A multi-layer exploration on innovations for climate services markets

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List of Abbreviations

ACC	Acclimatise
BADC	British Atmospheric Data Centre
BASE	EU research project "Bottom-Up Climate Adaptation Strategies Towards a Sustainable Europe"
BSC	Barcelona Supercomputing Centre
C3S	Copernicus Climate Change Service
CDR	Climate Data Record
Climate KIC	Climate Knowledge and Innovation Community
CLIP	Climate Information Portal
CMCC	Centro Euro-Mediterraneo per I Cambiamenti Climatici
CMEMS	Belgian Copernicus Marine Environment Monitoring Service
CMIP5	Coupled Model Intercomparison Project, Phase 5
CO2	Carbon dioxide
CRU	University of East Anglia Climate Research Unit
CS	Climate Services
CSP	Climate Services Partnership
CTA	Constructive Technology Assessment
DG	Directorate-general
DIG	Data Infrastructure Governance
DKRZ	Deutsches Klimarechenzentrum (German Climate Computing Centre)
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EC	European Commission
ECHO	European Civil Protection and Humanitarian Aid Operations
ECMWF	European Centre for Medium Range Weather Forecast
ECSP	European Climate Services Partnership
ECV	Essential Climate Variable
EEA	European Environment Agency
EIT	European Institute of Innovation and Technology
EO	Earth Observation
EOSDIS	Earth Observing System Data and Information System
EPA	U.S. Environmental Protection Agency
ESA	European Space Agency
ESGF	Earth System Grid Federation
EU	European Union
EUPORIAS	European Provision Of Regional Impacts Assessments on Seasonal and Decadal Timescales
FAO	Food and Agriculture Organization of the United Nations
FMI	Finnish Meteorological Institute
GCOS	Global Climate Observing System
GCOS ECVs	Global Climate Observing System Essential Climate Variables
GFCS	Global Framework for Climate Services
HELIX	High-End cLimate Impacts and eXtremes
ICSU	International Council for Science
IMPRESSIONS	Impacts and risks from higher-end scenarios: Strategies for innovative solutions
IOC	UNESCO's Intergovernmental Oceanographic Commission
IPCC	Intergovernmental Panel on Climate Change
IPSL	Institute Pierre Simon Laplace
ISO	International Organization for Standardization
JPI-Climate	Joint Programming Initiative "Connecting Climate Knowledge for Europe"
KNMI	Royal Netherlands Meteorological Institute

LL/LLs	Living Lab/Living Labs
MLP	Multi-layer perspective
NAPS	National Adaptation Plans
NASA	National Aeronautics and Space Administration (USA)
NCEI	National Centers For Environmental Information (USA)
NMHS	National Meteorological and Hydrological Services
NOAA	National Oceanographic and Atmospheric Association (USA)
PIK	Potsdam Institute for Climate Impact Research
PLACARD	PLAtform for Climate Adaptation and Risk reDuction
R&D	Research and development
RAMSES	Reconciling Adaptation, Mitigation and Sustainable Development for citiES
RISES-AM	Responses to coastal climate change: Innovative Strategies for high End Scenarios -Adaptation and Mitigation-
STS	Science and Technology Studies
TopDAd	Tool-supported policy development for regional adaptation
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
WCASP	World Climate Applications and Services Programme
WMO	World Meteorological Organisation

Contents

LIST OF FIGURES

LIST OF TABLES

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 it 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.

An extremely important sub-programme in H2020 is the COPERNICUS Climate Change Service (C3S) programme, which aims to generate 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.

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.

1.2 Scope and remit of this report

This report, which is Deliverable 1.4 of the H2020-funded project EU-MACS, will explore the socio-technical and governance dynamics of current marketisation of European climate services. EU-MACS reviews the climate services (CS) market, its business models, quality assurance, and infrastructure aspects in Deliverables 1.1, 1.2 and 1.3, respectively.

This report informs the EU-MACS project about additional barriers and enablers to the climate services market stemming from the socio-economic and socio-technical dynamics linked to climate services. Relevant findings from deliverables 1.1. (section 3.6.3 on innovation dynamics), 1.2. (chapter 8, with section 8.4 on innovation in particular) and 1.3. have been considered.

1.3 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.

