firms from advantaged public actors, from where these data originate. As was however shown in D5.1 a significant part of the climate services is or evolves into market and delivery models of a hybrid nature, and often involving both public and private partners. The risk is in that case that a very strict separation discourages a part of the innovations (i.e. newly developed climate services) to get realized. This can be illustrated theoretically (see text box) and was corroborated in the interviews held (see Annex 2).

This **policy combination of open data and market separation** leads also directly to the policy scenario options. The policy combination can be motivated from the premise that the enablement and promotion of entrepreneurship will generate the most benefits. Yet, the policy package can also be motivated by the premise that the emerging climate services portfolio should benefit the entire society as good as possible. The latter approach is more goal oriented (rather than means oriented) and can lead to either a state led approach aimed at maximizing an equitable climate services portfolio or to a pragmatic flexible approach allowing more space for various forms of public-private cooperation.

For reasons of **national resilience** and/or for **historic reasons**, quite some NM(H)S provide some charged climate services to the energy sector and the transport sector. With newly emerging climate services providers, often with international capabilities, this situation not necessarily perpetuates in each Member State. Private customers of these NM(H)S may decide to switch climate services provider, e.g., because of integration options with other environmental or risk management tasks. In some cases, the NM(H)S of another country might compete.

The **open data situation** is generally spoken improving across the EU (Annex 3), but differences persist, while some individual countries have been catching up better than other ones. For flourishing of climate

services, it is not just a matter of good and affordable access to weather and climate data, but also to various other domains, such as land use data (see Annex 3).

## From a supply side inspired frame to a demand side inspired frame

The above discussion, even though attempting to be broad scoped regarding organisational alternatives of climate services and allowing for responsiveness in climate service development, still presumes that the **upstream (and early midstream) supply portfolio frames demand** for climate services. If a growing number of so-called end-use sectors, notably urban planning, financial sector, public health, energy supply, and agri-food, are getting more experienced, demand for climate services may instead frame the supply portfolio of climate services. In the first place this would imply that feedback from downstream climate services even stronger steers the development in the midstream segment (models, tools, dedicated application specific data platforms). This can entail sophistication for given applications, but in all likelihood would also entail integration (e.g. serving all aspects of 'climate aware construction').

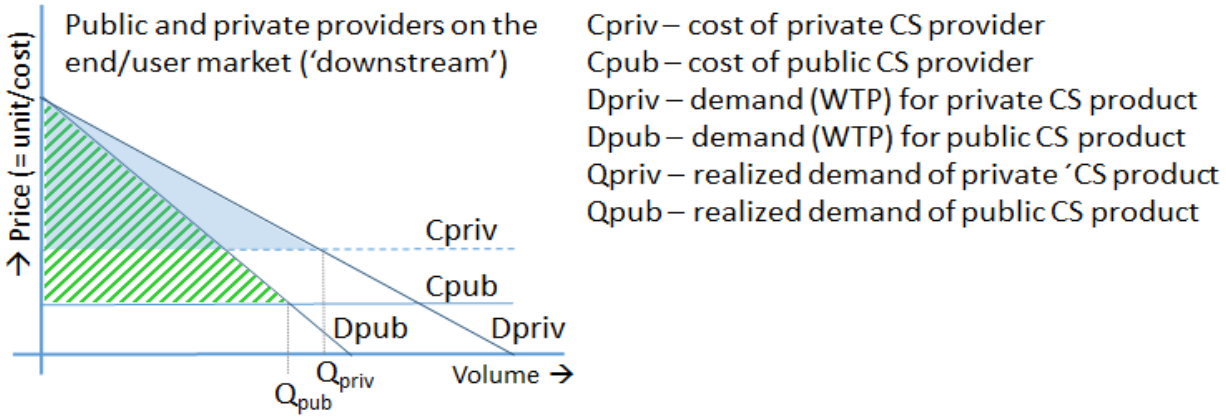
The (default) supply side frame and the demand side frame can also be seen as **subsequent stages of market evolution**. In the build-up stage of the climate services market a first worry is the availability of a broad scope of good quality climate data, i.e., upstream and early midstream climate services. Such basic climate services are typically a public good, and hence the prime worries are about open data, sufficient basic funding and delineation of the public service domain in the midstream segment. The open data situation is varying across EU member states, but the overall tendency is towards more open data. Basic funding for development of (basic) climate services is available, especially at EU level, within the WMO and other international collaborative bodies, as well through various national programmes. In contrast, funding for normal regular (operational) provision of public climate services is more precarious (Annex 2), especially the more midstream (or even downstream) one gets. This relates to the third element of delineation of public and private service domains, which seems to result in shortfall of some new (midstream) climate services rather than crowding out (Annex 2, Text box page 38).

When the **portfolio of climate services market** in the upstream and early midstream has gotten broad enough, these shortfalls may become a lesser issue (though they may cause notable delays in the development of some market segments). Instead, development of the downstream and more evolved midstream products becomes key, while for these types of products user needs-based design gets much more important, and hence the types of actors leading the developments changes, with more emphasis on affinity with end-user decision contexts as well as with capabilities to integrate climate change risks and opportunities with other challenges to be dealt with in a sector. The leading types of actors in the demand framed phase will often have a private expertise background or will be rooted in local citizen or public-private initiatives (e.g., in case of urban and regional planning). It is also likely that Member States differ in the mix of underlying strategic drivers (adaptation, DRR, mitigation, SDGs; see D5.1).

Currently, the market for climate services could still be primarily regarded as being in the **build-up phase**, even though some (sub)sectors have already a more matured level of use of climate services. For the upstream climate services economies of scale and scope are large, and hence Copernicus Climate Change Services and perhaps various user segment-oriented hubs and market places can probably cater for a large part of upstream climate services provision in Europe. Yet, for midstream and downstream climate services the diversity in sectoral and/or regional specialisation will be appreciably larger, and as a consequence the landscape of the climate services market can be expected to change crucially. As indicated in chapter 2, there is, however, choice in pathways with more or less public service emphasis, and more or less flexibility in delineation of private and public domains and hence of PPPs, depending on weights put on national completeness and fairness, business innovation potential, or citizen well-being and self-determination.

For the midstream and downstream market segments the promotion of climate services is after all meant to maximize the benefits for the users, with the proviso that the conditions should be good enough for the provider(s) to continue. Benefits for the users are typically referred to in economics as 'consumer surplus'. Figure 1 shows for a public and private provider of a comparable climate services how their demand curves may look like. The private product has a better customer orientation (e.g., thanks to user-friendliness), and therefore users show a higher willingness to pay (WTP) than for the public climate services. On the other hand, thanks to economies of scale and scope the public provider has lower unit cost. In this case, assuming the price is close to the unit-cost, the consumer surpluses for users of private and (charged) public climate services respectively are quite similar. Furthermore, the public provider has some scope for improving the user friendliness of the product while retaining some of price advantage. In the absence of a public provider charges may rise as the private provider enjoys a monopoly, whereas in the absence of a private provider product fitness may develop more slowly. So, for climate services products with few private providers the admittance of a public provider to the market may be beneficial for the end-users.

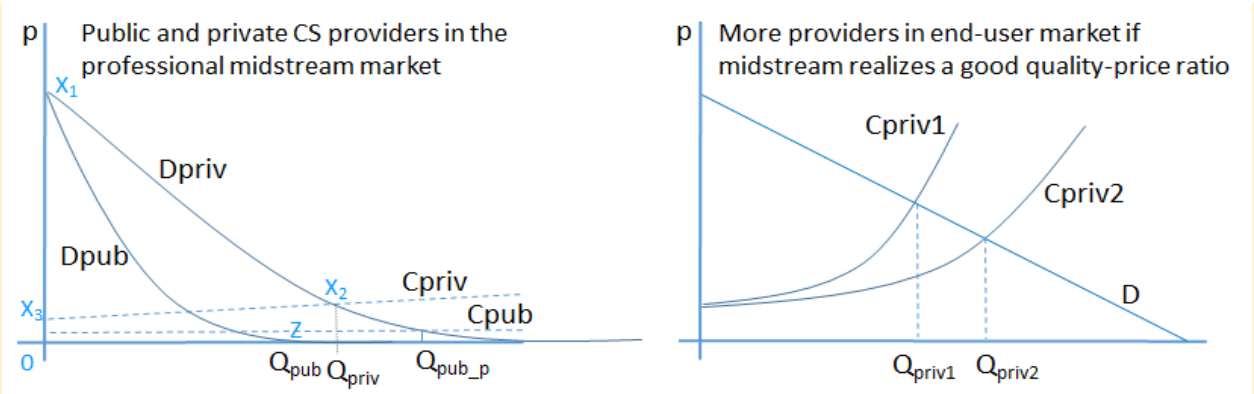
FIGURE 1: DEMAND CURVES FOR PUBLIC AND PRIVATE PROVIDERS




Denying entry to the midstream market can reduce competition on the downstream market for end-users or even prevent the rise of a certain climate services value chain. This non-realization risk was indeed reported by several interviewees. Reduced competition would mean higher prices and/or less diversity in (similar) climate services products, and consequently less user benefits. This is illustrated in the Figure 2 below.

In the midstream market the inherent modelling and data advantages of public providers can really count in terms of economies of scale and scope for at least a part of the climate services products (e.g., models to be used downstream). This is shown in the left-hand side where a public and private climate services provider's demand curves and cost curves are shown. Purchasers/users of the midstream climate services products for downstream climate services products can thereby acquire cheaper climate services for end-use provision (shift from Cpriv1 to Cpriv2 in the right-hand figure).

FIGURE 2: DEMAND CURVES FOR PUBLIC AND PRIVATE PROVIDERS UNDER REDUCED COMPETITION



## 4.3 Possible business models

As was explained in D5.1, the **manoeuvring space for feasible business models** is to a significant extent outlined by (1) relevant regulation on exclusive public and private domains in climate services provision, (2) the extent of inherent public good properties of different climate services, (3) technical and informational characteristics of the climate services product, and (4) characteristics of the organisation under scrutiny (size and capacities, organisational culture and vision, position in the value chain and value network, relevant earlier experience).

For a given organisation, which wishes to decide in the short-run about a certain business model, the actual status of the above **factors** can be regarded as given. On the other hand, in case of pondering longer-term prospects it should be realized that each of these factors can change due to exogenous trends (e.g., in technology) and change as consequence of a policy preparation discourse.

From the above, one might infer that in principle **a lot of diversity could exist**. On the other hand, the existing points of departure imply that only a limited number of business model seems of particular relevance. Using the four main product types identified[28], *Maps & Apps* (i.e. data and maps focused climate services), *Shared Practices* (collaboration for more versatile datasets, for (mutual) knowledge transfer, for co-design), *Expert Analysis* (generation of *tailored* quantitative and qualitative information as classic transaction or as cooperative effort), and *Climate-inclusive Consulting* (consulting and/or coaching of single or small groups of users, can include any amount quantitative climate services), each of them can be associated with varying degree of private vs. public climate services, and seasonal vs. adaptation-oriented climate services. This is laid out in table 8 below, in which insights from desk research, interviews, and surveys carried out in Tasks 1.1, 1.2, 2.1, 3.1, 4.1 and 5.3 are used. Annexes 2 and 3 provide overviews of the survey and interview results of Task 5.3. For the information from the other Tasks, the reader is referred to EU-MACS Deliverables D1.1, D1.2, D1.4, D2.1, D3.1, and D4.1.

By and large, **private climate services** can be associated to some extent with Expert Analysis and notably with Climate-inclusive Consulting, especially when it concerns seasonal climate services. The underlying reasons are that the quality of a seasonal climate service can be verified (accuracy and beneficial effects on decisions). Expert Analysis often concerns a verifiable information service (e.g., based on past performance), whereas Climate-inclusive Consulting means tailored advice based on a mutually agreed set of topics and aims. If there is sufficient transparency on performance and price-quality ratios these activities render themselves very well for market-based provision, and market mechanisms will work selectively in favour of the better products.

**Public climate services**, on the other hand, can be largely associated with Shared Practices and with Maps & Apps, notably in relation to adaptation-oriented climate services. Yet, Shared Practices and Expert Analysis have also quite some common ground when operated in collaborative frameworks, such as Public-Private Partnerships (PPP) and Public-Public-Partnerships (PuPuP). They can also evolve into one another depending on product portfolio development. The underlying reasons are that up- and midstream climate services are more generic in their nature and therefore are either generated as a public good by a public agency and/or assume a public good status as (easy) access to such information is essential for many different actors. However, the openness of midstream information can have far reaching ramifications for the creation of benefits in downstream use of climate services. Furthermore, the effective organisation of collaborative climate services provision frameworks is often by no means costless and may have also consequences for the service portfolio of the contributors. As a consequence, these kind of climate services provisions have often not anymore a pure public good character, but can be *club goods* or *common-pool resources*, which complicates resourcing and market regulation—not the

[28] In D1.4 (Stegmaier/Visscher 2017) the concept of innovation scenarios in the context of the CTA approach was used. In Visscher et al. (2019) they are translated into climate service interaction types. Here, it is more appropriate to use the term product type or product-market segment.

least also because of differences between EU Member States in current resourcing structures and regulations. We will explain the differences between public, private and semi-public goods further down in this chapter.

TABLE 13: FITNESS OF DIFFERENT PRODUCT TYPES FOR PUBLIC/PIRVATE PROVISION AND SEASONAL OR LONG-TERM CLIMATE SERVICES

| Product types | *Private CS* | *Public CS* | *Seasonal CS* | *Adaptation-oriented CS* |
|---|---|---|---|---|
| **Maps & Apps (M&A)** | + On top of public data simple applications are possible – limited attraction due to public and private competition; private uncharged as 'entry service'<br><br>*Downstream* | +++ Good interfaces as access to public data – varying from basic to complex<br><br>*Up-/midstream* | + For some apps possible, but viability is vulnerable<br><br>*Downstream* | +++ For initial investigations and as input for model simulations; also, for informing citizens<br><br>*Up-/midstream* |
| **Shared Practices (SP)** | Basis of SP is hard to arrange as classic private client service<br><br>*Mid-/downstream?* | ++ A part of the SP aims at augmenting public data & CS, but cost of sharing need coverage; this is often advanced CS and other cooperation<br><br>*Mid-/downstream* | Perhaps in exceptional cases SP is advantage, if SP is club of users *and* providers, e.g. for damage modelling (but this becomes easily more like EA)<br><br>*Midstream* | +++ Especially for more advanced or comprehensive CS for region or sector<br><br>*Mid-/downstream* |
| | **PPP: +++** By its very nature, SP will often fit to PPP set-ups<br><br>*Mid-/downstream* | | | |
| **Expert Analysis (EA)** | ++ EA fits single user delivery, but its costs suit only high value user segments<br><br>*Downstream* | + Public EA is important for some strategic plans, may easily link to SP<br><br>*Mid-/downstream* | ++ More demanding CS would typically fit as (private) EA<br><br>*Downstream* | + Some strategic exercises for public authorities (i.e. extensive impact-scenario simulations)<br><br>*Downstream* |
| | **PPP: +++** Applications of semi-public, mixed, and sectoral purposes would typically fit PPP<br><br>*Mid-/downstream* | | + Some specific CS e.g. for tourism regions and insurance pools<br><br>*Mid-/downstream* | +++ For both extensive studies and very specific needs for both public and private users (or groupings)<br><br>*Mid-/downstream* |
| **Climate-inclusive Consulting (CIC)** | +++ CIC can include both consultancy embedded CS and consultancy on another issue involving a notable share of CS<br><br>*Downstream* | As a public CS this would be quite rare, but there is some CIC going on between public sector experts (as input to follow-up CS)<br><br>*Midstream* | + At initial stages of CS use for a new user, or when introducing a new CS<br><br>*Mid-/downstream* | +++ CIC can include both consultancy embedded CS and consultancy on another issue involving a notable share of CS<br><br>*Mid-/downstream* |

**Legend:** + of minor importance; ++ quite significant; +++ very significant

From desk research, interviews and surveys carried out in the earlier listed Tasks a number of **business models** emerges as being **particularly relevant**. Each of them is suitable for a few of the cells in Table 13. Some are well known, others newly emerging. In Table 14 all main types of business models are

listed and described regarding their probable fitness and tentative significance for that market segment.

One of the messages is that quite often the **business model viability** of climate services under development is not or not rigorously assessed, even though there is often quite some attention for user needs by means of stakeholder processes. Private climate services providers are often better placed to account for user needs, and evaluate the expected cost coverage of a new product. On the other hand, private climate services providers often cannot take the risks that (larger) public providers can take. Public climate services developers and providers rate success in terms of academic and research spin-off as equally important as the viability of the climate services. By contrast, (solid) professionality regarding minimum quality standards seem quite the same for public and private climate services providers. Both among public and private climate services providers, data quality and meaningful accuracy and reliability are critical factors for continuation towards an operational climate service.

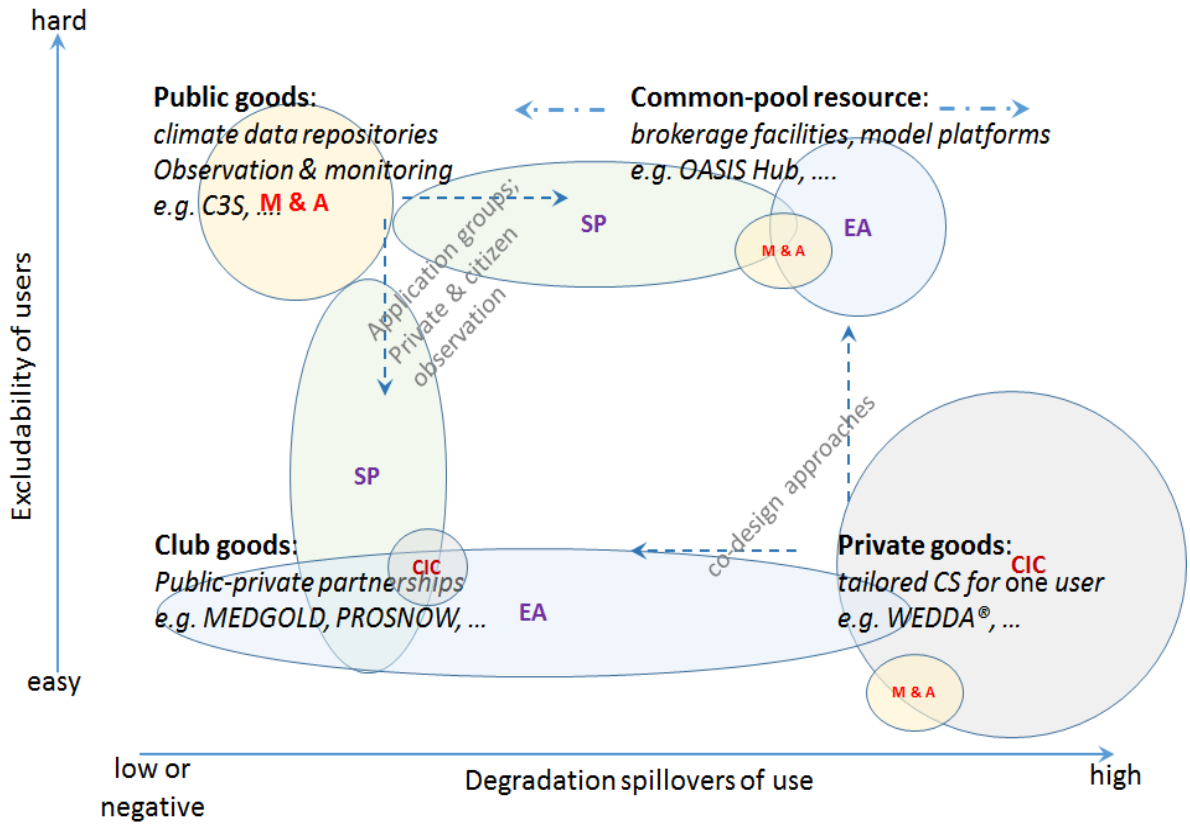
TABLE 14: CURRENT/POSSIBLE BUSINESS MODELS FOR CLIMATE SERVICES PROVISION, AND CLIMATE SERVICES DEVELOPMENT PROVISION

| Business models | Applicability comments |
|---|---|
| 0. CS is developed on the basis of a public grant, and intended CS is hoped to be effective enough to face positive WTP from users or state | Most EU and national funding schemes for CS development in public organisations are based on this model, which lacks guarantees after the pilot phase, even though project design requirements emphasize inclusion of future users and assessment of market prospects; through stakeholder processes and crowd sourcing fitness for purpose may get further enhanced |
| 1. CS is developed in conjunction with private or club-based observation capacity | Private sector funding from observation capacity owners or 3rd parties (venture capital); through stakeholder processes fitness for purpose may get further enhanced |
| 2. As part of basic service of a public organisation and funded from the basic budget | This can be okay for entirely upstream climate data, but leaves little room for development and user orientation, and therefore not suitable for mid- and downstream CS |
| 3. Provision on the basis of a public service contract between a public organisation and one or more ministries | This can function for all stages of CS, but especially relevant for mid- and downstream CS of which continuity and generic (public) access is deemed important; funding may have performance based elements |
| 4. As a largely self-financing public service of a public organisation | This becomes a relevant option if options 1 and 2 are insufficient to cover some CS of a public organisation; yet, if marginal cost of use are low, it violates PSI and INSPIRE directives and may stall uptake of CS; moreover, in some cases it might just as well be a private service |
| 5. As a partnership of several public provider organisations augmenting the value of the services by adding complementary data and information | The use value of climate information and the enabled CS grows quickly if a large diversity of information can be offered in a systematic way; yet data and user interface management and maintenance need still some funding—so this model could be combined with no. 2 (and showing savings compared to X times separate no. 2) or some kind of user or member fee may help; this partnership could also be mandatory, skipping CS of the constituent organisations. This concerns mainly up- and midstream CS. |
| 6. As a partnership of both service providers and users to provide tailored, often co-designed, information to users (and also back to providers) (PPP or PuPuP) | In this case the CS are modelled after the needs of the users, thereby ensuring good value; by further expanding the datasets/information more options to include impact indicators and evaluation options; often much broader set of skills needed to fully exploit all the information; all or most partners contribute, while cost sharing and/or internal pricing can be partnership specific; possibly also some service delivery to 3rd parties based on different (higher) prices |
| 7. Multistage CS development and use partnership (PPP) | One or a few public organisations with (upstream) CS knowledge cooperate with private organisation(s) (mid-/downstream) to first develop and subsequently deploy CS; the CS deployment (regular provision) is done by the private organisation, but product improvement cycles may include public partners; funding of the public organisations is based on either invoicing their labour cost and/or by sharing in the expected revenue flow of the operational CS; in early stages of the project an external private or public funder is necessary |
| 8. CS offerings and matching facilitated by a CS brokerage | This model is an add-on to several of the other options, relieving those (public) providers from a significant part of the marketing and sales efforts, while improving and supporting choice processes for users—inter alia by |

| | |
|---|---|
| | promoting comparability (standards) and transparent quality assurance; yet, it can just as well create synergy as competition between CS providers; brokers may also offer own training and awareness raising services as supplement to not necessarily very abundant brokerage fee income; Member States, large sectors or the EU may regard the role of brokers important enough to engage in some kind of support programme. |
| 9. CS provided and charged as private service – subscription based | Especially among seasonal CS there is scope for subscription based recurrent (e.g. monthly updated) service provision. Also, in the financial sector-oriented climate risk exposure indicators could belong to this category. For (partly) vulnerable sectors, such as agriculture, there could be forms of subsidized CS use. |
| 10. CS provided and charged as private service—case wise consultancy contracts | This type of CS conforms most to a free market product. Every delivery is a carefully considered private transaction. Directly matched by the user(s) and provider(s) themselves or brokered (no. 8) Even though good comparability may take more effort to develop, it would help uptake if standardized terms and product categories are adopted, as well as minimum standards and codes of good conduct. |

In a next step, we can **project** the four main types of climate services on the scheme explaining private, semi-public and public goods, where the term 'goods' may also refer to services. This is shown in Figure 3. By definition for a (pure) *public good* it is hard to exclude users, whereas use of that good by one user doesn't diminish the use possibilities of other users. Some goods, such as a radio station, may seem in first instance to be in conformity with the public good definition, but when one realizes that radio stations are competing for attention, and one can listen—practically spoken—to one station at the time, there is still competition among radio stations for attention. A similar notion applies to climate services.

FIGURE 3: ASSOCIATIONS BETWEEN MAIN TYPES OF CLIMATE SERVICES DEGREE OF PUBLIC CHARACTER




The use of a particular Maps & Apps service does not diminish its **utility** for other users, but there is overt or covert competition between similar Maps & Apps, which apparently leads also to confusion to

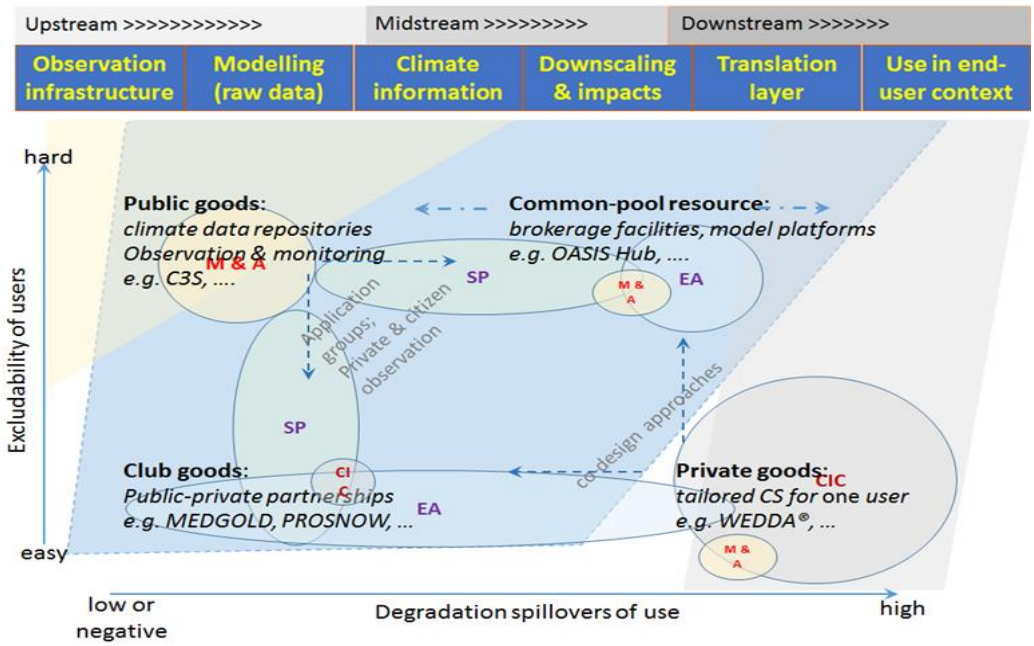
(prospective) users. Technological change (such as digitisation which among others makes counting of customers cheap) can affect the degree to which a good is still 'public'. Of the semi-public goods two types are distinguished. Each type representing a deviation from one property of a public good.

**Common-pool resources** represent types of goods of services, where exclusion of users is hard, but with a growing number of users the quality of the use (utility) starts to degrade (the gravity of this can vary). Expert analysis climate services are probably scalable to some extent without quality effects, but further increase in demand leads to quality loss and/or crowding out of users and consequently higher prices or longer queuing times. For Shared Practices similar concerns can apply, depending on the degree of value-added services in the Shared Practices.