1.3.1 Market

In this Deliverable on innovation of climate services a richer—multidisciplinary—understanding of a market is used than the definition of 'market' based on economics presented in the glossary of terms of Deliverable 1.2. In this report a market is understood after Callon (1998: 3) i.e. as "*a coordination device in which a) the agents pursue their own interests and to this end perform economic calculations which can be seen as an operation of optimization and/or maximization; b) the agents generally have divergent interests, which lead them to engage in c) transactions which resolve the conflict by defining a price.*" This notion of market and calculative action attempts to avoid the prescription of more or less durable ideals (Durkheim 1988), but rather to (cynically) observe the reality of economic behaviour and organization.

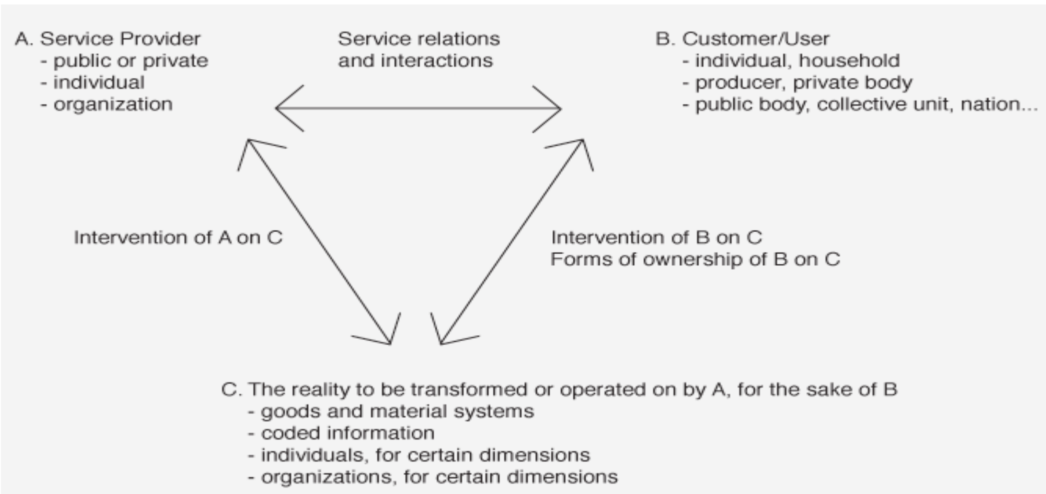
In doing so, we hope to avoid naïve projections into how a climate services market could be built or even be successful. We need to understand and use the interrelated calculations in decisions and the formulation of actions—by looking at de facto rationalities and calculative relations, not by starting from a priori assumptions about (supposedly) rationally made choices.

1.3.2 Services[1]

Services can be offered, requested, provided, used—they are a give-and-take-relationship. The quality and fit of a service depend substantially on whether there is anybody on the user side that can engage in communication about data—or do they need mere service? Are the service providers actually capable of not troubling users with details they don't need to know, if the service works well? 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 1 for a graphical representation of this.

FIGURE 1: DIAGRAM OF SERVICES



The idea of service has shifted from product provision to service provision (Bruhn/Hadwich 2016). It is of utmost importance to view the CS 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 CS

[1] For the sake of conceptual coherence, this section follows nearly completely the wording as already used in Deliverable 1.3 and in the EU-MACS glossary (author: P. Stegmaier).

market), and ways to mediate between those who could potentially find together on a new, optimized CS market.

1.3.3 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 2: SIMPLIFIED CLIMATE SERVICES DIAGRAM BASED ON EUROPEAN ROADMAP FOR CLIMATE SERVICES DEFINITION (HAMAKER ET AL. 2017: 12)

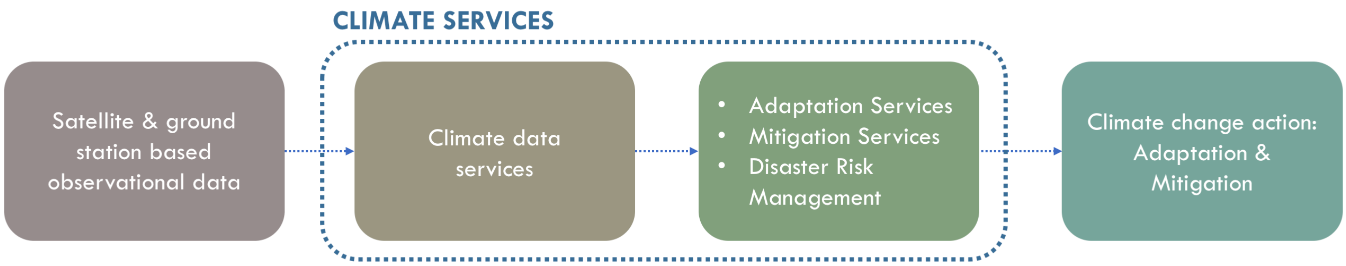


Figure 2 visualises this definition. "*In it, climate data services, referring to climate data records, projections, forecasts, and climate models, are separated from adaptation, mitigation, and disaster risk management services, which include vulnerability and risk analyses, recommendations for climate change action, and more refined information. The dotted line around the two boxes in the middle is meant to symbolise the fluidity of the CS boundaries.*" (Hamaker et al. 2017: 12)