**Club goods** hand concern goods or services, which do not suffer from utility degradation due to increasing demand, but instead enable exclusion of certain users. Indeed, one solution to protecting quality levels is to make entry conditional. For example, a package of Expert Analysis climate services can be provided to a regional or sectoral club of users. The exclusiveness prevents free riding and thereby can ascertain sufficient resourcing and continuity. For Shared Practices, climate services similar concerns can lead to establishment of a club. Yet, as the benefits of sharing may continue to grow with growing diversity in contributions, exclusion is a tricky concept for this product type and therefore may be applied in a graduated way.

Figure 3 shows that Maps & Apps and Climate-inclusive Consulting can quite clearly associated with *one* particular public or private good status. In turn, this hints at less need for **business model variation**. On the other hand, Expert Analysis and Shared Practices stretch out between different public or private good status options, which indeed implies that a larger variation of business models is needed. Now it also gets clear why traditionally typical public agencies, such as national met-offices, may find it difficult to apply the most appropriate business models to their collections of climate services or to the collaborative frames in which they participate. A further complication is that for particular climate services clusters technical and organisational innovations can change the prevailing character of such climate services, e.g., from Maps & Apps to Expert Analysis or Shared Practices. Providers of Climate-inclusive Consulting and Expert Analysis as private goods may be very successful, making some of their climate services concepts hallmark products, which could be licensed to model platforms thereby turning an originally private good into a common-pool resource or a club good.

FIGURE 4: MAIN TYPES OF CLIMATE SERVICES, THEIR PUBLIC/PRIVATE GOOD CHARACTER, AND MOST SUITABLE VALUE CHAIN SEGMENTS



Finally, we add the **association with segments of the value chain** (Figure 4). The coloured zones covering the matrix of climate services product types link to segments of the value chain, indicating where those product types most suitably apply. It should be noticed there is a significant overlap between area identified for public goods and those for semi-public goods. Similarly, a somewhat more limited overlap with private goods exists. The zoning is indicative. For example, it doesn't mean there are no public climate services for end-users, but it is not the mainstay of that category, e.g., because end-user implies almost automatically a need for tailoring.

## 4.4 Resourcing and willingness to pay

The overall picture regarding **resourcing of climate services** remains quite tentative due to the substantial share of publicly funded climate services development and piloting efforts, which are not always clearly distinguished from regular climate services provision in interview and survey responses, and neither in more formal reporting. The market figures from the MARCO project do not help so much either in this respect, as an unknown fraction of the publicly funded activity is included, whereas the scope of activities captured under climate services is broader than applied in EU-MACS.

Currently, almost all upstream climate services are depending on **public funding**. It is likely that this continues in the future, but technological change in conjunction with ongoing (information/observation) unit-cost reductions may enable commercial potential for integrated observation and (climate) service delivery. For midstream and downstream climate services, especially in case of more advanced products, there is so far an obvious dependence on public funding, but the continuity of that funding tends to be much weaker. There is a widely shared view (and experience) that operation of more advanced, often public sector owned, climate services lack clear funding frameworks. Public actors are often expected to resource it from their current (basic) budgets and otherwise supplement this by project-based payments. However, so far, the clientele consists to a large extent of other (lower) public actors with limited means. Exceptions have been several large cities or infrastructures with obvious benefits from proper mapping of climate related risks. Also, the more broadly scoped sustainability and resilience plans of cities, regions, sectors, and companies entail to some extent the use of climate services, i.e. as readily available climate scenarios (via Maps & Apps or via Shared Practices) or as tailored support (Climate-inclusive Consulting and both public and private Expert Analysis).

> The current uncertainties whether the climate services eventually make a **sufficiently beneficial difference** are mostly large enough to cause very low willingness-to-pay (WTP).

With the exception of pockets of more advances climate services development, such as for insurances and electric power companies, a large majority of (potential) users in the three focus sectors (and beyond) regard **regular use of climate services** still as something of the future. The current uncertainties whether the climate services eventually make a **sufficiently beneficial difference** are mostly large enough to cause very low willingness-to-pay (WTP). Indeed, as regards adaptation-oriented climate services the various interviewees and survey respondents indicated that—in as far as there might be any use for the climate services in the nearby future—one would prefer the use of public free-of-charge climate services (mainly upstream and midstream). Climate services that are translated into actual decision variables of the end-user (e.g., expected deviation from the monthly average number of hotels using tourists in a tourist region) mostly arouse much higher interest, and potential WTP, but also raise the quality requirements of such indicators. Some end-user segments can also have preferences for handling a part of climate services information in-house, i.e. acquiring mid-stream or 'early' downstream climate services, if it is deemed competition critical information.

As was discussed in the previous section and also reiterated in quite some interviews, a significant part of the climate services provision will be generated by **collaborative structures**, which tend to require creative business models and multiple source funding. Yet, many public actors feel that current funding structures do not support these organisation forms very well, while in some countries current regulation may be downright very restrictive in this respect. Both private and public actors acknowledged that this organisational and resourcing uncertainty simply frustrates a part of climate services innovations,

whereas the substantial expertise input and failure risks imply that its inclusion of public sector expertise is indispensable. In other words, the underlying assumption of strict separation of public and private domains that such segregation will give the private sector enough space to generate more innovations, seems to fail in this case. Cooperative public-private partnerships are necessary to get a part of the innovative climate services actually working. Whether in a longer-term perspective of well-established climate services markets a part of these climate services products can be totally allocated to private provision cannot be answered now, and also depends on the societal and political criteria as distinguished in the three Climate Service Policy Scenarios (see chapter 2).

Table 15 presents **alternative business models** for climate services development and provision, as well as integrated development and provision. For each business model is indicated what are likely (and feasible) funding sources. Finally, is indicated how well business model—funding option combinations would fit in each of the three Climate Policy Scenarios. It should be emphasized that this table focuses climate services delivery (and related development). Additional specific and generic innovation policies, including for example high-level education and R&D are discussed in the chapter 3.

TABLE 15: RESOURCING OPTIONS FOR BUSINESS MODELS AND FITNESS FOR CLIMATE SERVICES POLICY SCENARIOS

| Business models | Phase* | Resourcing options | Policy scenario fitness** |
|---|---|---|---|
| • CS is developed on the basis of a public grant, and intended CS is hoped to be effective enough to face positive WTP from users or state | | Annual or multi-annual grant from state or international public body | I. Yes, especially for end-use gaps<br>II. Only if crucial for key industrial opportunities<br>III. Complementary, if other options fail |
| • CS is developed in conjunction with private or club-based observation capacity | | Private sector funding from observation capacity owners or 3rd parties (venture capital; crowd sourcing) | I. Less likely, less needed<br>II. Favoured option<br>III. Yes, if fitting to bottom-up approach |
| • As part of basic service of a public organisation and funded from the basic budget | | Annual budget from national and/or regional authority earmarked for certain use; future levels not (completely) guaranteed | I. Yes<br>II. Minimal, and mostly as no. 4<br>III. To some extent, but preference for no.4 |
| • Provision on the basis of a public service contract between a public organisation and one or more ministries | | Annual budget from national and/or regional authority earmarked for certain use in conjunction with performance criteria and options to reward (sanction) over (under) performance; can also be combined with other revenue source (e.g., sales), where public service contract aims to fill anticipated gap. | I. Yes, also as main funding<br>II. Yes, but mainly as complementary funding<br>III. Yes, emphasis on user quality experience and flexibility (avoiding de-facto perpetuity) |
| • As a largely self-financing public service of a public organisation | | Possibly basic budget share complemented by revenues from service sales, often involving some price regulation; may entail PSI / INSPIRE issues | I. Only if hard national budget limits<br>II. No<br>III. No |
| • As a partnership of several public provider organisations augmenting the value of the services by adding complementary data and information | | Partnership has no genuine own budget, but depends on cost sharing of constituent bodies;<br>Constituent bodies transfer parts of their earmarked own budgets to the new body, thereby having a real own budget;<br>For both previous options the state (or region) may provide basic funding extra cost beyond what constituent bodies can transfer;<br>Revenues from member (user) fees may be additional, but often not dominant funding | I. Yes, if open<br>II. Yes, if also other sources (fees) and sufficiently open to business<br>III. Yes, but sufficiently open at least for relevant target groups |

| | | | |
|---|---|---|---|
| | | source. Usually hard to have really significant sales revenues. | |
| • As a partnership of both service providers and users to provide tailored, often co-designed, information to users (and also back to providers) (PPP or PuPuP) | | Funding by partner correlates with use and is inversely related to amount of expert contribution (net payers and receivers). Use by 3rd parties against higher rates can be additional funding source. States, regions or EU might operate general support & promotion programmes for this. | I. Yes, but dash for maximum access & openness may limit this to some extent<br>II. Yes, but no public support programme<br>III. Yes, but some precautions against exclusiveness may apply |
| • Multistage CS development and use partnership (PPP) | | Public CS experts develop new CS for/jointly with private CS provider; private CS provider pays public agency's cost<br>a. completely and owns new CS, or …<br>b. partly and public agency shares in the revenues from the use of the CS | I. Possible, but public funding emphasis lowers public agency's interest in this<br>II. Yes, favoured over no. 1<br>III. Yes, public agencies are incited to choose 8.b option |
| • CS offerings and matching facilitated by a knowledgeable CS brokerage organisation | | A key point will be the neutrality of the brokerage, which can affect preferred funding models. Options:<br>a. purely user fee based<br>b. mixed – state or EU base funding + user fees<br>c. sector (private) funding based + user fees<br>d. fees from acknowledged CS providers + user fees | I. Only 9.b, moderate fees + openness requirements<br>II. All, except 9.b<br>III. All, except 9.d—guidelines to avoid (excess) profits<br>Especially Policy Scenarios I and III may require clear quality assurance management |
| • CS provided and charged as private service, subscription based | | Self-explanatory, may include some degree of tailoring.<br>There may be some pressure for subsidizing users, but that is better to be avoided. | I. OK, but private CS market may be smaller than in other scenarios<br>II. Preferred way, limitations or exclusion of public actors from private market<br>III. OK<br>In all three Policy Scenarios, especially I and III, CS comparison and monitoring could be promoted |
| • CS provided and charged as private service—case wise consultancy contracts | | Self-explanatory, may include also CS development or tailoring.<br>There may be some pressure for subsidizing users, but that is better to be avoided. | I. Yes, but private CS market may be smaller than in other scenarios<br>II. Yes, limitations or exclusion of public actors from private market<br>III. Yes<br>In all three CS Policy Scenarios, notably I and III, CS comparison and monitoring could be promoted |

*) **Phase**: development (green); provision (blue); development + provision (grey)

**) **Policy scenarios**: I : state-cenntred; II : business-centred; III : network-centred.

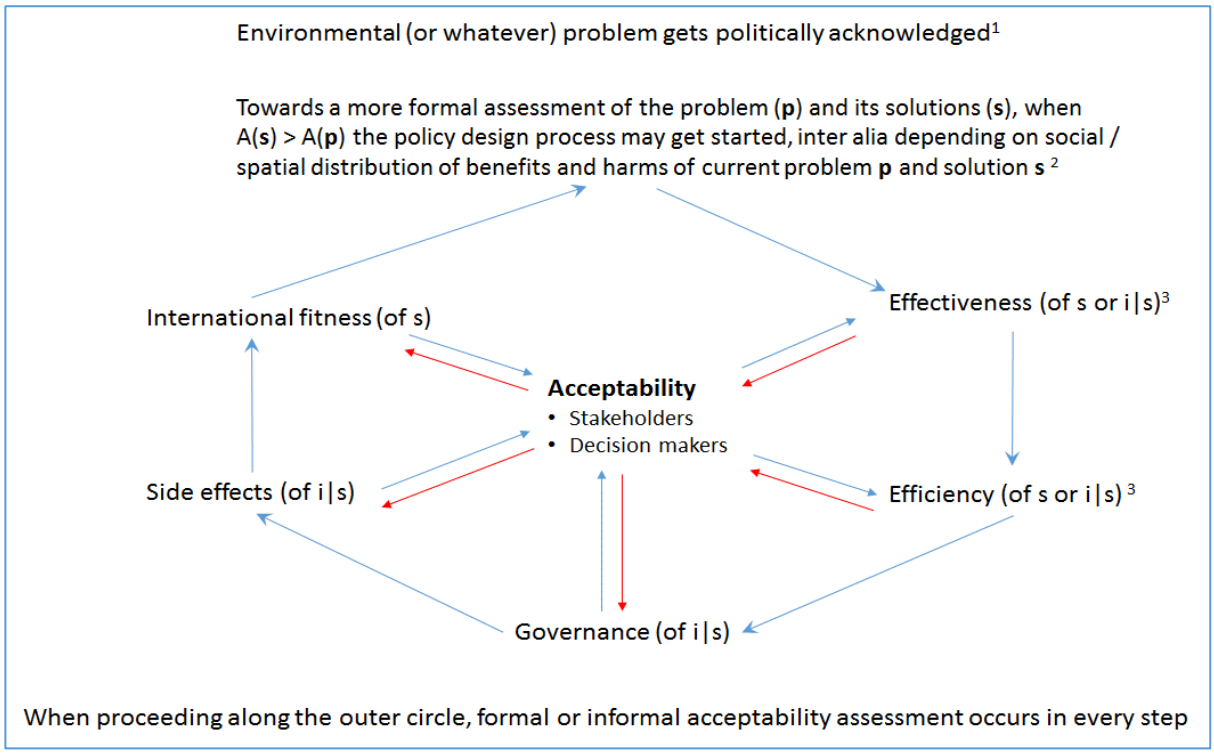
# 5 POLICY SENSITIVITY OF SERVICE UPTAKE

## 5.1 A pluralist evaluation frame

Exact **assessment of effectiveness** of alternative policy instruments and policy packages (policy mixes) is not possible due to incomplete and imprecise data and limitations of evaluation tools when dealing with novel instruments or instrument packages. We aspire to provide nevertheless an impression of the relative effectiveness of at least a selection of measures and packages. In this respect, it is also important to acknowledge that acceptability and contextual applicability are inescapable qualities from a feasibility point of view.

For new policy areas, such as in this case on facilitation, promotion and public-private role division of climate services, the policy process is not yet crystallized and therefore understanding of the **interaction** between aspired results and existing policy regime on the one hand and the establishment process on the other hand is important for the different actors. It is not only a matter of a not yet established policy frame and practices, but also of an emerging dynamic market in conjunction with several types of innovations emerging in different parts of the value chain.

FIGURE 5: THE RECURRENT REVIEW OF ACCEPTABILITY IN POLICY DESIGN AND ITS EVALUATION – LINKING PROCESS AND OUTCOMES




**Legend**: 1) Dinkelman 1992: "an (environmental) problem gets only (politically) acknowledged after at least one solution has come in sight" 2) In fact one should make a distinction between the eventual technical/behavioural etc. solution (build dike, switch to vegetarian diet, etc.) and the incentives/facilities (instrument i) that a policy proposes so as to promote or ensure realization of the solution; A(s) means than acceptability of a solution s, regardless of the pathway of promotion/realization; A(i) means acceptability of instrument i, regardless of its purpose; A(s|i) means acceptability of solution type s given realization through instrument i, and A(i|s) means acceptability of instrument i given solution type s; 3) In early stages (first rounds) of policy preparation the effectiveness of the actual solution is often first assessed; once the most sensible 'technical' options are known, the assessment shifts to instruments in combination with given solutions.

Generally, when evaluating policy designs, initially **separate instruments** are evaluated on effectiveness, efficiency and affordability. Already during those steps, acceptability—politically and by the public—may be an issue. If other elements, such interaction with other policies and with international legislation, as well as social equity considerations are taken into account acceptability often gets even more challenged. As a consequence, the stepwise design and evaluation of an emerging policy is often

recurrently—implicitly (e.g., via public opinion) or explicitly via formal consultation—scrutinized on acceptability. A certain drift can then occur in the design features of the policy, indeed resulting in an effective or less effective compromise. The interaction between the policy aspects 'process' and 'conditional results' is summarized in the Figure 5.

## 5.2 Main sources of effects on uptake of climate services

In section 5.1, the concept of **acceptability of policy design** was introduced. This concept is operationalized at different levels. Firstly, by showing fundamentally different pathways in the form of three different scenarios representing different governance philosophies (state central, market central, citizen well-being) policy makers can seek for policy packages that seem most suitable for their current or aspired governance regimes. Each of these philosophies implies that some policies are less relevant or acceptable or get less priority, also implying that in a given governance framework particular instruments can be particularly effective or ineffective. Secondly, the obstacles and mechanisms *inherent* to the market for climate services typically imply the use of particular instruments if a certain objective is to be pursued.

In this chapter in particular **efficiency and effectiveness** of various instruments will be scrutinized. Subsequently, can be inferred how the three policy scenarios may perform, and how disadvantages may be compensated by other advantages or adaptations in the (intensity of) policy instruments. The assessment will be carried out by means of an exploratory model, which has been used in EU-MACS D2.1 (Hamaker et al. 2019), while also leaning on earlier work concerning valuation of weather and climate services (Nurmi et al. 2013; Perrels et al. 2015). The model plus some extensions are presented in Annex 3.

We concentrate here on the 4 main attributes of the uptake function:

- Indicator for **fitness for purpose** (of the climate service for application in the user's context)
- Expected (max.) **benefit potential** addressed by the (collection of) climate service(s)
- Indicator of **value enhancement or discount effects of sharing of information** depending on market conditions of end-user markets
- **Costs of search & selection, acquisition and use** of climate services.

All the mentioned policy instruments and business models, including the ones dealing with climate service development and education of (prospective) user each **affect** one or more of the attributes. For example, policies dealing with promotion and improvement of user inclusive quality assurance means a more effective appreciation of fitness for purpose.

Apart from the policy instruments, there are two other **factors influencing** the value of climate services and the uptake probability, being: (1) the development of expected damage (in absence of planned adaptation) expressed as fraction of GDP lost as a consequence of climate change, and (2) economic growth as expressed in GDP development. The tentatively estimated effects of various policy instruments can be compared with the approximate effect sizes of the two external drivers (damage and growth).

## 5.3 Theory and application regarding information value

In the preceding EU-MACS synthesis report D5.1, **obstacles to uptake** of climate services were discussed, categorized, and rated, also against the backdrop of various theories pertaining to aspects of market imperfections, notably transaction cost theory (Williamson & Cheng 2014), and to more diverse individual and organisational behavioural models (Teece 2010; 2018), extending beyond trivial versions of (economic) rationality, and accounting especially for cooperative solutions for common pool resources (Ostrom 2005; 2010). In relation to these identified obstacles, policy instruments and alternative business models could be determined, which can alleviate the obstacles and reinforce uptake motivations and mechanisms. Yet, from this diverse palette of options it is hard to generate even tentative quantifications of (changes in) uptake probabilities. Not the least due to lack of data. If there would

be no data limitations, the **diversity** would result in a plethora of sketched uptake pathways per product segment or user segment.

In EU-MACS D2.1, an illustrative calculation for one hypothetical climate service for the financial sector was presented, using the model described in Annex 3. The **illustrative example** of D2.1 is mainly reflecting a so-called 'expert analysis' type of climate service (in this case a subscription based semi-standardized product of medium complexity). Despite its limitations the illustrative model use for D2.1 showed nevertheless that

- the development of the **benefit potential** and the **fitness for purpose** of a climate service will usually be the decisive factors for the degree of market success of the climate service;
- whereas **acquisition and use cost** will matter much less for the eventual levels of uptake (perhaps it matters for competition between very similar products), these costs can be a significant obstacle at early stages of a (new) climate service;
- the choice for a **collaborative or competitive** (non-sharing) strategy in climate service acquisition may have longer lasting consequences for how the benefit potential for separate users and for all users together develops, whereas it may not be always a priori evident what is the best strategy.

In the exercise in the next sections the emphasis will be on the **factors affecting the expected benefit** of a climate service, in connection with a medium to long term prospect for the market development (2030). In addition, factors affecting costs for users at initial stages will be separately considered, seeing it more as a temporary issue during the unfolding of the climate services market.

Since quite a large number of policy instruments has been identified, while there is very little empirical material available to meaningfully represent uptake developments, a semi-quantitative approach at macro level is applied. Considering the above findings regarding the uncertainty regarding benefits of information sharing, whereas a macro level approach will be used to rate policy instruments regarding their effect on promoting uptake, first a short discussion is presented based on literature regarding the 'social value of information'. This topic is in particular popular in (more fundamental) economic research of financial markets, in relation to sharing of information and information disclosure. Even though the discourse is still going on, e.g. aiming for more precise delineations and conditions, there is a fair degree of consensus that **complete sharing and disclosure** does not always raise welfare as much as more selective information strategies.

Kohlhas (2017) discusses disclosure of original—unprocessed/non-tailored—information by one public (financial) authority, which is partly substituting private, only partly shared, information. This may nevertheless create less efficient outcomes than more sophisticated user needs oriented, but condensed information (i.e., a policy indicator) or even than the original use of all private information, if the latter is sufficiently diverse. This indicates that 'fit for purpose' in its end-user context is a very important feature. Yet, Svensson (2006) illustrated in an earlier paper that public transparency is in most cases welfare augmenting. **In summary** (for both papers), **when there are trade-offs regarding the fitness for purpose and the degree of exclusiveness of information when substituting between public and private information sources, the generation of private and social value added can be either positive or negative.**

Angeletos and Pavan (2007) also discuss **welfare effects** of additional public information (as compared to—only partly identical—private information separately collected by each actor) and indicate that it depends on (1) the extent and quality of substitution of private by public information and (2) on the competitive properties of the product markets on which the users (firms) of the public/private information operate.

Furthermore, Teyssier (2012)—applying game theory in a public choice setting—discussed consequences of differences in **non-selfish motivations of firms** (or actors) for policies based on sharing (information, resources, etc.). Translated in climate services' use terms the outcomes indicate that:

- the degree of climate change risk disclosure (and hence climate services demand) depends on the (expected) variation in the social utility function, and the expected benefits of shared information
- the degree of sharing information in climate services design, acquisition or use depends on the (expected) variation in the social utility function, and expected benefits of shared information
- theory, experiment and practice indicate that such variation in social utility function exist.

As stated before, the model is properly explained in Annex 4, but we introduce it here briefly in order to enable the reader to associate variables (factors affecting the expected benefits or the cost) with policy instruments as presented in Table 16. The following **variables** are distinguished:

$\alpha$ Fitness for purpose of the considered (cluster of) climate services

$B$ Expected (max.) benefit potential addressed by the (collection of) climate service(s)

$\kappa_s$, $\kappa_{ns}$ Indicator of value enhancement or discount effects of sharing of information depending on market conditions of end-user markets

$C$ Costs of search and selection, acquisition, and use of climate services.

The Benefit-Cost Ratio (BCR) amounts to:

$$BCR = \frac{f(B)}{g(C)} = \frac{\alpha . B . \kappa}{C_{ss} + V_{ss} + p_{cs} + C_{ip} + V_{ip}}$$

TABLE 16: LINKING CLIMATE SERVICES' UPTAKE FACTORS WITH POLICY INSTRUMENTS

| Uptake variables | | Relevant instruments | Comments |
|---|---|---|---|
| $\alpha$ | Fitness for purpose *(meaning that provider improves product information/design/flexibility; and/or the user is enabled to better judgement)* | • QA promotion via common standards and transparent QC<br>• Standardized terms for products and quality levels<br>• Communities of practice to promote learning & feedback<br>• Promote good quality CS brokerage and market places<br>• Development & piloting of interfacing options (visual; non-climate/climate data; etc.) | QA promotion can be state led as well as adopted by private sector;<br>Adopting shared terminology is typically common task of CS provider and user groups;<br>Communities of practice is primarily a task for private sector and local authorities; public financial (start-up) support can be considered, under certain conditions;<br>Brokerage can be initiated both by public and private actors, if private public start-up subsidies could be considered |
| $B$ | Benefit potential *(meaning that users learn to better exploit CS or measures to disclose benefits to users; and/or new or improved CS enable users access to hitherto not addressed benefits)* | • Awareness raising campaigns<br>• Integration of climate knowledge in non-climate curricula at different levels<br>• Communities of practice<br>• Monitoring and ex-post evaluation of CS use and its effects—results open access<br>• Inciting development of *new applications* for hitherto not served topics and of *substantial improvements* in models or data<br>• (Self-) regulation on mandatory climate risk reporting, transparency and accountability | Awareness raising is a low key initial step, its need will diminish over time;<br>Monitoring and evaluation should also entail dissemination of results, this connects well with communities of practice;<br>Inciting specific new CS developments is not just R&D support, but also about getting the *most needed* CS developed; by including piloting and *performance based* funding user need orientation can be optimized; resourcing models may entail multi-stage structure (see section 3.4);<br>Reporting and transparency obligations would involve standardization and data quality requirements |
| $\kappa_s$ | Information sharing premium (meaning that sharing input and perhaps | • Regulation on mandatory climate risk reporting & transparency | Enforcement or voluntary uptake of such regulation in finance and urban planning will oblige most other actors to be transparent |

| | | | |
|---|---|---|---|
| | output data is beneficial) | • Facilitating or subsidizing data portals, given certain quality and maintenance conditions<br>• Adapt legislation on segregation of public and private domains if preventing joint CS development and use | as well; as a consequence a good quality generally trusted source of open basic data will need public funding, possibly supplemented with funding from key sectors |
| $K_{ns}$ | Information exclusiveness premium (meaning that non-sharing of data is more beneficial than sharing) | | Private decision, which would need particular supporting policy, perhaps the opposite—exclusive information with high societal relevance (beyond the user) could be scrutinized or the use of public data for these purposes could be charged |
| $C_{ss}$ | Search & selection cost (policies aim to lower transaction cost) | • First mover subsidies, for newly engaging sectors or product segments, in exchange for sharing experiences (with delay)<br>• Promote good quality CS brokerage and market places | |
| $P_{cs}$ | Information purchase cost (meaning that policies aim to keep prices low where possible, while ensuring viable resourcing of CS) | • Safeguard resourcing of basic CS to ensure free or affordable access<br>• Start-up subsidy for new provider, which somehow fill gaps in the market, possibly earmarked for certain types of users<br>• First mover subsidies for early user in newly engaging sectors or product segments, in exchange for sharing experiences (with delay)<br>• Enable and support exploration and experimentation with alternative viable business models | Use of conditional subsidies may easily swell administrative burden, in that case it is worthwhile to either simplify the conditions or refrain from a (user linked) subsidy |
| $C_{ip}$ | Cost of in-house information processing | • Training and education at sector level | If a public policy this may conflict with options for training as a private climate service or as a part of a larger climate services package (private or public or PPP);<br>Can also be a (private) sector initiative |

## 5.4 Comparing policy effects to the effects of growth and damage base

The **benefit potential** of climate services is contained in the avoided cost and additional opportunities realized. When there is more economic activity and more assets, the amount of avoided cost and opportunities will increase. In other words, regardless of the existence of climate services promotion policies the benefit potential of climate services is growing due to economic growth. For example, even a modest annual growth rate of GDP of EU 28 by 1.125% between 2016 and 2030 amounts to an expansion of the benefit potential by about 20%. By 2040 this effect has risen to 36%, when assuming the same annual growth rate.

The effect of economic growth on the benefit potential as represented here does presume that **no additional adaptation measures** are installed automatically (i.e., without extra policy). In practice the difference between planned and new adaptation and current levels of adaptation may be hard to determine, at least not precisely (Perrels et al. 2015). Furthermore, the way the economic growth takes shape (sectoral profiles, locations, technologies) may enhance or reduce the economy's vulnerability level. The applied growth rate also implies that for the next few decades climate change and climate policy are not expected to crucially affect the pace of economic growth in the EU. Summarizing, the effect of the economic growth rate is relevant and can be significant, but the size of the effect is subject to uncertainty, even if the economic growth rate is known.