1.3.4 Climate services infrastructure[2]

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:

a) **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] Section 1.3.4, due to its overarching relevance, has been used again from deliverable 1.3 (Hamaker et al. 2017: 57-58) with slight modifications. It was originally written by Peter Stegmaier.

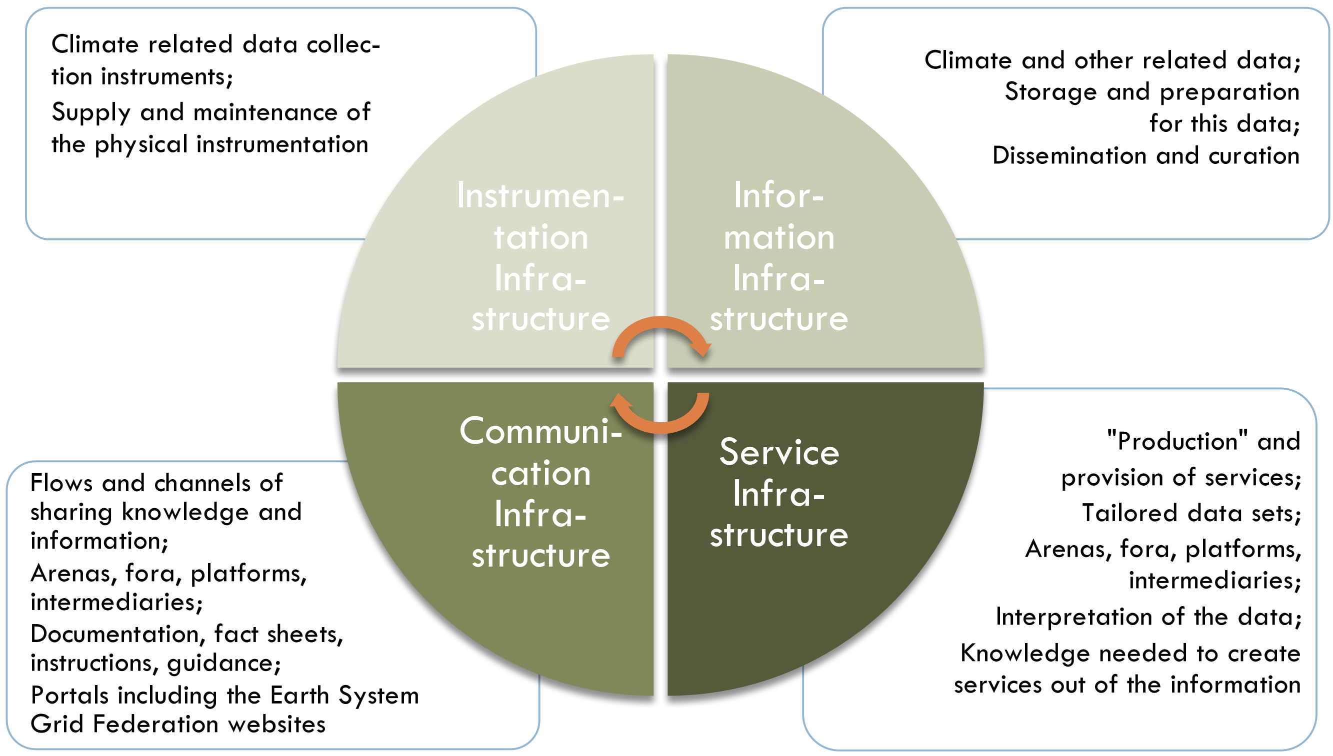
b) **Information Infrastructure:** information is the data plus meaning and organisation, which is all that is needed for qualifying data for climate-related and service-related use, the structure of storage as well as its preparation (curation) for dissemination; all kinds of data become climate data 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;

c) **Communication Infrastructure:** the entire machinery of channels along which exchanges of climate-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;

d) **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.

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 3 depicts these four dimensions and provides concrete examples in each category.

FIGURE 3: DIMENSIONS COMPRISING THE CLIMATE SERVICES DATA INFRASTRUCTURE



1.3.4 Governance

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) 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).

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

1.3.6 Strategic intelligence

In the following 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. 2009; 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.

2. METHODOLOGY

This deliverable has a double intermediary task. On the content level, it collects findings from Deliverables 1.1, 1.2 and 1.3, synthetises them, and it suggests additional multi-layer governance and innovation dynamics perspectives to the stakeholder interactions in work packages 2-4. For this purpose it also collects findings about how the first stakeholder interactions worked out, and documents the overall approach interactional formats used in this project. From first experiences, suggestions for further workshops are derived. As basic orientation for looking into climate services niche innovation and regime/landscape contexts we took the main barriers types, as suggested in Cortekar et al. (2017: 34).

Stakeholder interactions were developed iteratively in the course the empirical assessment of the focal sectors for the work packages 2-4 until October 2017, starting with a pilot workshop in Helsinki for work package 4. Therefore, this deliverable has also developed a dual life: on the one hand, it summarises what after most of the preparations for stakeholder interaction has been figured out as appropriate interactional formats; on the other hand, its authors were constantly involved in setting up all the workshop formats, and thus also had ample opportunities to feed their findings into the workshop preparations even before this deliverable was ready, and at the same time to learn from experience and include findings from workshops and sector assessment into the multi-layer analysis of conditions for climate services market building.

In brief, the making of this deliverable was an interactive endeavour, closely connected to the main tasks of the EU-MACS project itself. We are convinced this served the purpose of the project and this deliverable substantially more than a very early completion. The multi-layer dynamics analysis thus became far more specific and targeted, and the suite of interactional formats far more realistic and doable.

Besides input from the prior deliverables, the analysis is built heavily on a scanning of the horizons of directly and indirectly relevant issues around climate services market building through extensive literature study. This went beyond the narrow scope of existing climate services scholarship, precisely with the declared aim of raising awareness for broader developments and potential links, for “unusual suspects” (actors, events, processes) and critical new developments (such as the possible withdrawal of the Trump administration from the Paris agreement and elections in key countries of the EU, such as the Netherlands, France, Germany, Austria, with consequences for climate-related policies).

Limitations of this report consist in its preliminary, or better: explorative character of taking stock for what during the first half of the project has been found. Later deliverables will extend on issues mentioned in this report. This deliverable is not meant as an exhaustive stock-taking, but rather as explorative collection of crucial issues identified in the expert interviews and from literature.

3. FINDINGS

3.1 Introduction: Governance of the climate services market in Europe

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. 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.

Governance addresses the establishing, maintaining, changing, and occasionally de-aligning of social and political order, based on the interaction of all kinds of actors (also beyond the political system as such). Applied to climate services and their markets—the main focus of the EU-MACS project—this means with the governance perspective we focus on patterns of policy, regulation, and instruments aiming at fostering climate services in the context of (more or less specific) institutional arrangements, routines and procedures. Major dimensions of governance are, first, the **Framework Governance** that the EU establishes as initiatives to promote various issues, among them also climate services, second, the **EU Climate Services Governance** more specifically attempting to develop the European climate services landscape further, as well as within the EU climate services subareas as 'climate services quality assurance', which this project reviews in Deliverable 1.2, and 'climate services data governance', addressed in Deliverable 1.3. Taken together, these dimensions can be seen as a nested bundle of governance actions with interrelations that affect all three dimensions. Briefly, we address the first two dimensions in order to set the stage, before we refer to the main issue of this deliverable: the multi-layer view on climate services market development. The **multi-level perspective** on climate service governance will allow us to put developments both into more detailed as well as into broader context with respect to the EU and beyond.

3.1.1 Framework Governance

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 2017e), the specific actions for climate services seem rather disentangled from general environmental concerns and tend to rather focus on market building.[3] From the EU Com-

[3] 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.

mission 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 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 2017b). 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 2017c). The EU agenda for climate services can thus be seen as one form of climate change mitigation and adaption.