A second source of increase or decrease of the benefit potential of climate services are the **physical effects of climate change** that constitute hazards or systematic reductions in productivity of assets or labour. Even though climate change impact attribution of single events is still a precarious exercise for Europe as a whole, over a time span of a few decades one may apply simplified damage functions, responsive to global temperature rise, as a first approximation. In this case we use two versions of the damage function as used in the DICE model (Nordhaus 2010, 2016), which were used by Ackerman and Stanton (2012). One version is based on Nordhaus' own work, representing a moderated sensitivity of GDP development to global temperature rise. The other version is based on an elaboration by Weitzmann (2010), in which damage development accelerates beyond 3 degrees global temperature rise. As we are considering only the not so distant future (2030, 2040), expected temperature rise is not surpassing the 2 degrees in most scenarios (if any) in the considered time span. Table 17 shows the multiplier factors for the global warming damage base and economic growth. Overall the growth in damage owing to climate change is significantly more important than the contribution of economic growth. Even if the assumed economic growth rate would be doubled (from 1.25% to 2.5%) the damage factor would remain clearly dominant.

TABLE 17: BENEFIT POTENTIAL MULTIPLIER FACTORS FOR GLOBAL WARMING-BASED DAMAGE AND ECONOMIC GROWTH

| | 2030 | | 2040 | |
|---|---|---|---|---|
| | ΔT =1.35 °C | ΔT =1.5 °C | ΔT =1.5 °C | ΔT =2.0 °C |
| ***Damage factor (Nordhaus)*** | 1.82 | 2.24 | 2.24 | 3.97 |
| ***Damage factor (Weitzmann)*** | 1.83 | 2.27 | 2.27 | 4.18 |
| ***GDP growth*** | 1.19 | 1.19 | 1.35 | 1.35 |

Unlike the multiplication factors driven by climate change damage and GDP growth, the factor for **policy effectiveness** is expressed as a fraction representing the realized share of the (theoretically) maximum attainable benefit.

The line of reasoning is based on earlier experiences with economic evaluation of weather services (Perrels et al. 2013; Nurmi et al. 2013; Pilli-Sihvola et al. 2016; Perrels et al. 2013), but elaborated for climate services (see EU-MACS D2.1 and Annex 3 of this report). In brief, there are three main factors that affect how the eventual perceived benefit of a climate service is rated, being: **fitness for purpose, benefit potential addressed, and enhancement effects of sharing information**. Fitness for purpose can be understood as a kind of gate keeper or faucet, denoting that if there are doubts about the fitness for purpose for a user, such a user will either drop that alternative right away or significantly discount the expected benefits from use. So, as regards communicating a climate service to potential users it is important to enable adequate and quick judgement whether a climate service would in principle serve the user's purposes, and to what extent it also requires complementary information, post-processing and acceptance of an approximate level of uncertainty. In practice, this means promotion or even requirements regarding quality assurance and standardization in product definitions and categories, and terminology.

On the other hand, for prospective users **social learning**, e.g., through communities of practice, can enhance the ability to judge fitness for purpose. Such communities tend to be started as private initiatives. Partly this will happen through existing relation with consultancies, interested to extend their service portfolio. A good example of an open, business driven, practitioner and knowledge exchange platform is the Climate Disclosure Project (CDP[29]), originally mainly oriented towards greenhouse gas emission reduction, but nowadays also encompassing direct and indirect risks of climate change. CDP is oriented towards large (multinational) firms. National and regional counterparts for small and medium sized firms could fill a gap, and the establishment of such localized networks may need public support,

[29] www.cdp.net/en [15 January 2019]

at least at early stages. Next to these consultancy or sector led platforms and clubs a prospective user could turn to a climate services broker (i.e., Oasis Hub[30]), which can offer assistance and advice in finding appropriate options. Under certain conditions, such as regarding openness and transparency in approaches, such brokerage services may merit public support for starting up as it improves market functioning. Yet, in the long run, one would assume these to be self-financing services.

## 5.5 Rating instrumental effectiveness regarding the four main variables driving uptake

For each of the variables introduced and identified with enhancing instruments in section 4.2 is presented what **level of approximate effectiveness rating** could be attributed in each policy scenario.

The list below summarizes what seem the **most important policies and measures** to enhance 'fitness for purpose', while it is also gives an indicative rating for the significance of the measures. It should be noted that more significant impact, may entail also more significant implementation cost. Apart from the R&D related measures on interfaces, the identified measures tend to be mainly at the private side or joint efforts of (sectoral or regional) public authorities and private actors. Start-up and first-mover subsidies may nevertheless be economically justifiable, as there is a public interest in better market functioning and promotion of learning process.

As explained in the text above and from surveys, interviews and workshops and previous Deliverables (5.1, 2.1, 3.1, 4.1, 1.2, 1.1) we do know that the most essential **measures for fitness for purpose** ($\alpha$) are:

1. Standardization in terms, categories, presentation +++
2. Pertinent QA procedures +++
3. Development and testing of new interfacing options ++
4. Reliable & good quality brokerage and market places ++
5. Communities of practice (private/PPP/regional) +

**Legend: +**, (very) helpful, but voluntary character limits impact; **++**, if implemented rigorously, this can make a quite significant contribution in reducing obstacles; **+++**, if implemented rigorously (including minimum requirement levels and inspection/peer review), this crucially lifts abilities to fine tune and communicate ´fitness for purpose' of climate services for different types of users.

The indicated significance applies to a situation of adequate application at a significant scale, and in the prime spirit of one of the three policy scenarios[31]. For some measures however, the engagement level may be lower in several policy scenarios. Furthermore, for all policy scenarios applies that these may harbour other agendas as well. Therefore, for each policy scenario an A and a B version is identified. In the A version policy choices are made in accordance with the principal philosophy and motivation of that scenario. In the B version, compromises or deviations are allowed owing to the harbouring of other agendas as well. In the B versions measures will be less effective and/or implemented less vigorously than in the A version, whereas the degree of effect devaluation can vary over the policy scenarios. Table 18 provides a summary of the differences between the A and B **variants of each policy scenario**. The differences in approximate effectiveness regarding enhancing fitness for purpose for the A and B variants of each of the policy scenarios is shown in Table 19. The scoring is based by dividing the attributed number of +-signs by the maximum attainable number of +-signs. For the next variables also bracketed signs (+) are included, indicating further moderation or conditional application.

**The resulting scoring should be regarded as indicative**, meaning that *in the most ideal circumstances* the so-called citizen led policy scenario seems to have some advantage over the other two policy scenarios in terms of alleviating obstacles regarding fitness for purpose. Furthermore, in case of adding

[30] https://oasishub.co/ [15 January 2019]
[31] Policy-makers have some leeway to insert elements from one policy scenario in another one.

other likely agendas this policy scenario seems less sensitive for devaluation of effectiveness than the other two, with respect to this variable.

**TABLE 18: PRINCIPAL AND COMPROMISED VARIANTS OF THE POLICY SCENARIOS**

| State-centred | Business-centred | Network-centred |
|---|---|---|
| A. Driven by equity & safetycon-cerns, aims to ensure sufficient resilience across society & in all regions to the extent needed & deemed affordable | A. Driven by free market philosophy, under assumption that this approach best enables creativity to become productive | A. Driven by the notion that citizens, civic groupings, regional collaboration, etc. knows best how to balance welfare & well-being interests, affordability, etc. |
| B. Safety, security & equity (as notion of social security)—possibly all absorbed into a comprehensive concept of societal resilience—is regarded as necessarily state supervised, possibly also lined to perpetuating (state dominated) institutional structures | B. As under A. Promoting innovation is an important motive, but as compared to A, focusing on dominant industrial innovation interests | B. Similar as A, but in this case, bottom-up initiative is structured & driven by local and/or sectoral (pre-existing) dominant interests |

**TABLE 19: TENTATIVE BENEFIT ENHANCEMENT EFFECTS OF POLICIES/FITNESS FOR PURPOSE**

| | Variant A | | | Variant B | | |
|---|---|---|---|---|---|---|
| **Essential measures for raising fitness for purpose ($\alpha$)** | **State-centred** | **Business-centred** | **Network-centred** | **State-centred** | **Business-centred** | **Network-centred** |
| 1. Standardization in terms, categories, presentation | +++ | +++ | +++ | +++ | ++ | +++ |
| 2. Pertinent QA procedures | +++ | ++ | +++ | ++ | ++ | ++ |
| 3. Development & testing of new interfacing options | ++ | ++ | ++ | + | + | ++ |
| 4. Reliable & good quality brokerage & market places | + | ++ | ++ | | + | + |
| 5. Communities of practice* | + | + | + | + | | + |
| | 0.91 | 0.91 | 1.00 | 0.64 | 0.55 | 0.82 |

*) This measure is also relevant for the next factor (benefit potential), and its overall significance is larger than would be inferred from this table only.

Similar as for fitness for purpose, a set of factors is identified for **enhancing the benefit potential**. In the first place, the recognition of a benefit potential needs to be ensured. For this purpose mandatory climate risk reporting, transparency and accountability (no. 2 in the list below) will be very effective. Furthermore, by complementing this with monitoring and ex-post evaluation of the effectiveness climate services evidence of the (variation in) benefits of different climate services will help users to make choices and providers to develop and adapt climate service portfolios. In various cases improvements in effectiveness will need significant R&D effort, and hence sufficient innovation funding remains fairly to very important for benefit potentials. As a prelude to recognizing the sense of climate services also awareness raising is still needed at least for various prospective user groups (e.g., in tourism, manufacturing industry, parts of the financial sector, and some types of regional or local authorities). Last but not least social learning boosted by communities of practice will help current and prospective users to better assess the benefit potentials addressed (next to fitness for purpose as discussed above). Similarly, in order to improve the ability to use climate services *in conjunction with other information* in several non-climate curricula (such as urban planning, architecture, etc.) climate knowledge could get more attention.

The significance under ideal circumstances of these measures is summarized in the list below and subsequently rated for the policy scenarios in their A and B variants below in Table 20.

Measures and their rating for *B* are:

1. Innovation programmes for breakthrough technologies enabling more climate servces benefits ++(+)
2. (Self-) regulation on mandatory climate risk reporting, transparency and accountability +++
3. Monitoring and ex-post evaluation of climate services use and its effects—results available as open access +++
4. Awareness raising campaigns +(+)
5. Integration of climate knowledge in non-climate curricula at different levels +
6. Communities of practice +

**TABLE 20: TENTATIVE BENEFIT ENHANCEMENT EFFECTS OF POLICIES/BENEFIT POTENTIAL (B)**

| | Variant A | | | Variant B | | |
|---|---|---|---|---|---|---|
| **Essential measures for raising benefit potential (*B*)** | **State-centred** | **Business-centred** | **Network-centred** | **State-centred** | **Business-centred** | **Network-centred** |
| 1. Innovation programmes for breakthrough technologies enabling more CS benefits | ++ | ++ | + | ++ | +++ | + |
| 2. (Self-) regulation on mandatory climate risk reporting, transparency, & accountability* | +++ | +++ | +++ | +++ | ++ | +++ |
| 3. Monitoring & ex-post evaluation of CS use & its effects – results open access* | +++ | ++ | +++ | +++ | + | +++ |
| 4. Awareness raising campaigns | ++ | + | ++ | + | + | + |
| 5. Integration of climate knowledge in non-climate curricula at different levels | + | + | + | | + | + |
| 6. Communities of practice | + | + | + | + | | + |
| | 1.00 | 0.83 | 0.92 | 0.83 | 0.75 | 0.83 |

*) These measures are also relevant for the factor on promoting information sharing.

In this case, the **state-centred option**, under ideal circumstances, seems to best address the total benefit potential of climate services in socio-economic terms. This is not the same as monetized market value of these benefits, which may still be higher in the business central and networked scenarios. The devaluation effect of additional agendas is expected to be less severe as compared to the first factor (fitness for purpose) and shows less variation across the policy scenarios.

Now, we are only considering **measures promoting sharing of information** (factor $\kappa_s$), not for exclusivity (factor $\kappa_{ns}$). Climate risk reporting will imply at least some degree of data sharing, at least for common input data as it makes transparency easier and attainable against lower cost per participant. Two of the four measures are also relevant for the Benefit potential. In this case, their effect is more indirect, i.e., if the implementation of these measures is sufficiently consistent and with minimal exceptions. These measures will also necessitate more data sharing, inter alia to fulfil transparency demands and improve benefits of monitoring information. The result is that in the A variant the policy scenarios would not differ notably, but in variant B the devaluation effects are much stronger for the state led and the business led options, mainly because full openness and sharing get less essential in these scenarios. The significance under ideal circumstances of these measures is summarized in the list below and sub-sequently rated for the policy scenarios in their A and B variants below in Table 21.

Measures and their rating for $\kappa_S$ are:

1. Regulation on mandatory climate risk reporting & transparency ++
2. Monitoring and ex-post evaluation of climate services use and its effects – results available as open access ++
3. Facilitating or subsidizing data portals, given quality and maintenance conditions +(+)
4. Adapt legislation on segregation of public and private domains if preventing joint climate services development and use ++

TABLE 21: TENTATIVE BENEFIT ENHANCEMENT EFFECTS OF POLICIES/INFORMATION SHARING & EXCLUSIVITY FACTORS

| | Variant A | | | Variant B | | |
|---|---|---|---|---|---|---|
| **Ess. measures for affecting info sharing effectiveness ($\kappa_s$)** | **State-centred** | **Business-centred** | **Network-centred** | **State-centred** | **Business-centred** | **Network-centred** |
| 1. Regulation on mandatory climate risk reporting & transparency | ++ | ++ | ++ | + | + | ++ |
| 2. Monitoring & ex-post evaluation of climate services use & its effects; results as open access | ++ | ++ | ++ | + | | + |
| 3. Facilitating or subsidizing data portals, given quality & maintenance conditions | +(+) | + | +(+) | + | + | +(+) |
| 4. Adapt legislation on segregation of public & private domains if preventing joint development & use | + | ++ | + | + | + | + |
| | 0.875 | 0.875 | 0.875 | 0.50 | 0.375 | 0.813 |

As stated earlier, **costs** are especially relevant in the earlier stages of market development, when doubts about benefits keep expected vales of benefits low. Costs arise during search and selection (user organisation's own efforts, expert assistance), at purchase (if the climate service is charged), and during (initial) use stages (integration with own data, acquisition of skills or equipment). In fact, the cost in the use phase are often quite significant or even dominant in the overall cost. Information sharing and other collaborative actions may also lower the cost for users, but this is unsure as cooperation may also entail extra cost. Therefore, collaborative forms are not mentioned explicitly. Instead, a broader notion of experimenting with business models is included, as such experimentation can include user cost reduction, net to improving viability of the service.

Over the climate services market is pending **significant product innovation potential**, yet, often the actual operation of innovative products and provision concepts often has high uncertainties and, hence, it creates social value to subsidize the first provider(s) who try, provided the experiences are (eventually) shared with other actors. Promotion and (mildly or temporarily) subsidising of brokerage and market places will make competition for users more effective and thereby put pressure on prices of charged services as well as pressure on user friendliness ('use readiness') of both free and charged services. Obviously, the extent to which climate services are considered by the state as 'basic' or 'essential' and thereby justifying availability free of charge will have a direct and notable effect on the average price of climate services. Yet, one has to realise that a more abundant subsidy base for climate services *provision* may slow down renewal of climate services as well reduce market initiatives. Last but not least, as use cost can often be the main cost component education and training of prospective users should help to get use cost down. Training can also be part of climate services delivery, e.g., in connection with particular models or data used both for mid-stream actors (being user *and* provider) and end-users, but cost awareness will usually not be the first concern of such courses. Hence, it would also be

helpful to have, e.g., introductory courses free of charge, which can help in realistic planning and avoidance of expensive mistakes. Training also fits well as part of all kinds of sharing and collaborative practices—also in that case promotion and subsidies will help to improve use skills and properly manage use costs.

The **state-centred** policy approach has high penetration rates of climate services as a prime goal, and hence it can be expected it rates well on cost reduction effects (Table 22). For the **business-centred** policy scenario, the very critical stance towards (lasting) subsidies on the one hand and the inherent business interest not to lower prices too much make it harder in this policy scenario to promote uptake a lot through cost reductions. Under ideal circumstance, the **network-centred scenario** may achieve similar cost reductions as in the state central policy, whereas in less ideal circumstances cost reductions supposedly deteriorate slightly less than in the state central policy.

Measures and their rating for $C_{ss}$, P, $C_{in}$ are:

1. First mover subsidies, for newly engaging sectors or product segments +
2. Promote good quality climate services brokerage and market places +
3. Safeguard resourcing of basic climate services to ensure free or affordable access ++
4. Facilitating or subsidizing data portals, given quality and maintenance conditions +
5. Enable and support experimentation with alternative viable business models ++
6. Training and education at sector level +(+)

**TABLE 22: TENTATIVE BENEFIT ENHANCEMENT EFFECTS OF POLICIES/COSTS**

| | Variant A | | | Variant B | | |
|---|---|---|---|---|---|---|
| **Ess. measures for affecting info sharing effectiveness ($C_{ss}$, $P$, $C_{in}$)** | **State-centred** | **Business -centred** | **Network-centred** | **State-centred** | **Business centred** | **Network-centred** |
| 1. First mover subsidies, for newly engaging sectors, or product segments, in exchange for sharing experiences# | + | (+) | + | | | + |
| 2. Promote good quality CS brokerage and market places | + | + | + | + | (+) | + |
| 3. Safeguard resourcing of basic CS to ensure free or affordable access | ++ | (+)* | + | ++ | (+) | + |
| 4. Facilitating or subsidizing data portals, given quality and maintenance conditions | + | (+)* | + | + | (+) | + |
| 5. Enable and support experimentation with alternative viable business models | + | + | ++ | (+) | | + |
| 6. Training and education at (user) sector level (public/private) | +(+) | +(+) | +(+) | + | + | + |
| | 0.85 | 0.55 | 0.85 | 0.65 | 0.25 | 0.70 |

#) Could be broadened into more generic start-up subsidy, if engaging new sectors or product segments
*) In the market emphasizing business led policy scenario it is likely that—at best—only one of the two support options is realized, especially in the A variant.

With this rating exercise, it can be illustrated that the efforts can really make a difference, and that despite the quite different policy scenarios the uptake of climate services can be promoted in all of them to a significant extent. It should be realized in this respect that the rated **effectiveness of the instruments** is relative to the reference level of the hypothetical total (longer-term) benefit potential

($B_0$) in each policy scenario. A state central policy scenario would lead to a very good general access and coverage of sectors and regions, but the weakening market incentives make it likely that less diversity and innovation is implemented and thereby the total benefit potential is supposedly smaller. In the summarizing Table 23 below is assumed that the enhancement effect on the benefit *potential* is the strongest in the business led policy scenario (while it is normalized at 1 for the state central policy scenario). Yet, the inserted figure of 1.3 (+30%) is **only an illustration.** Furthermore, what the results suggest is that under ideal circumstance the netwoek-centred policy scenario may after all realize most benefits ($E(B)_{max}$), whereas it may also suffer least ($E(B)_{min}$) from devaluating effects of other agendas.

The **favourable** position of what is called 'network-centred' relates to the notions that for a thriving climate services market all kinds of collaborative forms seem to be necessary, whereas such collaborations will often need to be regional or sectoral to keep them manageable and responsive to specific user (segment) needs. It should be reiterated that the figures in Table 23 are only **indicative**.

**TABLE 23: SUMMARY OF RATING RESULTS**

| | $\alpha$ | $B$ | $\kappa_s$ | $C$ | $B_0$ | $E(B)_{min} \sim E(B)_{max}$ |
|---|---|---|---|---|---|---|
| **State-centred** | 0.64 – 0.91 | 0.83 – 1.00 | 0.50 – 0.88 | 0.65 – 0.85 | 1.00 | 0.27 ~ 0.80 |
| **Business-centred** | 0.55 – 0.91 | 0.75 – 0.83 | 0.38 – 0.88 | 0.25 – 0.50 | 1.30 | 0.20 ~ 0.86 |
| **Network-centred** | 0.82 – 1.00 | 0.83 – 0.92 | 0.81 – 0.88 | 0.70 – 0.85 | 1.15 | 0.55 ~ 0.93 |

Finally, the **impact of uptake enhancement** can be compared with the estimated contributions of GDP growth and climate change driven damage potential (Table 10 in section 4.4). The average of the ratio of the maximum and minimum enhancement effect of the three policy scenarios is about 3, i.e., $\sum_{ps=1-3}\left[\frac{E_{max}(\mathrm{B})_{ps}\,/\mathrm{E}_{min}(\mathrm{B})_{ps}}{3} = 2.99\right]$.

With an enhancement effect of 3, the realized share of the **benefit potential** in the initial phase couldn't be larger than 0.33 and is in practice probably well below 0.3. For comparison, realized fractions of benefit potentials of weather services hover between 0.14 and 0.25 according to the WCSA method (Nurmi et al. 2013; Perrels et al. 2013).

As compared to the multiplier effect of GDP growth and climate change induced damage (Table 10 section 4.4), the policies and measures based **enhancement effect** can be larger. The combined effect of both multipliers for 2030 is rated at 2.3 to 2.7, but could be higher (considering the quite moderate GDP growth assumption). In other words, enhancement policies to precipitate and stimulate the uptake of climate services can have a truly considerable effect on total market size. Furthermore, for the proposed policy packages may be assumed that, when these policies are installed in the next two years rather than gradually over a longer period, before 2025 the boosting effect of these packages is appreciably larger than the other multiplier effects considered.

# 6 GOVERNANCE CONDITIONS FOR CLIMATE SERVICE INNOVATION

## 6.1 Introduction

In this chapter, we **review effects of governance on the functionality of the climate services market** from the points of view of the three focal sectors urban planning, tourism, and finance. By governance we refer in this case to structures and conditions (institutional arrangements, actor coalitions, instruments, processes, capabilities, capacities). This starts from a descriptive point of view, using many examples, whereas in the above chapters, we addressed these issues in more conceptual terms.

Instead of assuming innovation or market building policy for climate services would only need to employ the available "best practice instruments", we suggest to also **consider the context and conditions** of governance from an evolving process angle. Even though the above discussed policy scenarios (ch. 2) and their instrument mixes were evaluated with the understanding that implementation is usually not textbook like ideal, the actual realization and application of policy mixes is recurrently corrective process. We discuss here the unfolding and editing of the governance process, inter alia acknowledging there are different structures and (initial) conditions. We hope that might help fostering climate services from a more comprehensive (and thus also cutting across single sectors) point of view. In due course, we try also to be more concrete by giving many examples, referring to current organisations, programmes, initiatives and policies.

Instead of assuming innovation or market building policy for climate services would only need to employ the available "best practice instruments", we suggest to also **consider the context and conditions** of governance from an evolving process angle.

As regards the current and future evolution of climate services, various **policy frameworks** will be relevant, next to technological, economic, scientific, political, and social innovations. The promotion and development of climate services as a broad portfolio can be regarded as a form of innovation strategy, which has a lot of commonalities with current views on innovation policy as preferably being more mission-oriented than product-oriented. Yet, alternative paradigms exist, on how to support such mission-oriented innovation processes, notably varying in degree and type of public intervention in the unfolding innovation process (Mazzucato 2015).

Since innovations do not happen in a vacuum, it makes sense to observe the **entanglements** of climate services with organizations, their R&D departments, other technologies and services, sector dynamics, niche developments, society's responses, and the adaptive processes these undergo in response to policy changes. The aim is to see the **patterns that enable and constrain** (lock-ins, path-dependencies) efforts to build a (broader) market for climate services. Climate services are novel configurations that in some respects and cases already work, while in others still need to develop and mature. The challenge for climate services is to find their ways from niches characterized by local knowledge into mainstream regime developments.

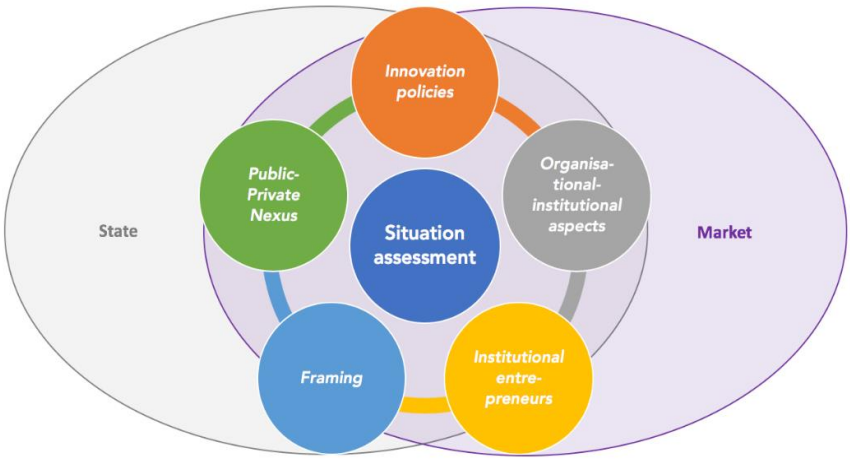



FIGURE 6: ASSESSMENT SCHEME FOR CLIMATE SERVICES IN GOVERNANCE CONTEXT: RATIONALE FOR CHAPTER 6

Before we look at policies that may influence climate service uptake, we will first briefly review some findings

from WPs 1-4 about **governance structures** that may in some way or another be crucial for the conditions under which climate services could get better established or face obstacles.

## 6.2 The governance situation for fostering climate services innovation

The question is how far the governance situation in the three focal sectors of this project, urban planning, tourism, and finance, and the sites we studied in this project in particular, actually provide a **basis for climate service innovation** or are rather hampering such efforts.

### 6.2.1 Strategic governance structures

**A.** In this section, we look at the **governance structures** (hierarchy, networks/heterarchy, competition, negotiation) crucially influencing climate service demand, purveyance, supply, and matching (e.g., acknowledging adaptation needs). We identify some more directly supporting structures as well as more indirectly supporting ones or instances where more indirect potentials can be seen. We start from the supranational and national levels with state or supra-state organisations central, and move to research and commercial actors with state less or not central.

1. In the EU climate governance, there is the **presumption** that climate services would automatically do good for mitigating and adapting to climate change and global warming.[32] While this might be right for many agencies, it still is a fact that climate services can be provided in accordance with every kind of value, be it the protection of the natural resources or the protection of the economic wealth. Indeed, this doesn't need to be a contradiction. In the context of 'eco-innovation'—defined as "*innovations that reduce environmental impacts, whether or not that effect was intended*" (Vollebergh/van der Werf 2014: 23; cf. OECD 2009)—it has been suggested to "*use the setting of standards as an explicit tool for stimulating 'eco-innovation'*" (Vollebergh and van der Werf 2014: 230), as this approach has shown positive effects for implementing environmental governance "*in fields as diverse as air pollution regulation and waste disposal* [...] *scrubbers, catalytic converters, and incineration plants*"; moreover, it is claimed that "*standards create demand for* [...] *services based in existing knowledge and technologies, but also to develop new goods, services, and technologies that reduce environmental impacts*" (ibid). In fact, there is no law that determines (cf. Van de Ven 2017) that climate services (or climate data) would only speak the language of "greening the economy" or "sustainability". One can do with climate intelligence many things—not necessarily fight global warming only. It remains an open empirical question, how the services with climate data and climate data itself can become charged with climate protective value in order to remain reflexive about the links between means and ends, political discourse and material effect. This is also the reason why in D5.1 four main thematic domains were identified (which are motivating use of climate services).
   a. **Horizon 2020** is the EU Research and Innovation programme from 2014 to 2020 that "*promises more breakthroughs, discoveries and world-firsts by taking great ideas from the lab to the market*", as well as that it will attract private investment in addition to the money from the EU and that it functions "*as a means to drive economic growth and create jobs*" (European Commission 2017a). While on this level of policy, discourse is still linked to environment, resource efficiency, and raw materials (European Commission 2017b), the specific actions for climate services seem rather disentangled from general environmental concerns and tend to rather focus on market building.[33] From the EU Commission discourse side, there is still emphasis on a connection to environmental policy in which the expectations are raised that "moving towards a 'green' society and economy", bringing "green solutions to the market" would contribute to helping "*to build a green economy, a*

[32] The paragraphs in 6.2.1-1, 1a, and 2 to 4, due to their specific relevance, have been used again from deliverable 1.4 (Stegmaier/Visscher 2017: 13-15) with slight modifications.