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 2017; cf. European Commission 2014a). The instrumental rationality behind this as described in official discourse:

> “*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 2017)

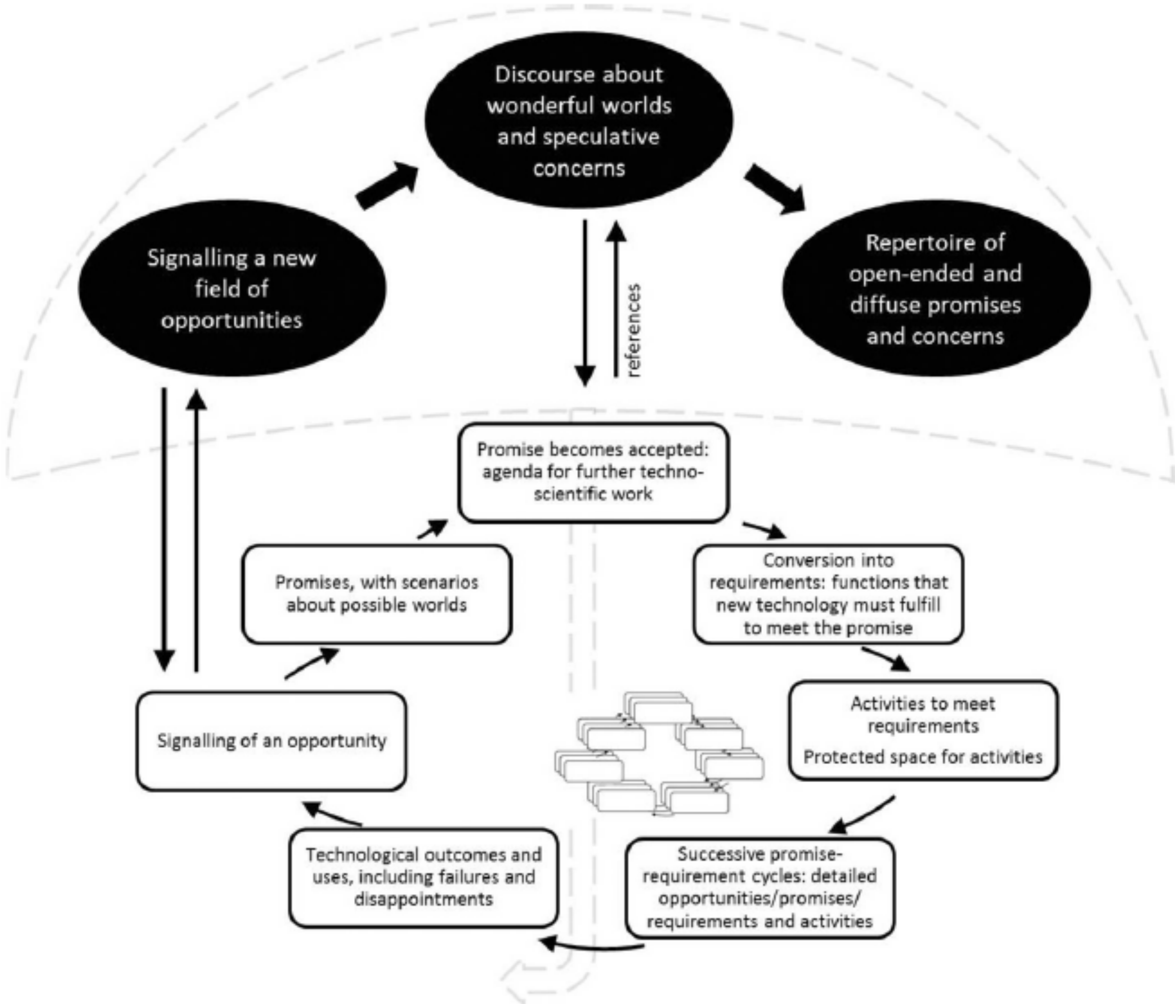
In other words, rising to the climate challenges, and while doing so creating economic value (European Commission 2017). There is a certain amount of trust in the fact that if sound climate system science and enormous amounts of data are available, the problem of serviceability and applicability of the 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 knowledge on climate developments can be kept (Harjanne 2017).

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 the US government), has become a commodity, a trade good: in Europe, many met agencies sell their data (while 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 – for profit, and with the aim of taking care that the consultants clients’ (e.g. in finance and reinsurance, food production, transport, and tourism) would neither lose profit nor face bankruptcy by neglecting climate change and weather variability impact on their businesses.

3.1.2 European Climate Services Governance (I): a case of anticipatory coordination

At closer inspection, we can see the EU climate services policy as an effort of coordinating an innovation journey in an anticipatory manner (cf. figure 4). Impulses are set by an entire bundle of activities and stimuli (slide EU project officer). 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. In general terms (as we learn from Deliverables 1.1 to 1.3), the most important ones seem to be a set of functioning business models for and across sectors, a good balance between users' demands and providers' services, a (far enough) unified data infrastructure, as well as sound regime for assuring quality of data and services.