[33] One could suspect that the EC wants that the billions spent on earth observation equipment and services (bundled in COPERNICUS) will start to pay off for society through abundant uptake. Yet, the evaluations so far hint at a large share of exploitation of results and services within the research and expert communities, and much less in uses that would be produce more direct value added.

*circular economy in sync with the natural environment*" by emphasising such actions that bear the "*potential for business opportunities and job creation while tackling important resource efficiency challenges*" (European Commission 2017c). There is little or no mention of "green economy" or general "environmental protection" vision in many reports and other policy documents we found on climate services. In the background of all this is, in fact, the idea of "creating the Energy Union" *through prioritising the policy area of "decarbonising the economy"*, emission trading system, efficiency labelling, and the implementation of the Paris Agreement (European Commission 2017d). The EU agenda for climate services, as officially presented in the Energy Union context, can thus be seen as one form of climate change mitigation and adaption. The Energy Union per se, however, is not pursued because of emission trade, but in the first place for security of supply and for affordable energy throughout the EU.

> *Here is an example how H2020 and other EU innovation policy efforts are taken up in practice by companies:*
> The EU Horizon 2020 research funding (including that which is funding this project) has helped support climate service development in Europe directly and indirectly, too. The **Oasis Hub**, which is an online market place for climate service products, for the finance services sector (mostly insurance) and other sectors, is the result of the Horizon 2020 Insurance project as well as of the Climate-KIC funding. In EU-MACS WP2, a small flood modelling company which now lists its offerings on the Hub explained it finds it an excellent way to bring their services to market, where development banks and insurers use their services.

b. The **Climate-KIC programme**, with its decision-metrics and finance theme, is an important (rather direct) support network for climate service providers interested in serving the finance services sector. For instance, climate service providers (e.g., Acclimatise) received several grants to conduct research helping them evolve their climate service product portfolios. Also, the KIC has helped establish new start-ups such as Carbon Delta[34] and other competitors. Climate KIC has also contributed to new platforms such as the Oasis Loss Modelling Framework (LMF), which is not a climate service, but is a platform which allows for open source catastrophe modelling, which in itself demands climate data and information. So, instead of relying on or outsourcing all catastrophe modelling to one of just a few companies, Oasis LMF might be helping to distribute and balance demand and supply.

2. With the WMO launching the process of developing the **Global Framework for Climate Services** (GFCS) at the World Climate Conference 3 in September 2009, climate experts have been successful in creating a narrative that links the dangers of global warming via calls for transforming into a decarbonised economy with a possible increase in demand for "*translating the existing wealth of climate data and information into customised tools, products and information ('climate services')*" (European Commission 2017e; cf. European Commission 2014a). The instrumental rationality behind this as described in official discourse reads as follows:

> *"Climate services have the potential to become the intelligence behind the transition to a climate-resilient and low-carbon society. They can help decision-makers take informed decisions in order to boost resilience and adaptation capacity by addressing existing or emerging risks." (European Commission 2015)*

In other words, rising to the climate challenges, and while doing so creating economic value (European Commission 2017). There is a certain amount of trust in the fact that if sound climate system science and enormous amounts of data are available, the problem of serviceability and applicability of the data—next to the need to transform it into useable products—will ultimately also be solved. The empirical question remains to which extent the promises of helping the economy with deeper

[34] Carbon Delta have advanced software and analytical capabilities to be able to offer solutions to the highly complex problem of climate risk assessment across investment portfolios.

knowledge on climate developments can be kept, if it is taken into account how realistic the understanding of climate services is (cf. Harjanne 2017).

3. The **climate services discourse** itself has developed into a distinct zone of action, mainly concerned with building business opportunities. Climate services, partially even based on free public data (e.g., data sets from US government agencies), has become a commodity, a trade good: in Europe, still various MetOffices charge their data, while others offer both free data and free model code (and, e.g., ESA and EUMETSAT also have public free data sets). Indeed, such business can indeed raise environmental awareness in the economy and have, in this sense, positive side effects on greener and more climate resilient approaches to conduct business. Nevertheless, one should be aware that efforts of building a climate services market are first and foremost seen as an opportunity for climate experts to valorise on their expertise

4. At closer inspection, we can see the **EU climate services policy** as an effort of coordinating an innovation journey in an anticipatory manner (cf. Stegmaier/Visscher 2017). Impulses are set by an entire bundle of activities and stimuli (Pietrosanti 2016). This can be read as an attempt to project a broader kind of path into future by concerted action among various actors. This attempt is based upon and justified by the shared perception of an increased policy and strategic interest in pushing climate services. New opportunities are mainly signalled in the promise and expectation that there in fact is a realistic chance to fight climate change with economic growth, here, on the one hand, **by climate services supporting** all kinds of other industries, businesses, politics, and services to prosper more (in economic terms) or even better (in ecological terms), and on the other hand, **by supporting climate services** to prosper themselves. Part of this is also an effort of nudging all sides to pay attention to climate issues, to climate intelligence (potentially) available, and to potentials in even officially recognising climate issues as crucial factors for success. We can also see that promises have at some point been accepted: when the EU climate services roadmap was used to set the agenda. At the end of the day, we will have to see how far the expected "ingredients" for market building and benefits will have been converted into requirements.

> As we have seen in Deliverables 1.1 to 1.4, 2.1, 3.1, 4.1, 5.1 the most important elements for uptake and matching of climateservices with demanding organisations seem to be:
> - a set of functioning business models for and across sectors (see chapter 4 in this report)
> - a good balance between users' demands and providers' services
> - fit with the clients' organisational culture
> - a (sufficiently) unified data infrastructure, as well as a sound quality assurance system for data and services.

5. The **United Nations Environment Finance Initiative** (UNEP FI), a division of UN Environment, has helped drive climate services uptake in the finance sector by facilitating experimental initiatives and bringing together international groups to achieve this in less direct ways:

   a. They have worked to develop the **Drought Stress Testing Tool** which brought together development organisations such as GIZ, natural catastrophe modellers such as RMS, commercial banks from China, US, Mexico, Brazil, and actors such as the Natural Capital Finance Alliance to develop tools which help banks consider droughts' impacts on their loan portfolios. Similarly, the UNEP FI also helped bring together a group which developed a **Water Credit Risk Tool** for assessing corporate bonds. Both tools encourage uptake of climate data and information by requiring it as inputs, but importantly, these initiatives have been early pilots which has worked to get this kind of analysis on the agenda within financial institutions, at a time when many were unsure where to start.

   b. UNEP FI have brought together working groups in the banking, investor and insurance segments to develop methodologies to allow these actors to respond to the **Task Force on Climate-related Financial Disclosures (TCFD) recommendations**. The banking group has just finished their work, and the investors and insurers are about to start. These working groups are also pioneering early methodologies which will be built upon in coming years.

6. The countries in focus have official National Hydrological and Meteorological Services (NHMS) that **provide climate services or the basic input data for climate services** (e.g., observation data). The Climate Services Roadmap emphasizes common European research infrastructure and collaboration networks, and mentions institutional users and national climate services centres, but the relation of NHMS to these structures is left ambiguous. In general, the Climate Services Roadmap emphasizes the role of public research institutes in creating and sharing open data and information.
   a. The NHMS in Austria, **ZAMG**, is an agency functioning under the Federal Ministry of Science, Research and Economy. Since 1990, it has the opportunity to conduct certain activities under private law. Hence, the NMS in Austria consists of a public as well as of a semi-public/semi-private part. Products and services which are provided in the course of the public service mandate are free of charge. Products and services beyond this mandate are charged with prices that depend on the purpose of use (i.e., scientific vs. commercial use; end-user vs. reseller, etc.). Whereas data for purely scientific purposes is usually free of charge (apart from the compensation of the processing costs), data used commercially has to be paid for. Although, the Austrian NHMS has to allocate costs internally when using these publicly financed data as input for commercial products, climate services providers interviewed in Austria see a competitive advantage of the NHMS in providing climate services, as compared to providers who have to purchase their (partly) publicly financed meteorological input data. Austrian open data policies in combination with public agencies' resourcing principles are, however, retarding the development and growth potential of climate services.
   b. In Finland, the **Finnish Meteorological Institute** (FMI) is a service and research institute under the ministry of transport and communication. According to the Act on FMI[35], one of the mandates of FMI is to collect, generate, procure and maintain reliable knowledge on the state of the atmosphere and its impacts on Finnish society and internationally, and offer expert services when requested. FMI can charge a fee for these services, which is regulated with an Act on payments of public authorities. Therefore, FMI can provide various types of climate services and charge a fee for them. FMI is also responsible for weather and climate observations in Finland and is offering practically all collected data as open data. Various other consultants who need climate data in their products and services are utilising the open data service of FMI.
7. **Legislation and court cases:** With regards to adaptation strategies, the legislation to actually enforce adaptation action in most European countries is often rather soft regulation or even lacking. Climate service innovations could instead come from private initiatives aiming at setting new standards in their very own interest, which do not have the status of legislation, but may lead shared standards of good practice or for the assessment of the quality of (screening, monitoring) tools.
   a. The UK Climate Change act has something called the **adaption reporting powers**. This requires certain sectors which have statutory requirements to provide services (such as water or electricity) to disclose climate change adaptation strategies. This does not include the financial services sector. The government did decide that the financial services sector was a critical sector to analyse in this sector in its climate change risk assessment, but that did not require the sector itself to analyse risks. Rather, it was the government doing the analysis (commissioning the climate service provider Acclimatise with this task).
   b. Established **knowledge sharing** between multi-lateral development banks (MDBs) and development finance institutions (DFIs) might help setting standards such as about a minimum level of investment in climate resilience. That has helped drive the need for climate risk screening, which is now common among this group.
   c. Sometimes, the knowledge sharing between this group leads to more direct uptake of climate services – their climate and resilience teams **share best practice techniques and advise each**

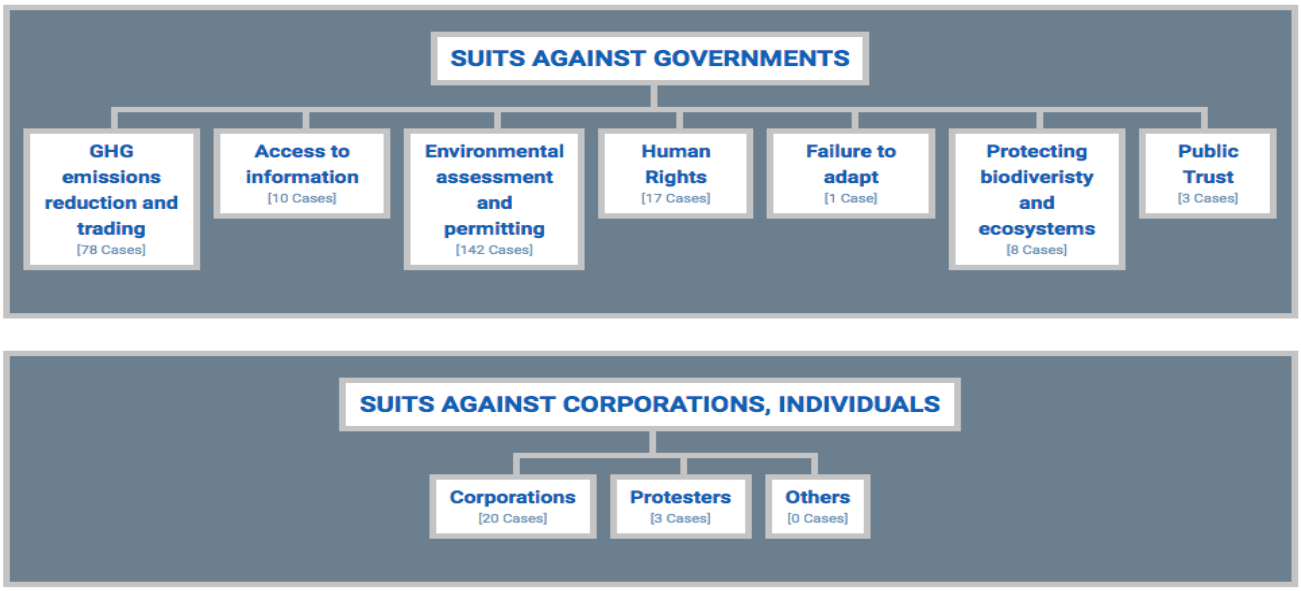
[35] www.finlex.fi/fi/laki/ajantasa/1967/19670585 [12 October 2018]

**other** on which tools to use. Staff in these types of organisations talk amongst themselves to share ideas informally, like about climate risk screening tools that really work, thereby helping drive climate services uptake.

d. Eventually, actors try to secure or reshuffle shares of the market through **law suits**, using courts as governance institutions for fighting over who dominates which part of or how much of a market. There is one example from Germany in the context of weather services where the private company WetterOnline filed and won trade court cases against the German NMS (Deutscher Wetterdienst, DWD) with regards to the latter's free weather warnings. This relates to how governments and standing law perceive the public and the private sector domains divide, as illustrated in our three policy scenarios (see ch. 2).

e. From a more general point of view, there are also numerous **public law cases** currently fought about failed duties and inactivity of government bodies in pursuing legal obligations e.g. for adaptation, environmental protection, emissions trading, or granting access to information (see Figure 7). Besides these, there suits against corporations and individual on a **private or penal law** basis, e.g., where a private airport company acts against protesters or a state prosecutor against a private airline. An overview is provided by the Sabin Center for Climate Change Law, which list in two databases U.S. and non-U.S. climate change litigation cases. In many ways, climate change, climate-related intelligence, as well as climate and weather services are already subject to legal confrontation. As one consequence, climate-related issues are not only being interpreted and legally regulated by governments, but indeed by courts and through case law. Through the latter, what could be called "climate law" as a whole new branch of law is emerging. Some of the cases are highly politicised, such as the series of air pollution control law suits of the NGO called Deutsche Umwelthilfe (DUH) against several big cities in Germany in connection with the still developing Dieselgate scandal. Interesting are also the lawsuits of Urgenda against the Government of the Netherlands regarding target based enforcement of climate mitigation efforts with reference to the constitutional duty of the government to protect the population.

FIGURE 7: CLIMATE CHANGE LITIGATION CASES[36]




[36] Sabin Center for Climate change Law 2018; cf. http://climatecasechart.com/non-us-climate-change-litigation [8 February 2019]

**B.** Currently, **climate services** themselves are mainly **provided** by either research institutions alongside to their research and teaching activities, or by meteorological institutes alongside to their more weather service and climate related monitoring tasks.

1. Hence, too little emphasis is put on **product development and design, marketing, and sales**, as well as **consulting activities**. Intermediaries with more service orientation taking on this role could possibly help to bridge the gap between supply and demand. Such more service-oriented intermediaries could be e.g. tourism consultants (by integration of climate related services into their general consultancy services), providers of products and services already used by the sector and suitable for the meaningful integration of climate information, but also (new) businesses that provide stand-alone climate services (integrated, tailored).
2. In countries where the use of meteorological data for commercial purposes is associated with **high costs** (e.g., Austria), the provision and take-up of climate services may be hindered. Costs represent a barrier particularly in the product development phase, where for testing purposes the data requirements often comprise several parameters, various locations, etc. Free access data policy of weather data (measurement data) would facilitate climate service provision.
3. Furthermore, **profit-oriented private companies** are often disadvantaged in funding programmes with respect to the funding rate. Thus, a low funding rate may hinder climate services product development by private companies (at least until they would have a "cash cow" product that would help financing new or more complicated/costly products).

> Which of the pioneering efforts will become new routines and how will they be transferred also to other fields than those from which they originate?

**Governance structures are in flux**, at least partially, that's the normal situation. The question is which of the above-mentioned and other pioneering efforts will become new routines and how will they be transferred also to other fields than those from which they originate.

### 6.2.2 The framework for climate services market dynamics

The next aspect we wanted to pay attention to, is which roles market diversity and regulatory frameworks for markets play across Europe: incongruences between Member State **regulations** and consequent **market power conflicts**, as well as between EU level and Member State level. This can only be a brief hint at only a few instances:

1. In the 2000s, the **global climate governance order** (Stegmaier/Visscher 2017: 25-25) became far more dispersed: the World Bank entered stage taking up climate concerns, and various "high-level, club-like forums involving the political leaders of a number of important countries" (Van Asselt/Zelli 2014: 141) were installed: summits of the G8 and G20 dedicated themselves to climate issues, US President Bush's initiative 'Major Economies Process on Energy Security and Climate Change' (in 2007), paralleled by multi-stakeholder partnerships (e.g., the Carbon Sequestration Leadership Forum, the Global Methane Initiative, the International Partnership for Hydrogen and Fuel Cells in the Economy).
   a. In terms of **market building**, "*a wide variety of regulated and voluntary markets … have been established*" (Van Asselt/Zelli 2014: 142) around Kyoto, such as EU ETS. Non-state actors started holding corporations accountable for carbon emissions (e.g. the Carbon Disclosure Project; ibid.), while on sub-national level, e.g., California adopted the Global Warming Solutions Act in 2006 (ibid.).
   b. Against this backdrop, we see the advent of various institutions promising that over the course of time (midterm to long-term) they could establish a global climate services regime (which is not entirely new). Some are dedicated to climate services directly, others to climate change policy and thereby indirectly paving the way to potential demand of climate services. The organisations are all rather recent, not yet fully developed in their structures and activities at least in terms of

institutional standing. They are manifestations of the efforts of building a world-wide community of climate services enactors, which reach back half a century. From this point of view, they might seem like regime phenomena. Climate services are still **not (yet) established** as a fully-fledged and functioning institution of intelligence deeply, which is also connected with all kinds of climate services using bodies and actors (e.g., the World Meteorological Organisation, the Global Framework for Climate Services, the Climate Service Partnership, the World Climate Research Programme, etc.)[37].

2. It might be worthwhile looking into policies relating to **climate risk disclosure laws or schemes**:
   a. In the **UK, France, the Netherlands, Finland, Sweden, and Switzerland** at least, there are indications that the central banks and other financial market authorities, are building up serious interest in possible effects of climate change and climate policy on financial markets, including the physical risks of climate change and related remedial measures, as well as at least studying on measures to promote climate risk management and transparency. These hints are already very much driving climate service uptake, and if policy is put in place like it is in France, there would be even further stimulus of uptake. In France, Article 173 is driving more uptake as there is a race to the top of sorts. In the UK, the chairman of the Financial Stability Board, which formed the TCFD, is the governor of the Bank of England (BoE). BoE have been holding interviews and surveys of top banks and insurance companies to investigate their approaches to climate risk assessment and disclosure, for example. Contacts at the BoE have indicated they are comfortable with the current voluntary disclosure frameworks, however, so there may be some delay before a mandated disclosure framework in the UK at least.

   > We see the advent of various institutions promising they could over the course of time establish a global climate services regime. Some are dedicated to climate services directly, others to climate change policy and thereby indirectly paving the way to potential demand of climate services.

   b. Interestingly enough, it is not clear which strategy actors in Germany are pursuing in this context. Typically, the country has long been known as a frontrunner in many areas of climate, but since a couple of years seems in fact to be losing (or even giving up) its forerunner position. It can be noticed, that there are far fewer **German** actors that are vocal when it comes to climate risk disclosure in the larger arenas where the discussion is happening—such as the UNEP FI. This is as opposed to actors from the **UK, NL, and France** being particularly vocal about the importance of climate risk disclosure (which could indicate a higher uptake of climate services). Some companies, such as Axa and Avivia, are taking concrete action (i.e., assessing and disclosing climate risks), but not all other market players do so yet.

### 6.2.3 Institutional and organisational aspects

It is important not to forget about the institutional and organisational focus, besides all those greater state- or market-related structures. The question here is which roles **institutional and organisational structures and practices** play for matching climate services demand, purveyance, and supply.

1. **Organisational problems:** Large city-related organisations, such as the Helsinki administration itself as well as companies offering services to the city of Helsinki, have a lot of potential demand for weather and climate information. The same is true for organisations in tourism and finance.
   a. Both, Helsinki and the organisation of the Helsinki metropolitan region are purchasing weather and/or climate information already, ranging from winter weather forecasts to climate risk assessments. However, in the context of multi-purpose climate services the **structure of the city organisation** is complex, which, with reference to EU-MACS (D4.1) results, complicates sharing

[37] Section 6.2.2-1, due to its specific relevance, has been used again from Deliverable 1.4 (Stegmaier/Visscher 2017: 25) with slight modifications; originally authored by Peter Stegmaier.

of such information and thereby risks to reduce the services' benefit potential. Similar results were obtained in Bologna, the other urban case study in EU-MACS. The low level of interaction among the different departments in the municipality organizational structure negatively affected the flow of climate related information. The EU-MACS cases and the scientific literature show that city departments, when acquiring and using climate information, quite often tend to act as isolated entities. This negatively impacts the effectiveness of climate information. Strengthening the interactions among the different city departments and enabling collaborative acquisition and use of climate services are key to enhance the potential for climate services market in urban planning. This, again, claims for innovative climate services capable to integrated a wide range of data and skills.

b. **The way many banks are structured**, in terms of their teams, could be influencing (now and in the future) climate services uptake. Banks have teams of outward facing environmental/sustainability/corporate social responsibility staff, which are motivated to act on climate (and conduct climate risk disclosure) due to their job report. These functionaries will be members of the UNEP FI sectoral groups. The issue is that members of these teams need to bring in members from more teams engaged in investment decision making, to be able to utilise climate data and information. The credit risk teams often have larger budget for procuring external analysis and advisory services, but they are not yet motivated to take on climate risk disclosure. Many stakeholders have hinted that these two types of teams operate in siloes which are difficult to break down. As such, this structure, the siloes, will probably continue to be a strong barrier to further uptake of climate services until credit risk methods incorporate climate risk considerations.

> In organisational context, climate risk information or even the deficiency of climate information is often not prioitised. It often is not a category to worry or care about. Lacking climate risk management may thus suffer from a lack of perceived relevance.

c. **Organisational routines:** In insurance, catastrophe modelling is now the standard means of understanding risks and pricing premiums. One stakeholder mentioned (in WP2 research) that rating agencies, at times, rate the credit scores of insurers based on which catastrophe models they use. The issue is that there are just a small handful of catastrophe modelling firms insurers can use. Their use of climate data and information is actually mostly within these cat models, so in effect they are not really direct users themselves, instead they are tied to the catastrophe modellers. Insurance companies *could* potentially use more climate data and information themselves if they might be able to break the dependence on catastrophe modelling firms. Yet, since their credit rating scores are in part linked to their use of conventional catastrophe models, it maintains. Worth noting is how the Solvency II regulations effectively ask for insurance firms to own their understanding of risk. This means they have to have an improved understanding of the cat models they use. It remains to be seen how this will play out—i.e., if insurance firms will increase their internal capacities for cat model validation and if yes, if that would be associated with increased demand for climate data and information.

d. **Responsibility** for action in climate issues is often shifted to other actors (e.g., between local, regional and provincial tourism associations and also public authorities, but also between tourism associations and tourism businesses). Thus, uncertainty in how responsibility is divided among different actors may hinder climate services use as well. How climate change is seen by representatives of a branch may influence the opinion of individuals (e.g., ropeways sector). But also, within a company, there could be a mismatch between those who may see the need for climate services (the operative level) and those who have the decisive power (the management level). Bundling of long-term and short-term oriented services could be an option, so that both levels (management and day-to-day business operations) are addressed with one service package.

e. Sometimes, there is an element of **climate change denial**, or climate change is seen as a long-term issue. Climate services providers in the finance sector have a lot of awareness raising to do

around this issue: they might have to "educate" clients about, for instance, how there are incremental changes which may be creating change now (and not just in the future). It's a lot of unpacking around how climate impacts are not just extreme events.

f. **Incremental mentality change**: In the finance service sector, responsibility is issue, too. One way to overcome this could be progressing in "roundabout ways". Mostly, in the finance sector, organisations are very interested and concerned with what their peers are doing. With the largest organisations taking on climate action (physical climate risk assessment), this could put pressure on the others. Having the TCFD-scheme in place helps as well—this is now the accepted mentality in the sector, which helps ease the hesitance to engage with climate service providers. Sector associations are quite active enabling knowledge sharing (see section on policy innovators). Another way to address and overcome the obstacles could be direct, personal communication (i.e. directly addressing those "influencers") and the use of testimonials.

2. **Categorization problems**: Climate services fall largely outside current institutional and organisational logic. Issues linked to climate services (mitigation, adaptation, weather risks, risk management, CSR and so on) are institutionalised in a way, which can make it difficult to locate use (let alone co-design) of climate services somewhere in the organisation. Instead, climate issues are integrated in different processes with diverse information needs and use. For instance, in terms of a usual PESTEL framework, climate issues would fall mainly under the category of "environmental" issues. There, climate issues would only be a part of the entire spectrum. This example may illustrate, why climate services in many information flows may play a minor role.

Thus, the current constitution of institutions and organizational structures in, e.g., urban planning and tourism does not seem to support the idea of climate services markets and is unlikely to do so since climate risk (or deficiency of climate information at least) is not prioritized to the level that would result in major shifts in these structures. Issues with shorter time spans that are closer to core business or legislatively mandated are prioritized higher. **Lacking climate risk management** may thus suffer from a lack of perceived relevancy.

### 6.2.4 Public-private

Another cardinal issue for climate services is the possibilities (and limitations) for **public-private partnerships** (PPP) & **public-private cooperation** (PPC) regarding development, provision and promotion of climate services.

1. **Potentials in urban planning:** There are quite a lot of possibilities for both PPP and PPC in climate services for urban planning, as illustrated in for example Bologna (see EU-MACS D4.1). As discussed in earlier chapters and deliverables (D4.1; D5.1) PPP and PPC will often be relevant and benficial organisation forms for climate services. PPP (or PPC) for climate services may help to improve the options for PPP based implementation of adaptation measures, including the funding of it. By setting examples in climate services co-development and co-provision PPP and PPC could also contribute to improve the design of the adaptation measures.

2. **Standing practice in urban planning:** Climate services (in a fairly broad sense) are already provided by both public institutions (such as FMI in Finland) and private consultants (Ramboll, SITO, WSP, Gaia). In Finland many private consultants are using open data provided by FMI (and other Finnish public research institutes), provided as open data in accordance with the EU INSPIRE and PSI directives. Occasionally, the public institutions also operate similarly to the private companies and participate in the tender processes. PPC is in a way an every-day practice in Finland. Ideally, services are co-produced with public organisations.

3. **Potentials in finance:** PPPs may have some potential also in finance. Upstream data could come from public actors, advisory services are already provided in a way. Government actors such as GIZ work with non-governmental actors such as UNEP FI, and commercial banks are co-creating climate

service tools. Development banks have partnered with various NMS, since climate risks in the finance sector can be quite large, e.g., in the insurance sector.

4. **Potentials in tourism:** PPP and PPC for climate services in tourism should be a highly relevant option in many cases. A significant share of the need for climate services in tourism has a regional orientation, while many actors are small in this sector and meaningful provision of tourist services is highly intertwined. For example, private and/or public climate service providers could cooperate with key local public services and (collaborating) private firms. Local tourist boards may function as a platform facilitating the cooperation. Such cooperation can take the form of joint product development, mutual promotion of climate services, mutual forwarding of requests, etc.) (cf. Damm et al. 2018: 56).

Demand for climate services will in many cases most likely be driven publicly or by public policy in some way or another (exception: insurance companies). However, where scientific climate data is processed in terms of mediating or refining for decision-making, private companies might be better suited. This does not necessarily require distinct public-private partnership structures, though, but private companies may as well be able to identify and exploit climate service business potentials (as has happened within tourism sector in Austria). The question is what could happen in countries **where NMHS can't be seen to be competing with or offering services** that the private sector could: would that mean more partnerships are necessary or would they instead be not possible or even forbidden?

Demand for climate services will in many cases most likely be driven publicly or by public policy in some way or another (exception: insurance companies). However, where scientific climate data is processed in terms of mediating or refining for decision-making, private companies might be better suited.

### 6.2.5 Policies of framing 'climate services': knowledge and language diversity

Know-how and terms used in climatology and meteorology are not easy to grasp for non-members of these scientific disciplines. Therefore, we look into which roles **knowledge and language** diversity (incl. strong professional jargons and cultures, technical terminologies, national or administrative languages/cultures, general use of English in academic climate services, etc.) might play for matching climate services demand, purveyance, and supply.

1. **Speaking of 'climate services':** already "climate services" as a term is unfamiliar to a broader audience and to most potential users:
   a. **Organisational relevancies:** This is a key issue in Bologna (WP4). The diversity in problem understanding and institutional roles affects the information needs and, thus, the climate service demand. Nevertheless, the adoption of climate services is (still) based on individual requirement (i.e., what a particular department deems to be necessary), without accounting for the others' needs. As a consequence, the climate services are not used for supporting collaborative planning. The EU-MACS activities showed that the diversity of problem understanding and thus of the information needs, is unavoidable in urban planning. Differences in roles and responsibilities in the planning process lead to different problem framings. The key to overcome this barrier is to make the different decision-makers aware of those differences.
   b. **Lacking user-friendliness** of climate services is one of the barriers to the use of climate services. According to the interviewed tourism stakeholders, both climate services and climate service-related research results are often too scientific for non-scientific users. Hence, climate information needs to be presented in simple language understandable by non-scientists.
   c. **Terminology:** Even when it has been explained in the interviews and workshop, it typically doesn't result in any eureka moments, but remains an ambiguous and hard to grasp concept. The first question stakeholders usually asked in this project was "what do you mean by climate services?".
2. **Potential solutions:** In the following, we have collected from work with stakeholders in WPs2-4 some suggestions how the problems with the terms 'climate services' could be handled:

a. **Terminology:** Perhaps it would be beneficial to put less emphasis on climate services as a concept and focus on climate risk issues more. This means starting from the actual problem description that counts as important in a given policy, business, or organisational context, while advocating climate services only implicitly. What could indeed be the terms under which people in organisations in your cases would accept something like climate services almost immediately (although called differently)?

b. **Management focus:** Integrate climate services idea in one way or another into the managerial culture and fashions. Consultancy services are often considered highly relevant. So, if climate services would be offered and delivered as integral elements of broader consultancy, the threshold could be lower, and whatever it is that would be included would already have been translated into a more commonly shared language and aligned with other forms of relevant strategic intelligence.

c. **Regulation**: As soon as laws and regulation require certified climate services, it will more likely be used as well as the terms 'climate services'. There is no guarantee, however, that law and regulation alone increase acceptance. Organisations might even look for ways to circumvent requirements that climate services can satisfy, find alternatives, workarounds, and ways to postpone (see D1.4 on strategies of non-use).

d. **Alternative terms:** Much more applicable terms in many areas are 'risk maps' and 'risk assessment', 'seasonal forecasts', 'climate scenarios', 'vulnerability analyses', 'coastal flood risk maps', and so on, which refer to more concrete services already offered.

e. **For internal use only:** 'Climate services' may be a notion used more internally, within the supply-side organisations, as an umbrella term for all potential services related to weather and climate. Perhaps after some time, once the overall idea of focus on climate and the usefulness of dedicated services has become more commonly shared, the term could even be used with stakeholders.

3. Here are two practice examples about how to better deal with linguistic barriers from the finance sector (WP2) in terms of more **context-sensitive framing** of climate issues:

a. 'Climate services' **is not a known term in the finance sector**. Also, there are real issues around what the sector thinks of when they hear 'climate'. The vast majority of stakeholders think of "carbon" when they hear "climate". So, when talking about "climate data and information" in WP2, a lot of time was spent trying to convey it is *not* about carbon data, e.g., carbon emissions and carbon foot printing. The delineation of climate risks that the TCFD recommendations (see EU-MACS D2.1) have put forth, being transition risk (carbon-related) and physical risk (risk of physical damage from acute or chronic climate impacts) has helped to clear this up to some extent. Many actors in the finance sector nevertheless still demonstrate an inclination to overlook or seriously downplay physical risks and hence need for climate services. Besided, climate services are also usefule for appraisal of certain mitigation investments, notably in renewable energy.

> Understanding the diverse set of end users (even segments of the sectors) will be important, and each comes with its own jargon. Climate service providers will have to accept their environment requires them to become **polyglot**, just as their prospectuses, fact sheets, software packages, and websites need to be multilingual. Translation into local and professional language instead of having all software and instructions only available in English sounding so scientific and technical, may also help to overcome barriers.

b. Another linguistic-related issue is around the term 'ESG' (**environmental, social, and governance**). Climate belongs, to many, as under the E in ESG, since it's obviously environmentally related. There is a lot of acceptance in the finance sector of the need to address ESG concerns. Typically, this can be done by obtaining ESG metrics of investments, equities, bonds, etc. One issue is, however, that ESG factors are still seen by many as non-financial

(i.e., not essential, important, worth considering), and more of a concern because of ethical reasons. Because they are seen as ethical issues, they can then get easily brushed aside. There is a lot of progress toward climate issues (including physical climate risk) being framed as a *financial* rather than ethical risk. But because it gets lumped into the E of ESG, there are issues with it being taken seriously still by many. If it is not seen as a financial risk, it will not be acted on (therefore climate services demand will be stunted).

As a general concluding remark to this sub-section, we would like to remind of what a climate service provider once said (in WP3): In order to be successful, it is important to speak the language of the customers. So, suppliers may for instance face a steep learning curve also when it comes to learning the language of the finance services sector. Understanding the diverse set of end users (even segments of the sectors) will be important, and each comes with its own jargon. Climate service providers will have to accept their environment requires them to become **polyglot**, just as their prospectuses, fact sheets, software packages, and websites need to be multilingual. Translation into local and professional instead of having all software and instructions only available in English sounding so scientific and technical, may also help to overcome barriers.

## 6.3 Existing policies fostering climate services innovation

This section aims at collecting hints from WPs 2-4 about those policies that are effectively fostering climate services innovation from the point of view of the sectors investigated in this project.

### 6.3.1 Existing general policies

This section addresses the already existing policies (incl. relevant innovation policies, instruments, and structures) that that (a) support climate services and (b) increase quality of matching demand and supply in the focal sectors in all kinds specific sectoral respects (open answers required!), as well as regarding market conditions in the focal sectors, resourcing of climate services in the focal sectors, quality assurance in the focal sectors, and data infrastructures for climate services in the focal sectors.

**A.** In general, **across all sectors**, we observed the following policy situation[38]:

1. **EU:** The European Union is one highly influential political, administrative, economic, and technoscientific environment, in which climate services are a public issue, next to the EU member states. There is an array of initiatives and projects that have natural links to climate services, without all being specifically dedicated to it (as described more extensively in D1.4 sections 3.1 and 3.2.1, A-3 and A-4). The EU is mentioned here again, not with regards to the governance framework dedicated to climate service market building itself, but with regards to EU research policy and the broader EU arena for climate-related policies and approaches—that might, at some point, contribute to the emergence of a more substantial climate services market.

   a. **Innovation policy**: "Innovation policy may […] be understood as actions by public organizations that influence innovation processes, i.e. the development and diffusion of innovations" (Edquist/Zabala-Iturriagagoitia 2012: 1758), addressing new products including services. One central actor is the European Commission that has declared support for building a climate services market as explicit policy target (EU Climate Services Roadmap). The Commission is responsible for a multi-billion euro budget for research and technology development (RTD) and has become a serious policy entrepreneur providing targeted funding. Funds fostering climate services come from several programmes providing this development, as far as it depends from EU governance, some degree of continuity and inter-/transnational coordination following a sort if sectoral principle of subsidiarity (Pilniok 2011: 293; cf. Edler et al. 2010).

[38] Sections 6.3.1-A-1 to 3, due to their specific relevance, have been used again from Deliverable 1.4 (Stegmaier/Visscher 2017: 38-40) with slight modifications; originally authored by Peter Stegmaier.

b. The RTD policy of the Commission could be seen as **public procurement for innovation** (PPI; cf. Edquist et al. 2015; Edler/Georghiou 2007; Edquist et al. 2000) of climate services as a means to solve specific societal and policy problems:

*"the objective (purpose, rationale) of PPI is not primarily to enhance the development of new products, but to target functions that satisfy human needs or solve societal problems […] the diffusion of the product from the procuring organizations is not always among the major objectives of this type of program. However, there are cases in which diffusion of the new product is aimed at from the very start of the procurement process. This difference reflects the distinction between PPI carried out mainly for the missions or needs of the procuring agency and PPI to support economy-wide innovation. Be that as it may, innovation is needed in all PPI before delivery can take place. In contrast to PPI, regular procurement occurs when public agencies buy ready-made products such as pens and paper "off-the-shelf", where no innovation is involved. Only the price and quality of the (existing) product are taken into consideration when the supplier is selected." (Edquist/Zabala-Iturriagagoitia 2012: 1758; cf. Thai 2009)*

While the European Commission makes sure its support for RTD fits the market imperative (cf. Flink 2016: 91), it plays the role of a **catalytic procurer**, who "*acts to catalyse the development of innovations for broader public use and not for directly supporting the mission of the agency*" (Edquist/Zabala-Iturriagagoitia 2012: 1758-1759). Besides the user orientations, the character of climate services market PPI is a mix of 'developmental PPI' implying for the most part "*that completely new-to-the-world products and/or systems are created as a result of the procurement process*", while there are also some elements of 'pre-commercial procurement', which aims at "*the procurement of (expected) research results and is a matter of direct public R&D investments, but no actual product development*" and service prototype development is included, as well as 'adaptive PPI', where "*the product or system procured is incremental and new only to the country (or region) of procurement. Hence, innovation is required in order to adapt the product to specific national or local conditions*" aiming at diffusion and absorption (Edquist/Zabala-Iturriagagoitia 2012: 1759). **Pre-commercial PPI** in our case refers to the search for, testing of, and further modulating of prototype climate services themes, formats, and business models. **Adaptive PPI** to existing climate services (e.g., by Weatherpark, Joanneum, Acclimatise), however not yet used in all sectors or countries.

c. Another actor, of course depending on European Commission policy, is the **EIT Climate-KIC** as fruitful environment, "*in which commercial CS products could be tested*" (EU-MACS 2017a: 49). Since there are currently six "*Innovation Communities*", each of which focusing on a different societal challenge, there could be spill-over effects that would also positively influence the role climate intelligence in other innovation and policy contexts. For example, the EU-MACS sister project MARCO is closely tied to the Climate-KIC community.

d. Next, the **Copernicus Climate Change Service** (C3S) and JPI Climate are important hubs for climate research and development of climate services, C3S as key European climate service motor from the research side and **JPI Climate** as promoter of climate services projects, also applied ones, among many other more or less related foci in the broader JPI landscape (with nine other JPIs, e.g., on 'Agriculture, Food Security and Climate Change', 'Urban Europe', 'Ocean—Healthy and Productive Seas and Oceans', and 'Water—Water Challenges for a Changing World', area-specific initiatives that resemble many usual climate services sectors).

**Innovation policy**: "*actions by public organizations that influence innovation processes, i.e., the development and diffusion of innovations*" (Edquist/Zabala-Iturriagagoitia).
One central actor is the European Commission that has declared support for building a climate services market as explicit policy target (EU Climate Services Roadmap). The RTD policy of the Commission could be seen as **public procurement for innovation** (PPI) of climate services as a means to solve specific societal and policy problems.

e. For an assessment of climate services markets chances, **structural obstacles or helpers** need to be considered, such as EU structural funds, as the European Commission itself suggests: "*The funded action for climate services may be part of a larger development (e.g. infrastructure, wind farm) that is funded by additional or follow-up resources, be it private or public. One example is the relevant regional/national schemes under the European Structural and Investment Funds (ESIF), in particular under the European Regional Development Fund (ERDF), or other relevant funds such as the Instrument for Pre-accession Assistance (IPA II).*" (H2020 SC5-01-2016-2017—Exploiting the added value of climate services)[39].

2. Examples for **EU-level procurement of climate service innovation**:

   a. **EU Climate Change Adaptation Strategy** encourages and actually requires Member States to develop national adaptation plans, and adaptation monitoring and evaluation schemes. Furthermore, it encourages sectorial integration of adaptation, which has the potential to boost climate services demand in various sectors (energy, forestry, etc.), if these strategies lead to more binding legal requirements to assess and manage climate risks based on up-to-date scientific information.

   b. **EU RDI-funding** (Horizon 2020, etc.) aims at climate services development. It supports climate services, but not necessarily market building, with several climate service-specific calls for research proposals, supporting climate services development. For instance, the **H2020 demonstrator projects** and other research projects often build the basis for climate services product development.

   c. **INSPIRE Directive** and other open data policies that force opening of a lot of climate related and other data enables new actors to claim the data and combine it into new services. INSPIRE itself is mostly neutral in terms to what the data is about, although there are some specifications also related to atmospheric and weather data. There is evidence that weather data is among the most used open data (cf. De Vries et al. 2011).

3. **Member states level:** This level of innovation policy and public procurement cannot be covered here, but should be offered as context in the sectoral studies (cf. Lember et al. 2014). EU member states in their climate change policies, in particular, and RTD policies, in general, are more independent of those of other countries than the EU can act, where member states' interest always need to be met (Flink 2016: 83).

4. **Market conditions:** There are national policies enabling the NHMSs to provide a broad range of services with different funding bases. Take the example of FMI: it is producing climatological data, mostly by basic government funding; or it carries out climate risk assessments, which are paid by public or private clients; or it offers online infographics, inter alia developed as part of EU-funded R&D&I work. In addition, national public climate change awareness raising schemes, such as online climate guide[40], official national strategies or scenario sets seem to help raising the awareness among users, thus creating ground for the market.

5. **Limited resourcing of climate services and competition:** EU project funding for climate services projects has supported the creation of climate services. Wether and how this may be extended to continued provision of some of these remains to be seen. From the interviews with public providers on the experiences with the development cycle of climate services (see Annex 2) clearly arose a picture that, even though decisions to develop climate services are usually based on a notion of an existing need for that service, the ideas on how to resource regular provision of the new climate service attend to be rudimentary at best. The EU and the Member States could consider to jointly develop guidelines on resourcing of regular provision of climate services, inter alia distinguishing

[39] https://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/sc5-01-2016-2017.html [20 October 2017]

[40] E.g., the Climateguide.fi (https://ilmasto-opas.fi/en/), which has been online since 2011.

between types/purpose, i.e. adaptation oriented (with inherent larger public significance), resilience/DRR oriented (often also with inherent larger public significance), and seasonal climate services.

6. **Data infrastructure:** The EU COPERNICUS infrastructure and the derived, tailored services produced has the potential to boost innovations and markets by providing lots of free climate-related data.
7. **Quality assurance:** WMO's World Climate Programme, and especially its Global Climate Observing System, serves as key framework for quality insurance in urban planning.

**B.** In the following, we have collected key findings from all three focal sectors in the EU-MACS study. First, the findings from **urban planning**:

1. The **Environmental Impact Assessment (EIA) regulation**[41] in the area of urban planning is one of the key mechanisms that requires the assessment of geophysical conditions for new projects. Such legislation can support climate services, since it requires actors to assess environmental impacts which are climate-dependent.
2. National urban planning and zoning legislation (e.g., in Finland) sets explicit requirements for climate adaptation. In Finland, there are official national land use goals, which state that climate risks need to be taken into account for any land use activity.[42]

For urban planning, we want to briefly describe the exemplary cases of Helsinki. The **EU Floods Directive**[43] **is one example of an EU-wide policy instrument** that has the potential, at least indirectly, to increase the use of climate information and thereby increase the demand for climate services.

3. **Helsinki:** The Floods Directive requires Member States to assess if all water courses and coast lines are at risk from flooding, to map the flood extent and assets and humans at risk in these areas and to take adequate and coordinated measures to reduce this flood risk. With this, the Directive also reinforces the rights of the public to access to this information and to have a say in the planning process.
   a. For instance, Finland has transposed the directive into national legislation through the **Flood Risk Management Act** (620/2010), which requires, for instance municipalities to undertake a preliminary assessment of urban flood risk and name significant flood risk sites. The first assessment was undertaken in 2011, and the assessment has to be updated every six years. If done properly, the Flood Risk Management Act would require the use of climate services in the form of Climate-inclusive Consulting or Expert Analysis (see chapter 6 below): flood risk modelling, by combining meteorological and climatological information, and other (spatial) data; is used to analyse the flood risk sites.
   b. In 2018, Helsinki is commissioning an **urban flood risk analysis**, which aims at identifying the sites and assets at risk from flooding; and in case significant flood risk sites are identified, a risk management plan for the sites is developed. The assessment is undertaken by a large private consultancy company, which has storm water risk assessments and management plans as part of their service portfolio.[44]
   c. Whereas the Flood directive is directly affecting EU member states, land use planning and management remains more in the hands of the member states. Still, there is the framework of the **EU Urban Agenda** is providing funding for investments in member states, but these have not addressed climate change related issues or climate service development.[45] In Finland, land use planning legislation does not explicitly require the use of climate scenarios. The legislation states

[41] On the European EIA directive: http://ec.europa.eu/environment/eia/eia-legalcontext.htm; cf. also http://ec.europa.eu/environment/eia/pdf/EIA_Directive_informal.pdf
[42] www.ymparisto.fi/fi-fi/Elinymparisto_ja_kaavoitus/Maankayton_suunnittelujarjestelma/Valtakunnalliset_alueidenkayttotavoitteet [19 October 2018]
[43] http://ec.europa.eu/environment/water/flood_risk/index.htm [15 October 2018]
[44] www.sito.fi/en/services/water [15 October 2018]
[45] http://ec.europa.eu/regional_policy/en/policy/themes/urban-development/ [15 October 2018]

that if needed, the municipality has to approve a storm water management plan; which has to hold also when rainfall intensity and frequency will increase (103 I §).

d. In Finland, **FMI** has for long been a major provider of climatological information, and the operational climate service has been functioning for years. This has traditionally been a de-facto monopoly structure (one seller, price discriminated). Two policies have changed the situation recently. EU INSPIRE and PSI directives initiated major open data efforts at FMI, thereby potentially develop a climate service market in Finland.

Second, the findings from tourism:

4. The **climate research network in Austria (CCCA)** established a **working group on Climate Services** (in spring 2018) with the aim to provide a networking platform for climate service providers in this regard and to improve the match between supply and demand. The working group on climate service is project based.
5. The CCCA **'Map of Competences'** is an initiative to map climate researchers and their expertise. However, in its current form it does not provide information on existing climate services. The suggestion of expanding this online mapping in a way that climate services providers have the opportunity to describe and promote their climate services attracted interest by the CCCA (as it was discussed in the course of EU-MACS interactions) and the technical implementation will be discussed internally.
6. There is no **sector-specific data infrastructure** for climate services in the tourism sector but the CCCA database provides a central national archive for climate data and information. Therefore, there is in principle no need for a stand-alone data infrastructure for the tourism sector. However, it is currently used primarily for basic climate data, less often for sector specific information (impact modelling results).
7. **Impulses from public administration:** Occasionally, public authorities ask applicants of investment grants for expert reports including the impacts of climate change on planned investment in winter tourism infrastructure. A climatological review and climate proofing of investments as (a mandatory) part of (public) funding application has the potential to improve decision making using climate knowledge.
8. **Links to urban and regional planning:** The "KLAR!" initiative in Austria[46] is a pilot programme, funded by the Austrian Climate and Energy Fund, supporting communities and regions who want to anticipatorily face and adapt to climate change. Twenty-three regions have received funding to develop a local adaptation strategy and raise awareness for climate change adaptation in their regions. The KLAR!-regions are supported by a service platform consisting of experts from the Environment Agency Austria (UBA Austria) and the Austrian Met Service (ZAMG). The service platform supports KLAR!-regions when creating the adaptation concept by providing information materials, conducing workshops and carrying out advisory services.
9. In Finland, the climate risks for tourism have increasingly gained interest as a topic within **tourism policy**. Some preliminary assessments and scenarios involving climate factors have been developed. The official policy response, however, still relies on the actions and regulations in the sectors (urban planning, transportation, etc.), on which tourism builds.

Third, the findings from the **finance** sector study:

10. Regarding existing policies fostering climate services in finance, we mostly find **very indirectly** support the use of climate services. They create the enabling conditions for climate services demand to expand. There are a very few instances where climate services themselves are directly supported, though.

[46] More information can be found on the website www.klar-anpassungsregionen.at (available only in German).

11. **Banking and investing:** The July 2017 release of the Task Force on Climate-related Financial Disclosures (TCFD) has been called a 'game changer' many times over the last few years. Despite the fact this is a voluntary scheme, the climate risk disclosure scheme has serious clout and is being taken seriously by the finance service sector. To report against the TCFD recommendations (i.e., to assess and disclose physical and transition (terms established by the scheme) climate risk and opportunities) climate services is required, at least on the physical risk side. The scheme was developed in a bottom up manner, as in it was created by members of the finance service sector and corporates together, notably without regulators. The finance service sector is supportive of it as well, because the ultimate goal is to have the corporates they lend to carrying out the analysis, and several stakeholders have indicated to get their clients to respond to TCFD, they need to show they, too, are responding.

12. The **Institutions for Occupational Retirement Provision Directive II (IORP II)** was issued by the European Commission in 2016. The Directive (2016/2341/EU) requires European occupational pension fund managers (or IORPs) to consider ESG factors, including climate risk, in their investment portfolios. Under the Directive, which replaces the 2003 IORP I Directive, EU member states shall require these fund managers to deliver risk assessments every three years or following any significant changes to the fund's risk profile. The risk assessment should include risks related to ESG, climate change, use of natural resources, and risks related to the depreciations of assets due to regulatory change (European Parliament and Council of the European Union 2016). These assessments are expected to drive greater analysis of both physical and transitional climate risks among IORPs, thereby driving demand for climate services to perform these analyses. Alongside regulatory requirements, the long-term investment profile of pension funds (30 years) may further drive impact assessment as climate risks become more pronounced. This Directive applies to tens of thousands of registered EU pension funds, that manage a combined EURO 2.5 trillion in assets. Pension funds have until January 2019 to integrate IORP II into their national laws, a timeline that should fall before Brexit (Rust 2016).

13. **Article 173:** France's Energy Transition act came in around 2016. This very well could be due in part to the hosting of the Paris conference, in late 2015, where the political will was very high to establish this sort of law. Article 173 of this law mandates climate risk disclosure scheme, really the first of its kind, requiring investors to analyse and report publicly on risks, which are material to their portfolios, including physical climate risks among other environmental risks. This has caused a surge of climate services procurement in the country, and has also meant quite a few new entrants of climate services providers in the market. Firms that have worked in carbon related risks within the FS sector have now started to offer *climate* services. Firms from the US, which have connections to Europe/France have set up shop in France to be able to provide disclosure services as well.

14. **Fiduciary duty**: The 1984 case, Cowan v Scargill, in England resulted in a judgement that was perceived to require fiduciaries (those managing others' money and assets) to work for profit maximisation should be placed above all other (e.g., environmental) considerations (Allianz 2017).

    a. As ESG factors grow in importance in society, some in the finance sector continue to see this narrow definition of fiduciary duty (profit maximisation) as a reason why they cannot consider longer term risks and ESG risks, including climate change. The logic goes that action on these topics, or the incorporation of these into decision making would inhibit their ability to maximise financial returns (stakeholder interviews; cf. Sullivan et al. 2015).

    b. **UNEP FI Freshfields report:** Sullivan et al. (2015) find important shifts in the interpretation of fiduciary duty have been made in the decade since 2005, following from the landmark UNEP FI Freshfields report. That report found the opposite of Cowan v Scargill: a lack of consideration of ESG factors could be in fact breaching fiduciary duty. Now, many investors take ESG into account in their investment process, which allow them to "make better investment decisions" (Sullivan et al. 2015: 14). Slowly, fiduciary duty is not the "obstacle it is commonly assumed to be" (ibid.: 15; Allianz 2017).

### 6.3.2 Existing dedicated innovation policies on sector level

There are some hints at specific **innovation policies** related to climate services, integrated into **sectoral** policies. Besides, environmental legislation has general tightening trend, and may result in some increased interest towards climate services. Very interesting is also to look into the promotion or fostering of climate services through policies pursuing socio-technical innovation: are there apps in the making, new products that depend on digitalisation and high-tech (see also EU-MACS Deliverable 1.4 on technological innovations)?

1. In Austria, a **new climate and energy strategy** was published in May 2018, an overarching strategy to reach the climate and energy goals 2030. The strategy is divided into general goals and tasks (mostly lacking of concrete measures), and specific flagship projects with details of responsibilities, instruments and the respective time horizon. Tourism is not directly addressed, but indirectly covered by topics such as green mobility, energy efficiency in buildings, etc. The strategy does not directly foster the use of climate services.
2. The **use of technology and digitalization** is increasing in the tourism sector as well (e.g., GPS based snow management, such as ARENA slope management[47] and SNOWsat[48], complex snowmaking systems, online booking systems, etc.). This opens up opportunities to integrate climate services in existing products and services, which is generally recommended. In the ongoing H2020 project PROSNOW[49], for example, a demonstrator of a decision-making service for snow management in ski resorts is being developed. More precisely, the project is about setting up and demonstrating a seamless snow prediction system that covers time scales from one week to several months ahead. The project includes several providers of snow production, monitoring and management systems in its consortium in order to design the planned meteorological and forecasting service in a manner to be also easily integrable into products already in use by ski resorts. More precisely, the idea is to provide interfaces (web services/APIs) that allow existing snow management software to easily integrate the produced and post-processed forecasts. In addition, the forecasts will also be accessible through a stand-alone web-based portal, the so called PROSNOW demonstrator (Morin et al. 2018).
3. The same can be said for **technology in the finance sector**. What's happening there is the development of platforms or web-based portals where climate data and information is integrated. This includes the integration of hazard maps and data on climate variables into existing financial data portals (e.g., Bloomberg or Thompson Reuters' portals), through to new platforms which provides tools for analysing certain risks (e.g., Swiss Re's CatNet tool.) This is an important development for finance actors, as these portals can help bring together non-climate information such as asset location information about a facility's production and it's insurance coverage levels on a technical, data infrastructural and a subject-related level. Normally, this needs to be done in a GIS environment, and some of these new tools and platforms skip this step. Important to note is that these portals and platforms may still have large data gaps for certain geographies, sectors, and climate variables, and hazards.
4. In urban planning (WP4) Helsinki has adopted some innovative practices such as the use of "**Green coefficient**" and some ambitious targets to improve climate risk management (see the Kuninkaantammi example mentioned in the next section). This does not necessarily turn into continuous need for climate services, as the calculative tools and guidelines are updated project-wise instead of relying on external climate services providers in operations.
5. A potential instrument, though not directly a policy instrument, is the **ISO standard** for resilient cities indicator system[50] which might boost cities to use more climate services in a coherent way.