FIGURE 4: DUAL DYNAMICS OF PROMISES (PARANDRIAN ET AL. 2012: 568)



3.1.3 European Climate Services Governance (II): on some assumptions regarding service relationships

The GFCS had the vision "*to turn scientific information from climate monitoring, research and modelling into operationally available information and services that would help society to better cope with climate variability and change*" (European Commission 2014). Such **promise** is built on, or nurtures the expectation that after prior, less- successful, efforts now the time would be ripe for a climate services market.

However, what initially has been missing in EU climate services-related documents is **explicit demand** uttered by potential or actual climate services users. On the contrary, characteristic of the EU policy view on climate services is still—since there have indeed been wake-up calls requesting to make the user more central "*with an uncompromising focus on the users*" (NASA et al. 2016: 36; Street 2016; Meadow et al. 2016: 13; Alexander et al. 2016a), perhaps even by help of participatory processes (Alexander 2016b: 49)—to start from the side of the climate system sciences and the climate services providers to look across the entire supply and value chains, always with an eye on users' actual demand articulation. At least, this is the natural standpoint of those who have in fact initiated the promotion of climate services; at worst, it is a normative illusion—just because one wishes the advent and growth of climate services, there is no guarantee that this will happen.

To understand the governance of climate services it is crucial to grasp the hidden or overt **assumptions** that frame what is thought to be 'climate services'. Let's have a look at what is presented as the "*essence of climate services*" (Alexander 2016b: 49) in the Advisory Group report of 2014 on Horizon 2020 climate action (see Figure 5 below)—as an exercise in close reading of prominent framings of climate services in key policy documents, serving us here a material evidence for policy discourse on climate services:

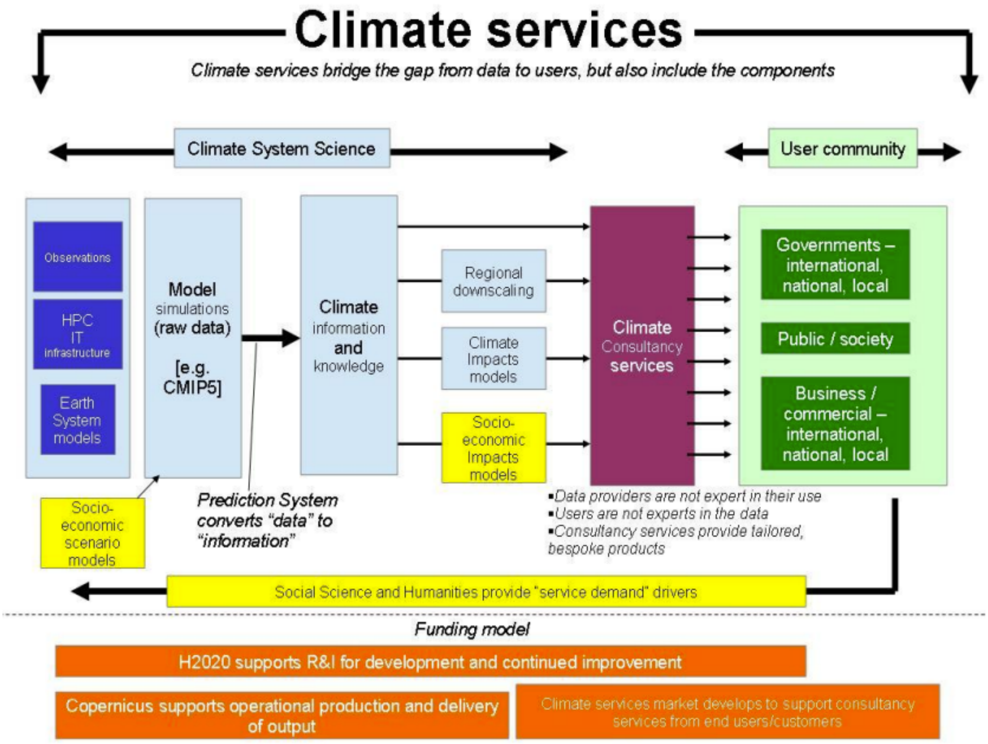
a) System structure and supply chain processes are depicted with great detail, whereas the **user dimension** is kept rather general. The question is: which users with which motives would actually consider using climate data and climate services for which purposes?