[47] www.pistenmanagement.at [10 October 2018]
[48] www.pistenbully.com/aut/de/innovation/snowsat-pisten-und-flottenmanagement.html [10 October 2018]
[49] www.prosnow.org [10 October 2018]
[50] www.iso.org/standard/70428.html [15 October 2018]

### 6.3.3 Institutional entrepreneurs

Which roles do **institutional entrepreneurs** or **policy entrepreneurs** play for matching climate services demand, purveyance, and supply? "Institutional entrepreneurs" are "those who not only play the role of traditional entrepreneurs in the Schumpeterian sense, but also help establish market institutions in the process of their business activities" (Li et al. 2006: 358). "Policy entrepreneurs" are actors who use their capabilities and capacities of a policy process to advance their own policy ends (Kingdon 1984). There are indeed municipalities that could be considered forerunners, such as the cities of Bologna and Helsinki, or the Ruka Ski Resort, that have ambitious adaptation plans or ongoing projects:

1. "**Framing champions**" as charismatic opinion leaders and institutional entrepreneurs (Garud et al. 2007) are a crucial element in the analysis on innovation dynamics. They are particularly skilful and successful in giving meaning and context to issues they care for (for some reasons, often in their own interests), and their views are very likely to be amplified through mass media as they are highly compatible with rules of media attention. For climate issues, most prominently it was **Al Gore** who influenced and partially even the political and social agenda, who as former U.S. vice-president run an environmentalist political campaign that was effective far beyond his own country. In winter tourism in Austria is one such figure, too, who is president of a big national winter sport association, entrepreneur in tourism and winter sport, as well as provider of panorama cams that inform TV and internet users about the weather conditions on mountain sports and tourism sites. He rejects climate services for the winter sports association.
2. In the case of **Bologna**, we want to emphasise the following findings:
   a. Bologna is the **most advanced** city in Italy concerning the adaptation to climate change. Nevertheless, only few experiences have been already carried out concerning the use of climate data for urban planning. A recent attempt regards the development of the Urban Plan for the Adaptation to the Climate Change. The plan has been developed as output of the BluAP Life+ project. However, the measures described in the plan are still far from being implemented.
   b. According to what we learned during EU MACS implementation, the **BluAP did not reduce the gap between climate services providers and users**. The process was mainly top-down oriented, and only one department in the municipality was directly involved in the design and use of the climate services. This negatively affected the use and sharing of the climate-related information throughout the municipal organization.
   c. Urban adaptation is still considered a s **strictly sectorial policy**. We registered a lack of awareness among most of the local actors. This, in our understanding, represent a barrier to the climate services market, because it is also hampering the whole process of climate change urban adaptation.
   d. The **data infrastructure** represents another important **barrier** to the climate service market uptake. It is still highly fragmented. The different departments have their own data infrastructure with a very limited degree of sharing.
3. Findings from the **Helsinki** case:
   a. In Helsinki city, there are some individuals working in different city agencies who act as institutional entrepreneurs and drive more ambitious and integrated adaptation policy for the city. Many of these belong to the **informal climate network** within the city organization, who share knowledge and information across their domains. Their interests lie on improving the climate actions (mitigation and adaptation) of the city. This network is about getting things done with already existing knowledge and sharing information—according to WP4 workshop results, there was no specific need for extended climate services.

> **Policy entrepreneurs** are actors who use their capabilities and capacities of a policy process to advance their own policy ends (Kingdon)

b. Helsinki has some **champions** in the urban planning department who take climate change seriously. Even though storm water assessment is done at some level in each new district, in recent years there has been a development site, Kuninkaantammi, which has become as a pilot project for the Helsinki Storm Water Strategy (Kuninkaantammi). The storm water solutions in Kuninkaantammi have not been extensively used in Helsinki before. The idea is to integrate the storm water management methods as technical solutions with the urban landscape; pools and stone streams, vegetation dents, trees, green roofs and rain gardens are all used to control storm waters in the area. An important way to increase the uptake of the alternative (compared to the traditional storm water pipes) methods was to include the storm water control in the zoning plan regulations. Among others, the following regulations concerning the storm water management have been included to the zoning plan of Kuninkaantammi: (a) The minimum demand of storm waters to be delayed in districts is 0,5m3/100m2 of each hard, impermeable surface; (b) delaying the storm waters should primarily be arranged through rain gardens shared by the plots; (c) green rooftops should be built on all one-storey building parts, outbuildings, bike sheds, etc. Regulation (a) has been used in other parts of the city prior to Kuninkaantammi, but regulation (b) was included in the regulation for the first time in this area: regulation (c) on green roofs has also been used before, but mostly for urban landscape related reasons.

c. Helsinki is using various tools and services in both mitigation of climate change and preparedness to extreme weather events and climate change adaptation. Some examples specifically used in adaptation are the Planner's Workbook for Climate-proof City and the ClimateGuide.fi. They both provide information on the impacts of climate change and how to implement adaptation activities in urban planning. Helsinki **commissioned** a weather and climate risk study, which was finished in spring 2018. The Helsinki Region Environmental Services Authority HSY has analysed the social vulnerability to climate change in the Helsinki Metropolitan Area (HSY 2015). A recent report identifies new challenges related to adaptation, and identifies potential monitoring and evaluation (M&E) indicators for sea and river floods, storm water and urban floods, water resources management, social vulnerability, green infrastructure, social and health services, general awareness on adaptation, business, adaptation integration and processes, education and development and climate change and its impacts (HSY 2017).

4. Tourism:

   a. **Ruka** is currently developing seasonal snow storage, inter alia also analysed in the H2020 BLUE ACTION project, where increased use of climate information may be needed. Seasonal forecasts could help in optimizing the snow storage operations, whereas decadal predictions could support in decision regarding investments in systems like this.

   b. Within the tourism sector, there are some **forerunner enterprises** that have piloted the use of climate services in decision making, or have taken a proactive stance on climate adaptation.

   c. Institutional entrepreneurs (e.g., interest groups: tourism associations, ropeways association) could play a key role in promoting the use of climate services.

5. **Finance:** While the mainstream policy actors (e.g. central banks, the EU) are getting on board now, there has been very important work being done by those within the sector to drive climate services uptake. Not necessarily matching, but again work which is a few steps back from that, work which helps the sector realise they need climate services.

   a. For instance, the **TCFD recommendations**, which provide a climate risk disclosure framework, seem to be such policy entrepreneurs. As mentioned, this framework has changed the game by outing climate risk disclosure front and centre, really helping to drive the need for climate services.

b. Another interesting pioneer is **Sarah Barker** from MinterEllison (law firm) in Australia. She has been pioneering the work in getting board level actors, including in financial institutions, to see they could be held liable for inaction on climate, as well as helping them understand that climate risk is not just a green or ethical concern, but is an actual financial risk.

c. **Umbrella sector associations** such as the Global Investor Coalition on Climate Change and its European-level group called the Institutional Investors Group on Climate Change (IIGCC) and those involved in the encouragement of responsible investing in general have been crucial for the discussion of climate risk and consideration of ESG factors in investing (with climate falling under the E of ESG). Many of these groups are currently conducting research into various tools and approaches available to their members to analyse physical climate risks, indicating the growing interest of the sector in climate impacts and therefore climate data and information.

d. **Initiatives** such as the '2 Degrees Investing Initiative', the 'Principles for Responsible Investing' (PRI), and the 'Carbon Disclosure Project' are further examples of groups which are putting forth relevant thought pieces and research (in the first instance) and frameworks for reporting environmental action (in the latter instances). These types of initiatives have been playing an awareness-raising role around climate risk for years, which is helping lay the foundations in these early stages for climate service uptake, though not really directly helping with matching. PRI and CDP have notably recently aligned their reporting criteria with the TCFD, thus directing further attention toward physical climate risks.

6. The focus of **funding programmes** (e.g., H2020 climate services demonstration projects) is influenced by policy entrepreneurs, such as selected experts from the climate services world and interested in setting a public procurement agenda for climate service product development.

7. The question is also who could **win the most in being a** climate services or climate services-combined-with-other-intelligence **forerunner or leader**. Directly affected are tourism businesses; tourism associations could play a role in joint acquisition. In the finance services sector, combining climate data with other capabilities such as GIS mapping is useful to banks and asset managers as they don't have this capacity internally.

8. Interest groups and umbrella organizations could in fact be relevant actors in **distributing knowledge** among their members: through their common distribution channels, newsletters, annual assemblies/seminars—inviting climate service providers to present climate service or latest research findings, etc., which is relevant also for climate information and climate services (cf. Damm et al. 2018).

## 6.4 Policy implications from the governance situation assessment

The overall finding about the governance situation is that **governance structures are in flux**, at least partially. There are also lots of **policies that bear the potential of stimulating the use of climate service**, at least in theory, but neither are policies often explicit enough about any requirements of climate intelligence nor have climate service providers often been able to translate their products into what these policies need or these policy logics into what climate service can provide (whatever it is called in detail, most often rather not "climate service"). There are strong efforts to officially stimulate climate service awareness, yet they are too often still too much related to framework level, not on operative level. The question is, as said before, which of these pioneering efforts will become new routines and how will they be transferred also to other fields than those from which they originate.

> The **overall finding** about the governance situation is that we are in a situation in which some momentum has already been created by state, and now first corporate actors take up the initiatives and translate them into their own contexts.
> The main question is, how far state will go to further promote climate services before trusting in their independent future (or losing trust into a future of their own), and how far corporate actors will go on their own.

We distinguish implications in three respects: for **fostering** the (co-) creation of new climate services, their **uptake** in the three focal sectors, and **matching** supply

and demand. These three dimensions help explain the context in which implications may develop their relevancy. The following list collects aspects that can be derived from the governance and policy assessment in Annex 4 below. The three dimensions fostering, uptake, and matching, however, are not just phases in a linear process, but three angles from which one can address the progress of climate services with policy. A more detailed account of policy options are described in chapter 5.

With regards to **policies fostering** the climate services market,

- **framework governance** (such as GFCS) has great importance. Since in many respects, there is no possibility to politically impose direct obligations to (a) calculate climate intelligence into policy and management decisions and (b) use climate services in some form, frameworks offer the chance to nudge into these directions while leaving leeway for users to adopt climate intelligence in the way they find appropriate.
- **RTD policy** of the EU can also help innovate climate services and the usage of climate intelligence in various use contexts, e.g., firstly, through novel technical or organisational solutions of embedding it into use contexts, secondly, through generating more suitable intelligence (be it better raw data, more fitting data resolution, or better integrated intelligence compiling climate and other expertise). Pilot projects could make solutions more tangible for development and appropriation.
- More emphasis on **service innovation** stimulated through EU, be it for climate services or other services, would also offer the chance to push European (on all levels) capabilities and capacities for developing and using more up-to-date services and service provision practices.

With an eye on policies strengthening both **fostering and uptake**,

- the **incremental adaptation** of the EU Climate Services Roadmap could be important, allowing EU actors and collaborators to keep a close eye on current trends and possibilities, while at the same time integrating it into an official and more general framework. In this way, actualy uptake and fostering could be constantly linked and disappointments through unrealistic expectations avoided.
- **National frameworks** can make such linkage also more specific, e.g., with the Austrian Climate and Energy Strategy 2018 that links climate intelligence more explicitly to the official strategy and thus opens up ways for developing possible uptake (without forstering climate services directly). As soon as uptake becomes the issue, more specific local policies become relevant, such as support for actually collaborating and strengthening new initiatives. The newly established working group on climate services at the Austrian CCCA climate research network is an example.
- **Global climate governance** efforts are nevertheless been useful for shaping conditions for establishing climate services markets in general. Also on this level, existing and new governance schemes could be supported, their binding force increased, as far as acceptance and implementation don't suffer.
- On the other side, there are cases like Germany, where a former forerunner in climate risk disclosure policy and major national economy is missing as climate policy promoter. Helping Germany **find back to** (joint) governance **innovation leadership** could be a major asset for many efforts.

With regards to **uptake policies** more specifically,

- there are (sector) **specific governance initiatives**, such as UNEP FI and TCFD, that help driving uptake of climate services in finance; thus continued collaboration with UNEP FI and TCFD may further stabilise climate services. C3S and JPI Climate, which have become important hubs for uptake, could be further used and even strengthened as promoters of climate services.

- Several **legal measures**, such as INSPIRE, the EU Floods Directive, and the Environmental Impact Assessment (EIA) regulation (the latter as a key mechanism in urban planning), could gain additional quality through stronger inclusion of strategic climate intelligence services and optimised climate services. At national level, national urban planning and zoning regulation can be mentioned as well as France's Article 173 of the Energy Transition Act mandating risk disclosure schemes, IOPR II (requiring to consider ESG factors including climate risk). The same is true, for the EU Climate Change Adaptation Strategy and the EU Urban Agenda as **political initiatives**. Here, urban and regional planning could be linked with energy and tourism, to name two potential links. All these, and more, could be taken as models for requirements in other areas.
- Although legally binding climate change adadptation planning is still weak and climate responsibility often shifted to other actors, there is now ample **precedence**, including requirements that in one form or another may lead to more climate service uptake. Frameworks, standards, and regulation need to be **strengthened**, private initiaves further supported, and knowledge sharing encouraged and facilitated. **Responsibility regimes** need to be established.
- Much of this doesn't require climate services directly. The hope is that stringer climate policies will lead to increasing climate service demand. However, one could also assume that well-developed climate services may, in turn, stimulate climate adaptation, as this is reasonable only with a sound knowledge basis and climate expertise. Climate services would be an important **means to an important end**.
- For all this, not only regulation (building more risk disclosure laws or schemes, mentioning 'climate services' or 'climate expertise' more explicitly in key regulation) is pivotal, but, firstly, also clever **framing and agenda-setting strategies**, such as using influencers as well as getting through to peers with the message about usefulness and profitability of climate services. As climate services are often outside existing institutional and organisational logics, it must, secondly, be more specifically translated into **key use contexts** how climate intelligence through climate services can fit and function well. Thirdly, as **new technology and digitisation** is available in use contexts, climate services need to be fitted into existing or new platforms, apps, and products.

With the last aspects, we are already close to the question of **matching** of climate services climate services demand and provision against the background of concrete use contexts, for which this chapter's analysis suggests the following implications:

- Other cities could **learn from Bologna**, as most advanced in climate services in Italy, and Bologna could actively share with other cities. Transferability needs to be critically reflected, though. Furthermore, while urban adaptation is often considered to be sector-specific, which is not necessarily wrong, it could nevertheless be wrong to consider urban contexts not as crossroads for all kinds of other areas, sectors, and policies, culminating in the **rich variety of a "city world"**, for which climate is relevant in many respects.
- The role of the NHMSs in the EU is still ambiguous. It would be crucial to **enable NHMSs** to position themselves in an emerging climate services market, e.g. by providing resources for R&D and modernising climate services business understanding in NHMSs, by supporting the installation of intermediaries that are capable of paving the ways to market and users. It may also help to develop free access data policy of weather data further at least during the product development phase, as well as to help financing new or more complicated or costly products until supply-demand-price balance fits.
- It was already stated how important it is to search and build practical, mindset-related **bridges**. This means, besides allowing for climate services- or climate intelligence-related cross-functional collaboration on organisational level, that climate services also need to be adopted/translated (in)to existing **epistemologies**, or spaces created to think beyond existing epistemologies (e.g., for checking out what climate services can do for an organisation). This could be accompanied by promoting more integral **management styles and frameworks**, make deciders and users

aware of these differences. This can also mean to explain climate services as useful element of **broader consultancy packages** that can be fit into already accepted from a given management. In brief, this means simplifying, translating, and explaining climate services—make them polyglot, develop alternative terminology that fits into particular organisational cultures.

- **Public-private partnerships**, when well designed, could help facilitate, e.g., implementation of adaptation measures (financing) in urban planning, just as partnering in linking public upstream data and advise with co-creating climate service tools as well as along large climate risks (insurance). Public-private **collaboration** could help improve, e.g., the design of adaptation and effectiveness of climate services in urban planning, tourism, and finance, as well as joint product development, profit sharing, mutual promotion, mutual forwarding of requests could help.

The overall finding about the governance **situation** is that we are in a situation in which some momentum has already been created by the state, while first corporate actors take up the initiatives and translate them into their own contexts. The main question is, how far the state will and can go to promote climate services before it decides that climate services have become either an established market or a marginal phenomenon, and how far corporate actors will be able and willing to go on their own, thanks to or despite public promotion of climate services.

# 7 CONSLUSIONS AND RECOMMENDATIONS

## 7.1 General

As this report is the concluding synthesis part of the EU-MACS project proper we take a somewhat wider reflective stance in this section than just covering the outcomes of the assessment in this report. Next to this Deliverable 5.2 a Policy Brief has been published on the main outcomes and recommendations of the project. Furthermore, in cooperation with the twin project MARCO a joint synthesis report (Deliverable 5.3) is produced.

Based on the work in the work packages 1 to 5, we can conclude that climate services are not used to the extent that seems recommendable from a societal point of view, which is in part due to non-availability and non-accessibility of these, but also various types of mismatches, readiness and under-standing among users, and the organisation of climate services provision and development count. There is a whole set of policy measures, as well as measures in climate service provider organisations and inside user organisations, that can all help to significantly improve the uptake of climate services.

In this case, the term climate services has a fairly broad meaning, notably also including knowledge products and services in which non-climate information has a significant role. These knowledge products will usually not be named as climate service, but rather referring to the sector or to the type of knowledge product (e.g., risk indicator or hydrological management tool). The role of the private sector in the provision of climate services will be particularly important for these embedded climate services, i.e., when being part of broader scoped engineering, accounting, intelligence, and risk man-agement services, and consultancy assignments.

Climate services can be used for different purposes, notably (1) resilience management (i.e., DRR), (2) intra-annual planning when seasonal variations count, (3) adaptation to climate change, and (4) comprehensive sustainable transition strategies (i.e., referring to the UN SDGs). The information needs for these purposes can be somewhat overlapping, whereas by using climate services for one purpose the user may learn the usefulness of these services for one or more of the other purposes. For example seasonal climate services, of which the usefulness is easier to verify than for the other purpose, can be a more attractive service to start with for users. Subsequently, many of these users will learn that these climate services or related products are also useful for one or more of the other purposes.

## 7.2 Value chain as a means to understand the climate services value formation

The value chain is a helpful concept for understanding the climate services market (see also D1.1, D5.1). In principal it means that the generation of climate services goes through several stages, starting with collection and processing basic data from observations, as well as producing projections with (usually large) climate models (GCM, RCM). From there, it continues to downscaling and other post-processing capabilities (such as inclusion of hydrological modelling). These stages are regarded as the upstream climate services, which by their very nature are mostly produced by public organisations (MetOffices, academic institutes, international bodies such as ECWMF). The Copernicus Climate Change Services (C3S) and Climate Data Store (CDS) are hosted by ECWMF, and form a very important platform for the generation of the midstream and sometimes downstream climate services. Midstream climate services typically concern (1) tools and models designed to answer specific questions or produce specific indicators, as well as tailored datasets (i.e., incl. non-climate information and visualization options) meant for use in particular sector or for particular risks. Sector experts can use these in downstream climate services to produce user specific answers. Downstream climate services will often include impacts translated in relevant effects and language of the user.

Key notions of the value chain for climate services are: (1) the share of non-climate information is increasing when moving to mid-stream and a fortiori downstream climate services, which has consequences for necessary skills and recommendable modes of delivery, (2) the potential to generate tangible value added tends to increase in accordance with the growing share of non-climate information and hence is often easier to extract more downstream in the value chain, (3) the more downstream in

the value chain one moves the less providers and users tend to perceive the generation of climate services as a linear sequenced process, instead they will often experience it as a process with more diverse inputs and actors, (4) there are alternative pathways from upstream to downstream to serve the same eventual climate services end-use needs, and thanks to technological and organizational innovations the number of alternatives is likely to increase, (5) even though there are in principle often multiple pathways possible, the actually existing number of existing pathways may be limited due to market regulation or economic viability requirements.

Even though the value chain of particular climate services may be entirely handled by one actor, i.e., by a MetOffice, there is a trend towards (more) sequenced handling, notably from upstream to midstream, and just as well a trend towards collaborative handling (notably from midstream to downstream). The reasons for these trends are inter alia rising complexity and the need for a wider set of skills, including other than scientific or technical ones. In practice this means that in particular (traditional) public providers of climate services have to carefully consider their roles in the value chain. Furthermore, it means that distinctions between 'providers' and 'users' can become blurred. Especially midstream and downstream in the value chain actors can be both providers *and* users, whereas also other types of actors occur such as broker, facilitator (i.e., of a platform), and purveyor (i.e., delivering services largely made elsewhere).

## 7.3 Obstacles really count, but can be removed

Based on the interactions with the focus sectors finance, tourism and urban planning (D2.1, D3.1, D4.1), the lessons from twin project MARCO, and desk research clusters of obstacles were identified related to the demand side (users), the supply side (providers), and operational matching (where users and providers attempt to transact) (see D5.1). For each of these obstacles one or more policies and measures were proposed by the project experts based on an internal survey. From these original propositions a set of policies and measures was identified, whereas also options for alternative resourcing models for different types of climate services were identified based on desk research and interviews (D1.2, this report). Last but not last three governance approaches were specified which represent typical governance philosophies in Europe, typified as 'state-centred','business-centred' and 'network-centred'.

Even though measures to improve matching processes, e.g., by improving user-friendliness of web-based services, are relevant and effective, the most crucial obstacles are within the demand and supply sides. For example, as long as users have no clue whether climate change or climate variability have notable impact on their current or future business, or if they regard it as a given phenomenon for which no useful measure is available. Similarly, providers may still show a tendency to focus strongly on the climate science aspects of the service content, whereas for example the eventual risk and uncertainty for downstream users often depends on intricate interactions between climate and non-climate variables. The set of most relevant obstacles varies across user groups, and in some user groups such as multi-lateral development banks the significance of obstacles is already appreciably reduced. D5.1 (chapter 5) provides a full appraisal of the obstacles. The good news is that virtually all obstacles can be resolved or at least significantly attenuated by means of policies and measures of public and private actors. The most important policies and measures are:

- **(Self-) regulation** on mandatory climate risk reporting, transparency, & accountability—at least for several sectors, such as financial sector, urban planning, critical infrastructure, and food supply;
- Enable, incite and support **collaboration** between different types of actors, notably also across the public-private divide, to engender learning and better needs based design and operation of climate services;
- When engaging in climate service development, especially public actors and public-private collaborations should adequately and timely **assess realistic and viable resourcing/business models** for the stage of regular climate service provision;

- **Standardisation**, such as of terms, product categories, and product ratings, and quality assurance which is also relevant to current and prospective users, should be pursued by the entire climate services sector;
- **Monitoring and ex-post evaluation** of climate services use and its effects, of which the results are public, with the aim to inform policy makers as well as providers and users, while inter alia also enabling to demonstrate the benefit generation capacity of different types of climate services for different types of users;
- Basic climate research aside, **innovation in climate services** should encompass user relevant aspects of service delivery, such as related to visualization, risk indicators integrated with the user's decision variables, collaborative mutual climate service development and delivery models, etc.

A **coherent and vigorous climate services policy package** can substantially lift the uptake of climate services, meaning that it such a policy package can both precipitate the uptake and increase the share of the market potential that realistically attainable. It seems however that of the three specified governance approaches within which policy packages are applied (tuned to the governance approach), the so-called *network-centred governance approach* would have the best guarantees to render a quite effective policy package.

Next to the above mentioned most crucial measures there is a **wide spectrum of innovation policy measures** for ministries, agencies, research institutes and private companies often aimed at embedding knowledge about climate services also in other disciplines as well as linking research and practice.

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# ANNEX 1: SUMMARY OF SURVEY CONSULTANCY COMPANIES

**EU-MACS T5.4 summary of survey among consultancy companies**

**Period:** 9.7.2018 – 30.9.2018; set up by: Adriaan Perrels & Tuukka Rautio (FMI)

**Sample:** 20 companies across EU, of which 12 with multiple locations in various countries

**Response:** 4 companies (from 3 of the 4 can be inferred who they are); 1 small, 1 medium, 2 large

**Clientele:** public and private organisations; such as ministries & public agencies (environment, infra, hydrology agriculture, forestry), industry, research organisations

**Partners:** companies, universities, other R&D, other consultants

TABLE 24: THEME AREAS SERVED X CLIMATE EXPERTISE/DATA SOURCING

| | Theme areas | | |
|---|---|---|---|
| | **Mitigation** | **Adaptation** | **Variability & extremes** |
| **Acquire CS** | 1 | 2 | 1 |
| **(co-)generate CS with CS provider** | 3 | 3 | 1 |
| **Co-design with client** | 3 | 4 | 2 |

TABLE 25: ACQUIRED CS (2 OF 4 RESPONDENTS)

| | |
|---|---|
| **Free of charge** | 2 |
| **Charged according to fixed scheme (subscription)** | 1 |
| **Tailored - charged** | - |

**Growth expectations regarding climate services volume** (and closely related) – **no one expects no growth!**

- Through more (new) clients 2 out of 4
- Through more service content per client 4 out of 4

**Reasons/sources for this growth:**

- From (other) consulting companies and R&D
- Climate & sustainability issues start to permeate across most of the consultancy work (main-streaming)

**What are factors reduce interest and/or ability of clients in these services:**

- Awareness, absence of incentives, the issues are not high on the agenda, lack of (perceived) urgency
- Costs (not prioritised high enough in their organisation)
- Lack of knowledge of the need for climate services. From the private sector clients, the under-standing of the need of science-based climate services is still quite limited
- Partly missing regulation and partly lack of financial (or other economic) incentives

The synthesis of the answers used here are available upon request.

# ANNEX 2: SUMMARY OF INTERVIEWS ON CLIMATE SERVICES DEVELOPMENT

**Interviewed organisations**: FMI, Met Norway, Met Latvia, KNMI, BSC, ZAMG, MeteoGroup[51]

**Interviewers** (from FMI): *Adriaan Perrels* (Met Norway, Met Latvia, KNMI, BSC, ZAMG, MeteoGroup), *Heikki Tuomenvirta* (FMI, Met Norway, ZAMG, MeteoGroup)

Each interview was conducted as semi-structures based on a small set of questions (see Annex). Actual answers and discussion was allowed to deviate from questions, elaborate on questions, or skip over questions. Some questions were very specific and concrete, whereas answers could only be given in a far more tentative fashion. The inability to give precise numbers is telling as such. We decided to continue with the original questions, despite the precision problem. Only for MeteoGroup the questions were adapted.

……..