b) The **funding scheme** modelled here moves within the range of now and the year 2020 only, for Horizon 2020 is one of the key funding sources. In addition, the diagram assumes the existence and further development of a climate services market that contributes to funding as well. —One question here is which users would or could pay why for which kind of "climate intelligence", while the quality (sort and resolution) of the climate data for services is heavily depending on the amount money users would be willing to pay; or put differently, which costs would be acceptable for which users under which circumstances? Another set of questions is: how sustainable is this funding model, how strong and reliable is the contribution of the market, and what will happen when Horizon 2020 ceases to contribute?

c) The **infrastructure** whereupon this entire machinery of climate services (cf. Hamaker et al. 2017) would function is not made explicit, it is in the subtext only, although it is the other material and social foundation besides the climate system sciences (as knowledge basis) and the market (as one of the financial bases of the model). Public policy, asserting another substantial basis for the entire climate services idea—in funding all kinds of projects, programmes and other formats, including infrastructure and most of the agencies that gather the climate data—is also kept in the dark. The question here is: Could the role of the public hand/EU be underestimated, or is it taken for granted that there will always be a substantial public contribution to these kinds of services (at least until we can imagine all the meteorological and scientific tasks will increasingly be delivered by non-public agencies, as it is the case nowadays for the privatisation of e.g. space travel, another heavily infrastructure depending field and related to earth observation)?

d) One should add that the "user community" suggested by this diagram in reality is a very heterogeneous set of more or less interested (potential or existing) business partners for climate services, or users that would never pay for climate services as provided right now (Street 2016: 3). Basically, there is **no such community**, and the single actors and various communities differ greatly in how they would behave as "selectors" —as those selecting new options of using climate services, such as regulators, policy-makers, clients, users/re-users, interest groups, etc. They all have different criteria of relevancy and preference, entry points, definitions of problems/questions and conceivable solutions/answers, resources and the willingness to pay (for services) and know (what one needs to know when working with provided climate intelligence). To speak of a "user community" appears to be a misleading simplification. Another group should not be forgotten: the non-users—what disinterests them and what could mobilise their interest in climate services (Alexander 2016b).

FIGURE 5: SCHEMATIC REPRESENTATION OF THE "ESSENCE OF CLIMATE SERVICES", AS FROM THE 2014 ADVISORY GROUP REPORT'S POINT OF VIEW (EUROPEAN COMMISSION 2014B: 7)