**1. How do climate services development propositions arise?**

- Through systemized feedback from (several) clients
- Through specific requests from one or a few clients
    - Possibly embedded in partnership structures
    - Mostly existing clients, very occasionally new client
- From internal processes (brainstorming; building on earlier research results

The options under the first two bullets are more often mentioned than the third (internal processes). Only for one organisation the internal process seems to be the dominant source of propositions. For two other organisations the internal processes, possibly in conjunction with externally assigned tasks/responsibilities, can be a source of climate services development initiation, but external requests are still more common, even though these requests cannot always be taken up – either because of complexity & analytical limits *or* because of designated roles of public and private providers. Also, alignment with current strategies can play a role.

All in all, also for almost all public climate services providers, climate services development tends to be initiated by external requests of prospective users (often already a client, sometimes new). Several interviewees emphasized the importance of collaborative structures between climate services providers and (prospective) climate services users as adequate specifications of the climate services needs typically arise from trust-based interactions and joint learning (supported by endorsement by peers), e.g., national and regional PPPs on adaptation (generic or for certain sector)(cf. NASA/NOAA/OSTP 2016).

**2. On what basis is decided to actually study the climate services proposition?**

These answers revealed an important bottleneck in the establishment of climate services product portfolios. The decision to actually develop new climate services, provided it fits in the overall strategy, is deemed technically possible, and is expected to contain 'skill', appears to be mainly steered by the availability of specific development (project) funding, while considerations how to resource the regular climate services provision later on (possibly in conjunction with ideas on alternative business model formats) are either very vague or just missing. Individual experts in the respective organisations are sometimes aware of this, but as yet this has not led to systematic improvements in proper and timely planning of the traverse from development product to regular service provision.

[51] Private service provider of meteorological services which contemplates extension of its currently minimal climate services portfolio.

Self-evidently, this is different for commercial providers, which may otherwise still decide to take a risk when deciding to develop a climate services concept into market ready climate services product.

3. **Can there be given an estimate of the number of (serious) climate services propositions since the year 2000? (Also trends like 'same / more / less' may be useful)**
4. **How many of these ideas (Q3) have been actually studied and (at least to some extent) developed?**

Interviewees usually mention several climate services products, but there is scant information about an original pool of ideas, requests and assignments from which a number of (currently) active climate services arose. Yet, considering the reactions in the interviews and exchanges over the course of the EU-MACS project, there does not seem to be a large number of prematurely terminated climate services developments.

Most interviewees indicate directly or indirectly that one can witness a growing need for climate services in diverse sectors, but it seems not always have led to clearly identifiable and steady growth in climate services products. In other words, there may be clear expansion in 'climate services activity', but less so in climate services product portfolio. There seem to be several reasons for this, such as:

- Curtailed response in public climate services related to resourcing and market regulation
- A part of the needs seems to be catered for by means of ad-hoc provision of climate information & expertise, but the output is not clearly cast as a (reproducible) climate services product

In addition, what may happen is that similar needs of other (same sector) users lead to slight variations in a climate services product. This means, once again, more activity, but not necessarily a broader set of products.

Some interviewees also indicated that incidentally satisfactorily piloted products may not really seem to fly after all. In other words, users may also go through a learning process, which teaches them that another climate services product may after all be still more fitting.

**Q5 How many of the developed climate services (Q4) have actually been turned into services (i.e. as regular service provision**

**Q6 How many of these services:** do still exist / have been further developed / have been transferred to another provider / are charged or not / are practically in a monopoly position/ … ?

Despite some differentiation and local fetaures the answers in fact underscored that economies of scope are often a crucial feature in the build-up of climate services portfolios. Quite some current climate services were developed from pre-existing versions, whereas also extension of monitoring capabilities, such as of water conditions or air quality, regarding forward looking capabilities occurs. In fact some interviewees conceded that it is often a matter of improvement of pre-existing climate services, among others based on feedback from users, and only occasionally of really new climate services is developed.

Either through own preparatory screening procedures and/or owing to pressures from the various EU climate services development support schemes (H2020, JPI and C3S) it was felt by several that there is pressure to ensure climate services are developed which are fit for operational services, and indeed in demand. In fact, it seemed that the tougher the pre-selection process the less drop-out occurs. Similarly, products arising from PPP like cooperations are also still in use. On the other hand a few others conceded that some developed climate services were not subjected to a pilot phase or after a pilot a climate services was after all not launched as a new service.

Budget limitations, which may exist either due to general budget limitations or due to government views on public and private sector service domains, lead either to a climate services portfolio with few free of charge services or to only quite limited number of good—yet free—climate services products. In the

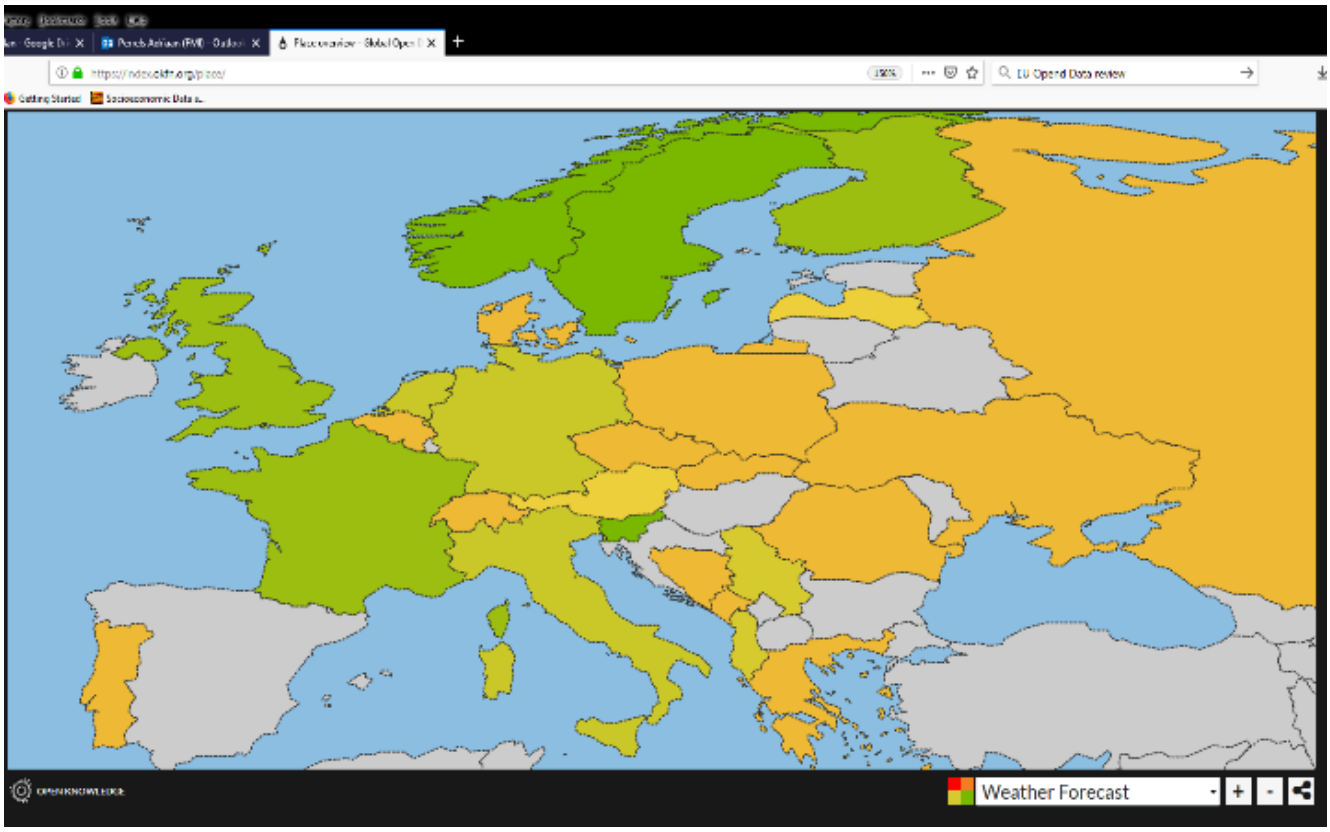
case of charged climate services, the services may also be quite user specific and thereby harder to replicate, while sometimes the paying customer demands uniqueness of the service. In cases where public-private service segregation is less strict more complex products have a higher chance to be (at least partly) charged. Next to strict separation of public and private service domains also vigorous open data policies tend to result in more free-of-charge provision. Yet, it may be that this partly takes the form of a kind of Do-it-yourself climate services, e.g., offering both data and models. On the other hand that can offer other actors the chance to develop their own (commercial or group shared) climate services. Other messages pertaining to budgeting and R&D orientation were that weak resourcing of development work shows in smaller offer of climate services, while the scope for innovation in interfaces, delivery modes etc. is supposedly large.

It was also underlined that climate services product-specific markets are often rather small, meaning that from the viewpoint of economic viability only one provider would suffice. This means that regulators should think hard whether de-facto monopolies for climate services can be private from a welfare point of view.

# ANNEX 3: OPEN DATA SITUATION IN EUROPE

The open data situation is generally spoken improving across the EU (Europe and Data Portal[52]), but differences persist, while some individual countries have been catching up better that other ones. Furthermore, the progress in open data implementation varies across application areas. Countries can rate well for one application area and much worse for another one. For climate services products openness in different application areas is important. The distribution of progress in open data policy implementation does not clearly unfold according to north-south or east-west gradients.

**FIGURE 8: OPEN DATA RATING FOR WEATHER OBSERVATION & FORECATS DATA[53]**




[52] Europe and Data Portal, https://www.europeandataportal.eu/en/dashboard#tab-overview
[53] Source: Global Open Dat Index

FIGURE 9: OPEN DATA RATING FOR LOCATION INFORMATION[54]

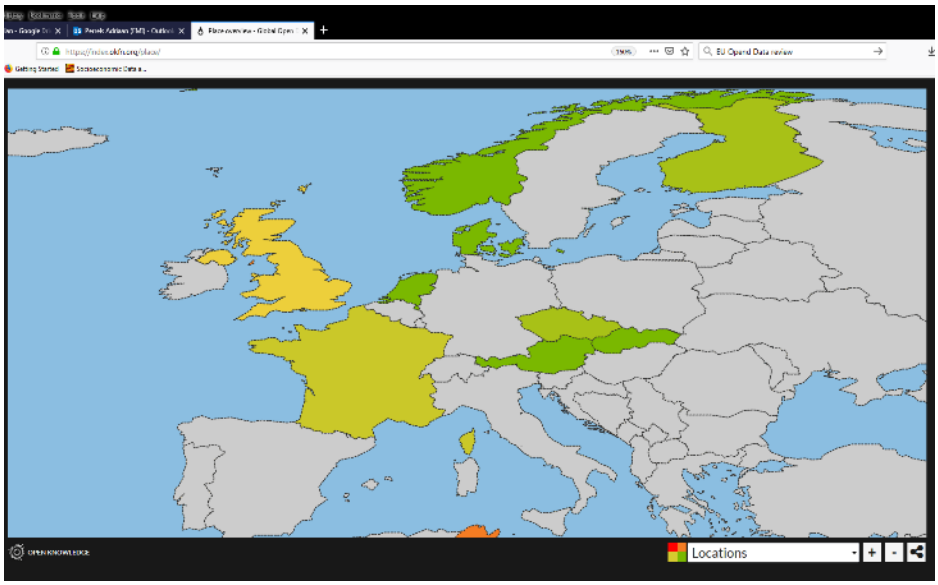
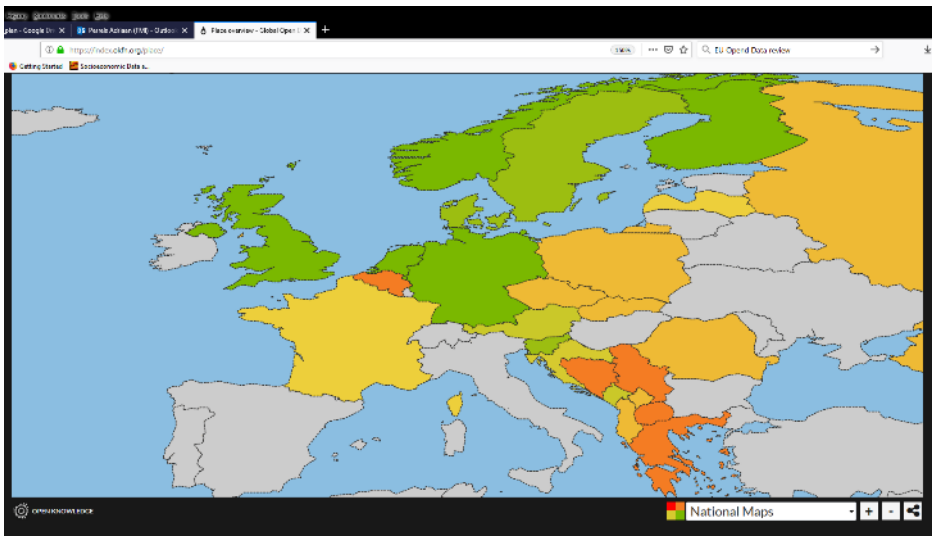



FIGURE 10: OPEN DATA RATING FOR DETAILED MAP DATA[55]




The maps in Figures 8-10 give some idea. Yet, this is far from complete another source (European Dashboard) gives the impression of less dispersion and progress everywhere. In this respect it is important to realize that good access, easy use, up-to-date and other practical features tend to be more important for most midstream and downstream climate services providers than being free of charge. Affordable fees are not a problem.[56]

[54] Source: Global Open Dat Index
[55] Source: Global Open Dat Index
[56] See also: www.europeandataportal.eu/en/dashboard#tab-overview; https://index.okfn.org/place/.

# ANNEX 4: MODEL OF UPTAKE OF CLIMATE SERVICES

Given the largely rational decision frameworks this sector lends itself for exploring a formalisation of the propensity to start using a climate services. In essence we assume that the uptake of a climate services by an actor from the financial sector gets highly likely if the expected benefits of using the climate services are well above the expected cost of acquiring and using the climate services. Generally spoken this is a valid assumption for any sector, yet only a part of them can be expected to apply formalised versions of such cost-benefit criteria, whereas it is more likely to be applied to seasonal climate services than adaptation orientated climate services thanks to better verification possibilities of the former climate services type.

In formalised terms, if the benefit-cost ratio rises beyond a certain threshold level uptake gets ever more likely. Since the uptake of climate services may partly happen via exploratory processes, this formalisation doesn't imply that actors from the financial sector are explicitly applying specified threshold levels for adoption of climate services. Instead, at least in initial stages it is more likely that the involved finance and insurance experts have at best some notion about what seems a fair benefit for a certain effort level.

The formalised assessment of the likelihood of uptake starts with recognising that the use of climate services can generate benefits and the subsequent specification of these benefits. The following main types of benefits can be generated or enhanced thanks to the use of climate services:

1. **Better pricing of risk**
   a. Leading to better coverage of expected damage from premium revenues --> less damage (re) financing cost
   b. More competitive (sharper) pricing for existing products --> more turnover and/or market share
   c. Better matching of asset revenue with asset price
   d. New options to make a competitive difference by pricing risks better than competitors (see also no.3)
2. **Avoidance of seriously underestimated risks**
   a. No excess losses on assets
   b. No excess insurance cost
3. **Opportunities for climate services enriched financial & insurance services**
   a. More revenues from new products
   b. Less claims & losses among better informed clients.

The second main type of benefit, avoided costs, is the classic example, which usually comes to mind first. This type of benefit is easier – yet as such not easy – to quantify than the other ones. For the financial sector as a whole the first main type of benefit seems however more significant, as it is eventually about improving efficiency and hence productivity within the sector. Over time, if more performance data are available the approximate quantification of this effect may become feasible. Lastly, the exploitation of opportunities for new financial products could be important, at least for some actors, but the quantification will be even harder than of the first benefit. We nevertheless assume that the concrete uptake of a particular (set of) climate service(s) by financial actors will be based on some notion of the order of magnitude of the benefits. As long as such a notion cannot be specified financial actors are assumed to use at best only some free climate services and/or explore to some extent climate services options.

Also indirect benefits can be identified (see Box 7), but these stay outside the formalisation approach discussed in this section.

The resulting benefit of the use of a climate services is postulated to depend on three factors:

- the perceived **benefit potential** which is addressed by the use of the climate services, denoted as $E_{it}(B_t)$
- the **fit for purpose** of the climate services (and of its mode of provision), denoted as $\alpha_{it}$
- the **information sharing and exclusivity** factors, denoted as $\kappa_{ist}$

where *i* refers to climate services product type, *t* to time (of existence) or maturity stage of the climate services product.

These elements can be influenced by several factors. We list a few for each of them below:

**Fit for purpose factor $\alpha_{it}$ :**

- Offered climate services is (perceived as) not fitting enough for the risk analysis needed (can be both over- and under-sophisticated)
- Ability to infer damage risks or financial service opportunities yet to developed
- Interface, guidance, etc. not sufficient
- Variation in climate services offered reduces confidence

**Benefits (perceived)) $E_{it}(B_t)$:**

- Lack of awareness that benefits could be generated from climate services
- Current risk management system & data are unable to generate good / meaningful estimate
- Available risk alleviation & sharing instruments are believed to suffice (i.e. the tentative expected *additional* benefit of climate services is perceived as small compared to the efforts needed)

$$\boldsymbol{E_{it}(B_i)} = f_i\,[E(R_{csi}) - E(R_{ncsi})]$$

where *R* denotes the fraction of GDP lost in period (year) *t* owing to climate change (represented by temperature rise T (in Celsius)), and is defined as sensitized to global average temperature rise (Nordhaus …), as e.g. implemented in the DICE model:

$$R_{t,ncsi} = \frac{\mathbf{1}}{\mathbf{1+d.T^x}}$$

In the 2016 DICE model d = 0.00284, and x = 2

Weitzmann (xxxx) suggests a more responsive variation to this function, being:

$$R_{t,ncsi} = \frac{1}{1+d_1.T^x+d_2.T^y}, \text{ where,}$$

$d_1$ = 0,00245074012352, $d_2$ = 0,00000502124953, x = 2, and y = 6,76

Both formulations will be used to define a lower and upper limit for annual damage in terms of lost GDP.

**Information sharing and exclusivity factors $\kappa_{ist}$ :**

Availability of same information for other financial sector actors is either positive (benefits of sharing / level playing field) or negative (benefit generation requires exclusivity). This is summarised in the table below. As value added from financial service provision for a particular provider can inter alia depend on – at least temporarily – unique knowledge, sharing of input information may be too risky in terms of losing a competitive advantage. If the knowledge differential is the defining factor of the business

model, information sharing is unlikely to occur. This is represented in column 1. Information sharing may also help to raise the credibility of a product, as wide spread use is an endorsement of its quality, whereas wide spread use may also help to improve the quality if social learning properly exploited. This is reflected in the options of column 2. Joint disposition of information improves alignment and ensures relevance of this particular information over nearby alternatives. At the same time joint acquisition cannot only lead to lower information costs but also better tailoring of the demanded data, due the more impactful demand volume. This notion is represented by column 3. In relation to value chains (see also D1.1, D1.2, D5.1, D5.2) column 1 refers to downstream and some midstream climate services, columns 2 and 3 to upstream and some downstream climate services.

TABLE 26: DISTINGUISHING EFFECTS OF SHARING OR SHIELDING INFORMATION UNDER INFORMATION FUNCTIONALITY REGIMES

| | **1. If information is common competitive advantage diminishes** | **2. If information is (more) common, credibility and hence value rises** | **3. If information is common more options for joint benefits** |
|---|---|---|---|
| **Information is not shared, but can be acquired by others** | In case of public source information copying will emerge soon;<br>Private (tailored) CS may lengthen period with advantage | Even if eventual products have also competitive elements, equally accessible basic layers would help uptake;<br>Coordination problem due to reluctant single movers | Separate acquisition leads to higher aggregate acquisition cost and risks for mismatches;<br>Only relevant if coordination cost are high |
| **Information is shared already in acquisition** | Irrational strategy, unless there are other benefits in sharing | As above but may need more time to realise;<br>May also lead to shake out at CS provision side as uniformity is a benefit | Usually most beneficial, unless coordination cost high |

Inferring from the above table we distinguish a shared and non-shared information option, i.e. $\kappa_s$ and $\kappa_{ns}$

If shared information reduces the benefit potential: $0 < \kappa_s \leq 1$, while $0 > \kappa_{ns} \geq 1$.

If the benefit of shared information rises with more participants the opposite process ensues:

$0 < \kappa_s \leq 1$ for early adopters, while $0 > \kappa_s \geq 1$ for followers, and vice versa for $\kappa_{ns}$.

**Costs**

Users can also expect to make costs when acquiring and using climate services. According to the WP1 survey results use costs are often even much more significant than acquisition cost, and this does not only apply to public (free-of-charge) climate services. We distinguish fixed search cost $C_{ss}$, effort related variable search cost $V_{ss}$, unit price of the climate services $p_{cs}$, fixed cost of in-house processing $Cip$, and variable cost of in-house processing $Vip$. Fixed search cost $C_{ss}$, and effort related variable search cost $V_{ss}$ are especially relevant for smaller actors, where specialisation and outsourcing may be more difficult to realise, and hence the opportunity cost of search cost can be high.

This can be summarised in the following simple equation: $g(C) = C_{ss} + V_{ss} + p_{cs} + C_{ip} + V_{ip}$

However, for the constituent variables further assumptions can be made:

$V_{ip} = f(p_{cs}, C_{ip}, S)$ where S denotes relevant skill, and

$\frac{dV_{ip}}{dp_{cs}} < 0$ and $\frac{dV_{ip}}{dC_{ip}} \geq 0$, meaning that a higher (unit) price is often related to adding features particularly

important for the user and thereby making (variable) use cost lower, while fixed cost of climate services use can be associated with investments in facilities that make the use of climate services more effective, but also will require more labour and expertise (skill) input to exploit all these capabilities.

**The benefit-cost ratio as uptake threshold indicator**

The probability that a prospective user will actually acquire climate services is tied to a certain state of that user, indicated as A. A can assume two values, being 0 and 1. The former indicates a state of the user which makes uptake of the climate services unlikely and the latter a state in which uptake is more likely than not. The quality of the state is determined by the benefit-cost ratio (BCR) of a climate service (package), which should exceed a certain level to change the state from no use (A=0) to use (A=1).

$$A = \begin{cases} 0, & BCR < 1 + \delta \\ 1, & BCR \geq 1 + \delta \end{cases}$$

Admittedly, it is more likely that the uptake has a smoother shape, e.g. like a logistic or Gompertz curve, but owing to lack of data we use the present approach as a first approximation.

The BCR consists of a benefit function and a cost function, both of which were explained above.

$$BCR = \frac{f(B)}{g(C)} = \frac{\alpha.B.\kappa}{C_{ss}+V_{ss}+p_{cs}+C_{ip}+V_{ip}}$$

TABLE 27: PERCENTAGE LOSSES AND ABSOLUTE LOSSES IN GDP OF EU28 FOR DIFFERENT LEVELS OF GLOBAL TEMPERATURE RISE

| | loss T=1.0 | loss T=1.2 | loss T=1.35 | loss T=1.5 | loss T=2 | loss T=3 | loss T=4 | |
|---|---|---|---|---|---|---|---|---|
| *Nordhaus* | -0,24 % | -0,35 % | -0,44 % | -0,55 % | -0,97 % | -2,16 % | -3,77 % | |
| *Weitzmann* | -0,24 % | -0,35 % | -0,45 % | -0,56 % | -1,02 % | -2,96 % | -8,94 % | |
| | | | | | | | | |
| CS effectiveness | | 0,25 | (assuming high use rate due to obligations) | | | | | |
| (cf. Nurmi et al) | | | | | | | | |
| **benefits of CS in %** | -0,0006112 | -0,0008792 | -0,0011117 | -0,001371 | -0,0024269 | -0,0053952 | -0,00943 | Nordhaus |
| | -0,0006124 | -0,0008834 | -0,0011211 | -0,0013902 | -0,0025603 | -0,0073977 | -0,02235 | Weitzmann |
| | | | | | | | | |
| **benefits of CS in €** | -9,168E+09 | -1,319E+10 | -1,667E+10 | -2,056E+10 | -3,64E+10 | -8,093E+10 | -1,4E+11 | Nordhaus |
| | -9,187E+09 | -1,325E+10 | -1,682E+10 | -2,085E+10 | -3,84E+10 | -1,11E+11 | -3,4E+11 | Weitzmann |
| | | | | | | | | |
| **market value of CS** | | | | | | | | |
| if 50% of benefits | -4,584E+09 | -6,594E+09 | -8,337E+09 | -1,028E+10 | -1,82E+10 | -4,046E+10 | -7,1E+10 | Nordhaus |
| | -4,593E+09 | -6,626E+09 | -8,408E+09 | -1,043E+10 | -1,92E+10 | -5,548E+10 | -1,7E+11 | Weitzmann |
| | | | | | | | | |
| if 10% of benefits | -9,168E+08 | -1,319E+09 | -1,667E+09 | -2,056E+09 | -3,64E+09 | -8,093E+09 | -1,4E+10 | Nordhaus |
| | -9,187E+08 | -1,325E+09 | -1,682E+09 | -2,085E+09 | -3,84E+09 | -1,11E+10 | -3,4E+10 | Weitzmann |
| ***damage growth rate*** | | | | | | | | |
| Nordhaus | | *1,438* | *1,819* | *2,243* | *3,971* | | | |
| Weitzmann | | *1,442* | *1,831* | *2,270* | *4,181* | | | |

# ANNEX 5: OVERVIEW OF POLICY IMPLICATIONS

Table 28 contains the findings from chapter 6 sorted into aspects of fostering (F), uptake (U), and matching (M). It gives an overview of the findings and implications; with the page references, it also helps findings back to the more detailed presentations of the issues mentioned.[57]

**TABLE 28: OVERVIEW POLICY IMPLICATIONS REGADING THE GOVERNANCE SITUATION FOR CLIMATE SERVICE**

| Foci | Findings | Implications | Section |
|---|---|---|---|
| F, U, M | EU RDI funding (e. g. Horizon 2020, demonstrator projects) helps getting CS ideas from lab to market | Follow-up in next framework programme | 6.2.1/A/1<br>6.3.1/A/1 |
| F | GFCS instrumental for creating a narrative that justifies climatological intelligence & CS | Continued collaboration with GFCS may further stabilise CS | 6.2.1./A/2 |
| | EU as highly influential and capable factor for innovation | More emphasis on service innovation in future EU innovation policies; CS as one pilot case | |
| | RTD policy of EU Commission | More emphasis on service innovation in future EU innovation policies; CS as one pilot case | 6.3.1./A/1-3 |
| F, U | CCCA climate research network in Austria | Collaborate with and strengthen newly established working group on CS; equip CCCA "Map of Competences" with information on existing CS; allow for more sector-specific data infrastructure development | 6.3.1./B/4-6 |
| | CS discourse spreads, yet not heard everywhere | Further use idea of "CS" and thereby promote from it from EU level | |
| | EU CS Roadmap raises expectations and makes promises about utility of CS | Adapt roadmap incrementally to what works and really happens; avoid disappointment | 6.2.1/A/6 |
| | Global climate governance efforts have been useful conditions for establishing CS markets | Support existing and establishment of new global governance schemes where needed; increase their binding force, as far as acceptance & implementation doesn't suffer | 6.2.1/A/2<br>6.3.1/A/1<br>6.3.1/A/7<br>6.3.3/5c |
| | Germany, as one key national economy, no longer forerunner in climate risk disclosure policy | Help Germany, as leading EU member state, find back to (governance) innovation leadership | 6.2.1/A/7d-e<br>6.2.2/2c |
| | Climate and Energy Strategy 2018 Austria, without explicit call for climate intelligence | Link climate intelligence and CS more explicitly to the Strategy | 6.3.2/1 |
| | CS ambiguous: help against climate change & help avoiding too big an engagement against CC | Adopt, ignore, or limit CS; note that the second variant may, on the one hand, raise business acceptance, while, on the other, public challenge; it might even discredit general credibility (also for "green" businesses) | |
| U | UNEP FI helps drive uptake of CS in finance | Continued collaboration with UNEP FI may further stabilise CS | 6.2.3/1b<br>6.2.4/3<br>6.3.1/14b |
| | TCFD manages to build a network and framework that helps driving uptake of CS in finance | Continued collaboration with TCFD may further stabilise CS | 6.2.1/5b<br>6.2.2/1a<br>6.2.3/1f<br>6.2.5/3a<br>6.3.1/B/11<br>6.3.3/5a, b |
| | Legally binding CC adaptation still weak | Strengthen framework and regulation of adaptation; support standards developing from private initiatives as well as knowledge sharing | |
| | Climate risk disclosure laws or schemes | Build such frameworks for supporting uptake | 6.2.1/5b<br>6.2.2/1-2<br>6.2.3/1b<br>6.3.1/B/11<br>6.3.1/B 13<br>6.3.3/5a, d |
| | Climate responsibility often shifted to other actors | Clear distribution of responsibility (responsibility regime) | 6.2.3/1d, f |
| | CC denial | Continuous or strengthened efforts of awareness raising in key sectors or at key players; progress through getting peers to accept CC and usefulness of CS; use of influencers | 6.2.3/1e |
| | CS often outside institutional and organisational logics | Link CS & climate intelligence into mitigation, adaption, risk management, CSR, environmental, etc. by translating what function climate intelligence can have in a specific use context | 6.2.3/2 |
| | Regulation doesn't use CS terminology | Check whether "CS" could be mentioned more explicitly in certain regulation | 6.2.5/1d<br>6.2.5/2a |
| | C3S and JPI Climate as important hubs for climate research | Use JPI Climate and C3S as promoters of CS | 6.3.1/A/1d |
| | EU Climate Change Adaptation Strategy | Include CS more explicitly | 6.3.1/A/2a |
| | INSPIRE Directive | Enable new actors to claim climate data & use it for new services through open data policy | 6.3.1/A/2c<br>6.3.1/B/3d |
| | Environmental Impact Assessment (EIA) regulation as one key mechanism in urban planning | Link climate intelligence into the assessment of geophysical conditions for new project | 6.3.1/B/1 |

[57] Abbreviations used in the table: CS for climate services, CC for climate change; PPP for public-private partnerships, PPI for public-private collaboration; ESG for 'environmental, social, and governance'.

| | | | |
|---|---|---|---|
| | National urban planning and zoning regulation explicitly requires climate adaptation | Link climate intelligence into these requirements | 6.3.1/B/2<br>6.3.3/3b |
| | EU Floods Directive | Use climate intelligence to make assessment more realistic | 6.3.1/B/3 |
| | EU Urban Agenda | Include climate intelligence and services | 6.3.1/B3c |
| | Public authorities occasionally ask applicants of investment grants to include climate impacts | Make climate focus mandatory | 6.3.1/B/7 |
| | "KLAR!" initiative Austria: pilot programme (Austrian Climate and Energy Fund) funding for communities & regions to develop local adaptation strategy raise awareness for CC adaptation in their regions | Link urban ands regional planning with e.g. energy and tourism | 6.3.1/B/8 |
| | Institutions for Occupational Retirement Provision Directive II (IORP II) requires IORPs to consider ESG factors including climate risk | Take this as model for requirements to other areas | 6.3.1/B/12 |
| | Article 173, France's Energy Transition Act mandates a climate risk disclosure scheme | Take this first of its kind as model for requirements in other areas | 6.3.1/B 13 |
| | Increasing use of new technology and digitisation in tourism, finance, and other sectors | Integrate CS into existing or new products, platforms, etc. | 6.3.2/2-3 |
| U, M | Bologna as most advanced city in Italy concerning the adaptation to climate change | Learn from Bologna, share with other cities, reflect on transferability | 6.3.3./2 |
| | Urban adaptation often considered as sector-specific policy | Not wrong, but it could be wrong to consider urban contexts not as crossroads for all kinds of other areas, sectors, and policies, culminating in the rich variety of a city world | 6.3.3./2 |
| | Oasis Hub works, companies use it to bring their services to market | Support existing and establishment of new hubs where needed | 6.2.1./A/1b-c |
| | Climate-KIC as important support network for CS providers | Support existing and establishment of new KICs where needed (e.g. on local, regional level) | 6.2.1./A/1c<br>6.3.1/A/1c |
| | Design of CS products, marketing, sales and consultancy activities are underdeveloped in NHMSs | Provide resources for R&D and modernising CS business understanding in NHMS; support installation of intermediaries that pave ways to market and users | 6.2.1./B/1 |
| | High costs of climate and meteorological data for commercial purposes in some countries | Help to develop free access data policy of weather data further at least in product development phase | 6.2.1/B/2 |
| | Profit-oriented private companies often disadvantaged in funding programmes (funding rates); obstacle to CS development | Help financing new or more complicated or costly products until supply-demand-price balance fits | 6.2.1/B/3 |
| | Complicated organisational structures hinder internal and external information sharing and collaboration (cities, finance firms, tourism associations) necessary for CS uptake & matching | Allow for CS- or climate intelligence-related cross-functional collaboration on organisational level | 6.2.5/1a |
| | Conventional epistemologies, e.g. insurers' catastrophe modelling, not open to use climate intelligence | Adopt/translate CS (in)to existing epistemologies, or create spaces to think beyond existing epistemologies (for checking out) | 6.2.3/1c |
| | Decoupling of those in need for CS (operative level) and those with decisive power (management level) | Search and build (practical, mind) bridges; promote more integral management styles/frameworks | 6.2.3/1d |
| | Differences in problem understanding unavoidable | Make deciders and users aware of these differences; explain CS as useful element of a broader consultancy package already accepted from a given management | 6.2.3/2 |
| | User-friendliness lacking in CS tools etc. | Simplify, translate, explain – make CS polyglot | 6.2.5 |
| | Term "climate service" often unknown | Translate into "actors worlds" what function climate intelligence can have in a specific use context; develop alternative terminology | 6.2.5/1d<br>6.2.5/2a |
| | Helsinki's 'Green Coefficient' innovation policy for improving climate risk management | Develop project-wise tools and guidelines ate least; be ready to meet occasional demand for CS; check options for more continuous CS in this context (e.g. for other cities) | 6.3.2/4 |
| | BluAP Life+ project (Bologna) didn't reduce gap between CS providers and users | Learn lessons, develop solutions, explore implementation of solutions; eventually share experiences | 6.3.3/2 |
| | ISO standard for resilient cities indicator system | Establish standard; useful beyond CS | 6.3.2/5 |
| M | Role of NHMSs in the EU still ambiguous | Help NHMSs to position themselves in an emerging CS market | 6.2.1/A/6<br>6.3.1/A/4 |
| | PPP offers possibilities | PPP could help facilitate e.g. implementation of adaptation measures (financing) in urban planning; partnering in linking public upstream data and advise with co-creating CS tools as well as along large climate risks (insurance) | 6.2.4 |
| | PPC offers possibilities | PPC could help improve e.g. design of adaptation and effectiveness pf CS in urban planning; also, in tourism and finance joint product development, profit sharing, mutual promotion, mutual forwarding of requests would help | 6.2.4 |
| | EIT Climate-KIC and its six 'Innovation Communities' | Could be used for testing commercial CS products regarding different societal challenges | 6.3.1/A/1c |

# ANNEX 6: TERMS AND DEFINITIONS

This section offers clarification on the following key terms, also indicating how they are used in this report: market, services, climate services, governance, multi-layer perspective, and strategic intelligence.

**Governance and Policy**

A simple definition of governance, for the purposes of this report (as for Deliverable 1.3), is the establishing, maintaining, changing (Borrás/Edler 2014), and sometimes even de-aligning or terminating (Stegmaier et al. 2014) of a social order in a political-administrative-managerial view (Colebatch 2009). Governance means reacting on emerging or ongoing dynamics (Geels/Schot 2007; Rip 2012; Turnheim/Geels 2012; Stegmaier et al. ) or the active, purposeful intervention on a socio-technical system like climate observation, a policy area like the EU turn from fossil energy to decarbonisation, or a business sector like climate services. In the case of this project, discussion on governance efforts to build, and stabilise interrelations and interactions of a market (Callon 1998) for climate services can be found. Governance as active practice entails struggling about defining a problem, setting problem definitions on agendas, developing, negotiating and selecting policy alternatives, as well as the politics of preparing and taking binding decisions (Kingdon 2011). 'Governance structures' refers to hierarchy, networks (heterarchy), competition, negotiation.

Policy refers to the de facto opening up and closing down of the spectrum of alternatives, aiming at identifying and pursuing a strategy. Policy-making regards (a) public matters that require attention and how they are being defined ("problems"), (b) proposals for change and producing solutions ("policy" in the narrow sense), and (c) making choices and decisions ("politics") as a 'window of opportunity' occurs. Governance efforts may be more tentative or more definitve (Kuhlmann et al. 2019).

**Market**

In this Deliverable a broader notion of market is used than in early Deliverables, notably D1.2, where a purely economic definition was introduced. The disadvantages of following a purely economic definition of 'market' are:

- climate services activities without transactions drop out
- 'the market' would desegregate in all kinds of different (sometimes pseudo) markets, for example in relation to research, development and demonstration of CS, whereas we also want to consider the dynamics of the *entire* field, notably from an innovation point of view

Therefore in this deliverable we consider, next to transaction based climate services, also climate service development activities, as well as provision of climate services without a transaction (such as mutual support among public agencies, some forms of education and training, data repositories (with poorly distinguished use statistics)).

**Institutions and organisations**

This refers to (a) what is known by whom (cognitive dimension), (b) is valued by whom (normative dimension), and (c) how things are organised by whom (regulative dimension). 'Institutions' are stabilised patterns of practice that persist even beyond their original context of emergence, as well as rules and norms. 'Organisations' are structured attempts to pursue objectives and achieve aims through the division of labour, standardisation, centralisation or decentralisation, formalisation, and configuration, using formal and informal rules and practices; often negotiated in inner-organisational micro-politics.

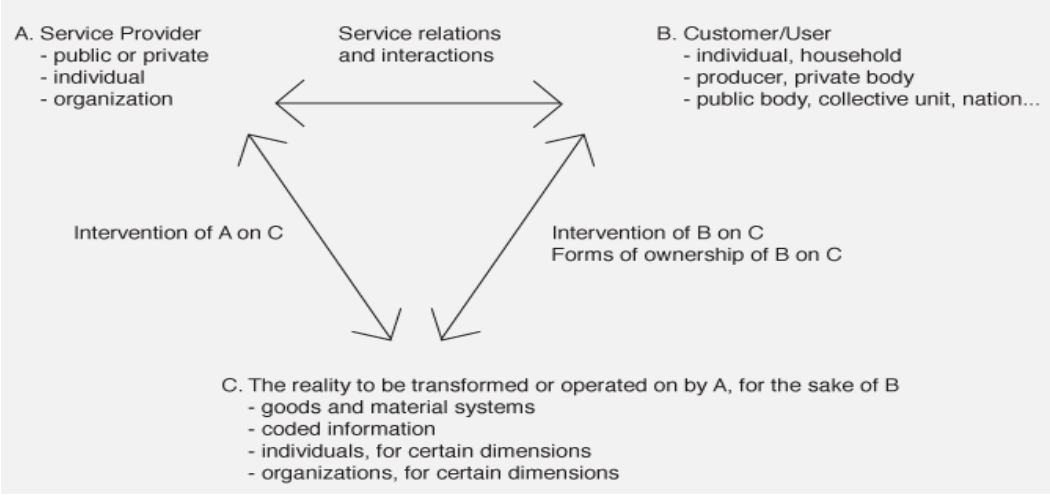
**Services and the matching of demand and supply**

Services can be offered, requested, provided, used—they are a give-and-take-relationship. When speaking of a service market, we look at a situation, in which all actors "*pursue their own interests and to this end perform economic calculations, which can be seen as an operation of optimization and/or*

*maximization;* [...] *the agents generally have divergent interests, which lead them to engage in* [...] *transactions which resolves the conflict by defining a price*" (Callon 1998: 3) or a contract.

A service activity is seen here as "*an operation intended to bring about a change of state in a reality C that is owned or used by consumer B, the change being effected by service provider A at the request of B, and in many cases in collaboration with him/her, but without leading to the production of a good that can circulate in the economy independently of medium C.*" (Gadrey 2000). See Figure 11 for a graphical representation of this.

FIGURE 11: DIAGRAM OF SERVICES[58]




The idea of service has shifted from product provision to service provision (Bruhn/Hadwich 2016). It is of utmost importance to view the climate services set-up as one in which users already have their place, instead of being taken as "external factors" to a somewhat closed system. Precisely here, we argue, success or failure of Climate Services will be determined: in our ability to view and practically embed users as integral and equal partners in the co-construction of Climate Services. In this sense, customers should hardly be considered simply as "outsiders", and if, only in terms of climate expertise, but certainly not in terms of their specific interests and usages for climate data. Service provision in a knowledge-intensive economy is a question of knowledge (Hipp/Grupp 2005): about technologies, actors, successful and failing enactments of services, markets, boundary objects (services, tools, products, problems, information, etc. that allow to travel between so far not yet connected areas and actors in the potential climate services market), and ways to mediate between those who could potentially find together on a new, optimized climate services market.

**Climate services**

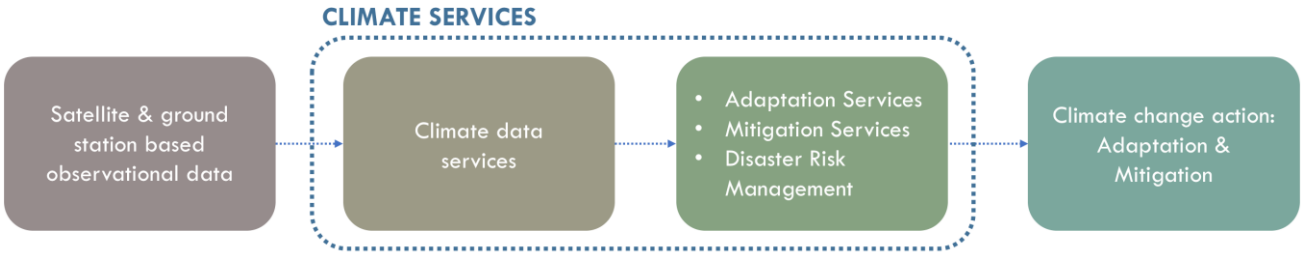
The term 'climate services' is relatively new and as such has no set definition. This report, as will the other deliverables of the EU-MACS project, will use the European Commission's definition, which describes climate services as: "*the transformation of climate-related data—together with other relevant information—into customised products such as projections, forecasts, information, trends, economic analysis, assessments (including technology assessment), counselling on best practices, development and evaluation of solutions and any other service in relation to climate that may be of use for the society at large. As such, these services include data, information and knowledge that support adaptation, mitigation and disaster risk management (DRM).*" (DG for Research and Innovation 2015)

Figure 12 visualises this definition. "In it, climate data services, referring to climate data records, projections, forecasts, and climate models, are separated from adaptation, mitigation, and disaster risk management services, which include vulnerability and risk analyses, recommendations for climate

[58] From: www.dubberly.com/models/service-triangle.html#more-1685

change action, and more refined information. The dotted line around the two boxes in the middle is meant to symbolise the fluidity of the climate services boundaries." (Hamaker et al. 2017: 12)

FIGURE 12: SIMPLIFIED CLIMATE SERVICES DIAGRAM BASED ON EUROPEAN ROADMAP FOR CLIMATE SERVICES DEFINITION[59]




**Climate services infrastructure**

We suggest a nested set of infrastructure dimensions (not layers in a hierarchical sense) could be an effective solution. Climate services needs infrastructure as the underlying foundation and framework for providing the services. But it is more than just a structure upon which services operate because infrastructure emerges in relation to organised practices (Star/Ruhleder1996). Tasks like processing or visualising data may be linked to more than just one dimension, depending on whether the building of a meaningful corpus of data is the objective (information dimension) or rather the ex-change within the climate research and services community (communication); it may even address both.

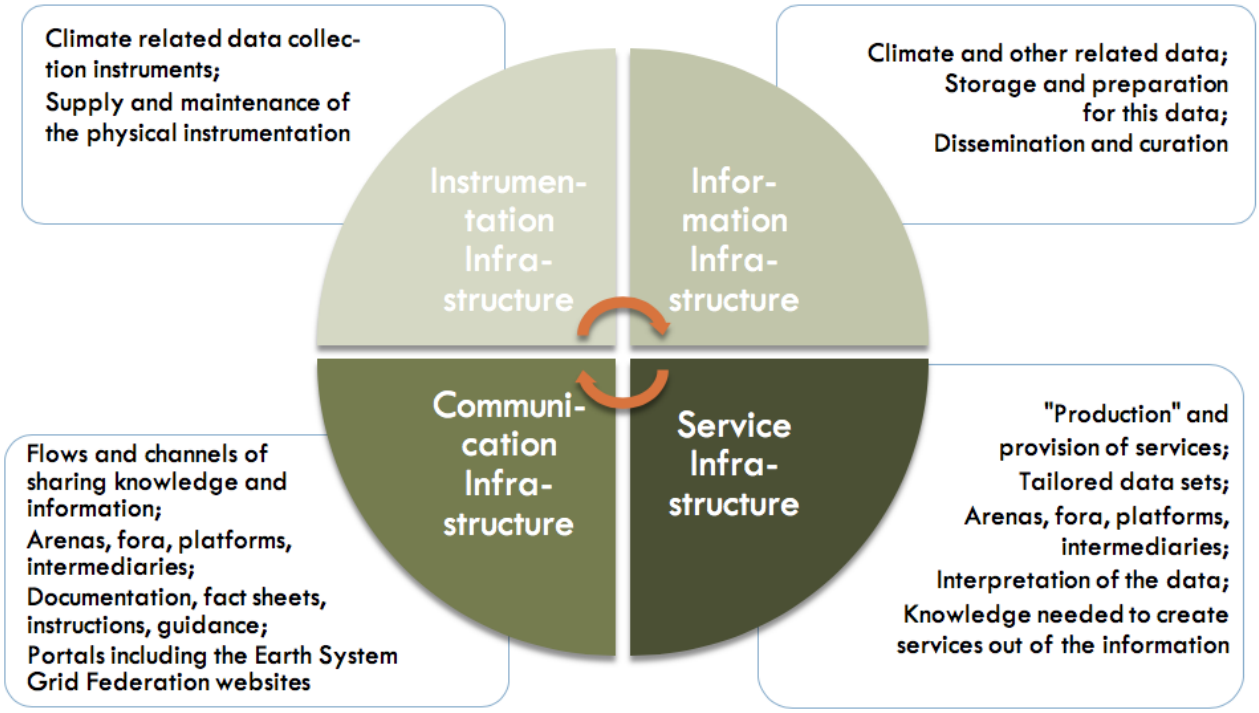
Climate services infrastructure in this understanding is comprised of four dimensions:

1. **Instrumentation Infrastructure:** this is what allows for the collection of all kinds of climate-related data; it includes (but isn't limited to) weather stations just as well as buildings, projects and partnerships, equipment such as computing facilities and satellites just as well as the practices and personnel, and the organisational set-up and institutional framework around these; e.g. national meteorological organisations are typically data-driven and providers of basic infrastructures;
2. **Information Infrastructure:** information is the data plus meaning and organisation, which is all that is needed for qualifying data for climate-related and service-related use, the structure of storage as well as its preparation (curation) for dissemination; all kinds of data become climate data of various forms, gets linked with non-climate data, and is again based also on social practices, personnel, and the organisational set-up and institutional framework around these;
3. **Communication Infrastructure:** the entire machinery of channels along which exchanges of cli-mate-related ideas and information take place, which are not considered to be services - even before any service is given, the collectors and processors of data and information need to be in meaningful exchange about data and information (share all this or first of all exchange ideas about what could be worth further sharing or using for particular purposes; conventions and other shared rules of use are negotiated by communication); the fora, platforms, arenas where personnel work in and are interested in, relating to climate data and information; including the institutional and organisational structures as well as personnel needed for the service activities;
4. **Service Infrastructure:** all the channels and practices along which the actual provision of climate services takes place; including the users (clients, customers, business partners), as they bring their sets of ide-as about why and how they would use climate services (either in mere reaction which services are offered or in an attempt of co-production); including the institutional and organisational structures as well as personnel needed for the service activities. This infrastructure is the most complex dimension as it relies on and inter-sects with the other three dimensions fundamentally.

[59] Hamaker et al. (2017: 12)

Essentially, all the dimensions interact like in a **matrix scheme.** Service relies on all other dimensions, while they exist and interact with or without the purpose of providing service to organisations outside the climate experts' own world. Figure 13 depicts these four dimensions and provides concrete examples in each category.

FIGURE 13: DIMENSIONS COMPRISING THE CLIMATE SERVICES DATA INFRASTRUCTURE[60]




### The multi-layer perspective on innovation dynamics

Since innovation journeys "do not occur in a vacuum", but rather are "part of larger processes, and are entangled with organizations, other technologies, sector dynamics, and anticipations of, and responses from, society", a the approach called 'multi-layer perspective' (MLP) can be most useful to "inquire how the context of innovation journeys influences the dynamics of innovation (as well as conversely how ongoing innovation will lead to changes in contexts, through expectations and adaptations)" (Rip 2012).

In a multi-layer perspective, the focus on the 'regime' refers to a set of rules, practices and institutions structuring the further development of a technology (and service, market, policy). The focus on 'niches' sheds light on protected spaces for vulnerable novelties that are shaped by requirements for protection and some boundary maintenance. Usually, they are carved out in selection environments, e.g., by benevolent selectors (sponsors of start-up firms) and may lead to mini-paths and a lock-in into the requirements of the protected space. Strategies to gradually un-protect and survive in the broader regime and landscape are of particular interest for this project. 'Landscape' includes attention for the whole backdrop of opportunities and constraints for technology, service, market, and policy development; here we are talking of, e.g., socio-technical infrastructure, trends in political, consumer, and economic culture.

Using an MLP perspective means putting market building in context beyond mere economic and policy aspects. Thus, most importantly also technological and material dimensions of an innovation are integrated, as well as relevant social and cultural aspects. We aim at catching a more profound picture of

[60] Cf. EU-MACS D1.4 (Stegmaier/Visscher 2017)

what could enable or hinder climate services market building than one informed "just" by the usual market logic by looking beyond market mechanism and business models.

FIGURE 14: THE THREE-LAYERED MODEL OF SOCIO-TECHNICAL CHANGE[61]

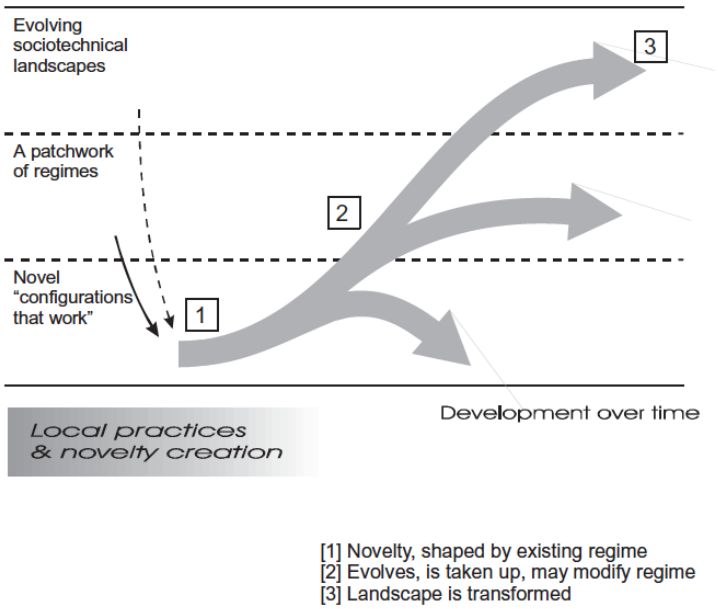



Figure 14 helps to visualise two interrelated potential dynamics of climate services that require further investigation: (1) **novelty creation** in and by local practices, as well as (2) **growth and decline** over time, leading to modifications of the regime (Rip 2012; Stegmaier et al. 2014). Whether or not landscape will be transformed, at least in the long run, is another story (3), rather difficult to tell at an early stage of a development. Empirical work needs to determine in which ways innovation is thus enabled and/or constrained by niches as protected spaces, by regimes with their social and market order (rules, governance), and by socio-technical landscapes that shape the space and topography (Sahal 1985) in terms of infrastructures, general policies and actions, culture, imaginaries, and other gradients (Rip 2012; cf. Geels/Schot 2007; Nelson/Winter 1977, 1982; Dosi 1982; Van den Ven 1999). These notions can also help to unveil the links between the static and dynamic level of analysis. For example, solutions to overcome principal-agent problems or to exploit economies of scope can either mean expansion of service volumes within current supply chains, or initiate innovations that transform supply chains.

[61] Rip (2012: 161)

TABLE 29: KEY TERMS IN THE TYPECASTING OF INNOVATION DYNAMICS IN EU-MACS

| Notion | What does this mean? |
|---|---|
| Multi-layer perspective (MLP) | "*Innovation journeys do not occur in a vacuum. They are part of larger processes, and are entangled with organizations, other technologies, sector dynamics, and anticipations of, and responses from, society.*" MLP helps to "*inquire how the context of innovation journeys influences the dynamics of innovation (as well as conversely how ongoing innovation will lead to changes in contexts, through expectations and adaptations)*" (Rip 2012) |
| Niches | Protected spaces for vulnerable novelties; carved out in selection environments and by some boundary maintenance; key problem 1: to find a niche (e.g. by help of benevolent sponsors, selectors) and enter mini-paths; problem 2: to avoid lock-in, face risk not to survive in wider world |
| Regime | Sets of rules, practices, organisations structuring the further development and leading to trajectories |
| Landscape | Shapes activities and interactions by a backdrop affordances, enablers and constraints, creation and destruction |
| Enablers | "*Focus on promise, and tend to disqualify opposition as irrational or misguided, or following own agendas*". They "*identify with a technological option and products-to-be-developed*", and "*see the world as waiting to receive this product*" (while 'the world' "*sees alternatives, can compare and select*" (Rip 2016: 15) |
| Selectors | While "*technological change is carried (pushed) by 'enactors' (promoters)*", others, "'*comparative selectors' (e.g. stakeholders in value chains, consumers, regulators) receive the new technology, but can/will be selective*" (Rip 2016: 5) |

### Strategic intelligence

In the above text, the notions of 'intelligence' and 'climate intelligence' are frequently used. They refer to the concept of 'strategic intelligence' (Carlsson/Stankiewicz 1995; Callon 1992; Johnson/Wirtz 2004; Kuhlmann et. al. 1999), defined as

> *"a set of sources of information and explorative as well as analytical (theoretical; heuristic; methodological) tools employed to produce useful insight in the actual or potential costs and effects of public or private policy and management […]. The creation of new spaces even more increases the demand for strategic intelligence based information, as the potential for new spaces has to be identified and actors have to be equipped with analytical insights." (Edler et al. 2006; cf. Kuhlmann 2002)*

The new spaces mentioned refer to the growing complexity and variation of arenas of policy-making characterised by multi-level and multi-actor negotiations of policy.