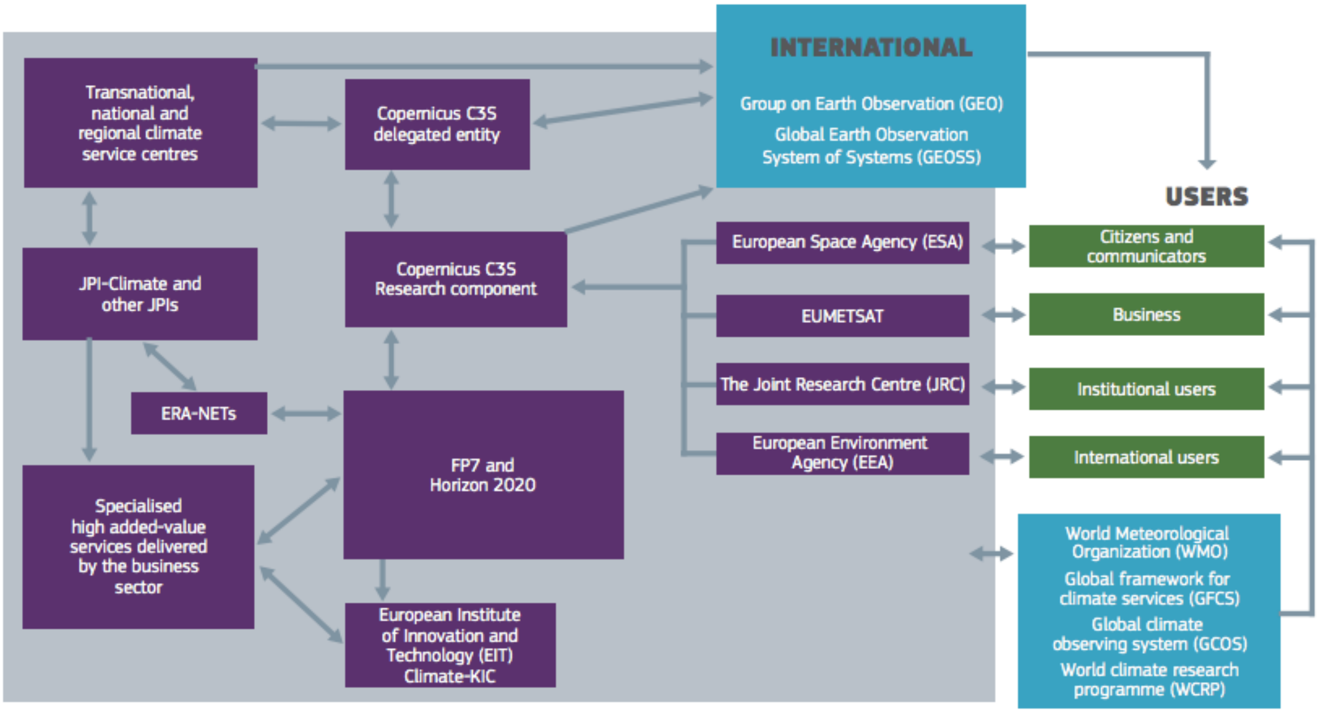


In order to augment the picture of **EU climate services representation**, another diagram (Figure 6 below) calls for our attention. Only two aspects will be highlighted here:

a) The grey box comprises all the European projects linked to climate services (and other, more or less related issues, of course, such as ecosystem observation and many more). In contrast to this, there are two blue boxes indicating links to worldwide initiatives. This presumes the EU side is like the "national" part and the non-EU links refer to international cooperation. The **EU is taken as a nation state**, no longer as a supranational or international arrangement. —As desirable as it might be for some, the question is how realistic this picture actually is—do we really have such an integrated and perhaps even harmonised European zone of coordination and collaboration at our disposal? There are strong hints that this is not the case: out there, within Europe, there still is a maze of data conventions, standards, practices, and formats for climate data (cf. Hamaker 2017), often presented in other languages than English, thereby offering further differentiation and fractioning of the market.

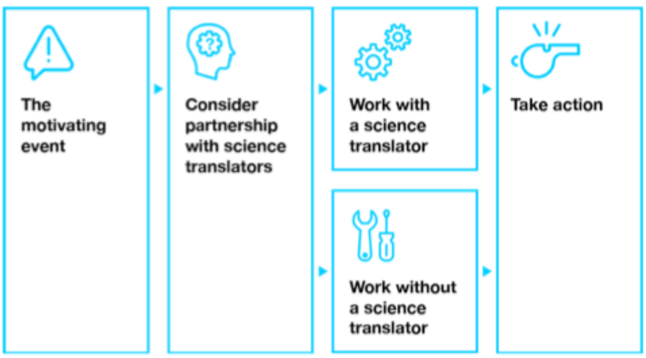
b) The picture can yet be read for another message: there are **many things going on** in the EU related to climate services. Questions arise, first, whether this is a very **structured** governance process of supporting climate services, or rather a combination of following the slogan "the more, the better" or of the principle of indiscriminate, all-round distribution (scattergun approach), of trial-and-error (tentative governance), and of flying blind (no clue what works), as well as, second, how **pervasive** is this multiplicity of efforts (or does it rather lead to the perpetuation of non-harmonised conventions for climate data management)? The overall approach here, however, seems to tackle different issues and goals with different approaches, and hope that the greater whole may profit from that vast body of infrastructure and mix of opportunities that to some extent can even be (seen as) coordinated.

FIGURE 6: SCHEMATIC REPRESENTATION OF RELATIONSHIPS WITHIN THE EUROPEAN CLIMATE SERVICES LANDSCAPE, AS FROM THE EUROPEAN ROADMAP FOR CLIMATE SERVICES POINT OF VIEW (DG FOR RESEARCH AND INNOVATION 2015)



Finally, the following diagram (Figure 7 below), which the authors called "journey map", offers a definitely user-provider-oriented viewpoint on the **order of the service interaction** (NASA et al. 2016: 9)—thereby complementing the diagrams discussed before. The interaction order in a nutshell: from a motivating event users may consider partnerships with "science translators" (agents that serve as intermediaries between hard core data expertise, on the one hand, and potential for applied use on the other hand) who offer ideas about how climate data or services might be useful; then the users may either continue their journey of getting increasingly aware of climate issues that count for them with or without the help of a "science translator"; this leads then to some action (or in-action, if the usefulness of climate data or services couldn't be proven). Still to investigate is what comes now: the ways in which users use climate services and data. We do not have any reason to believe there could be much variation to the US case in our EU case.

FIGURE 7: SCHEMATIC REPRESENTATION OF THE CLIMATE SERVICE INTERACTION, AS FROM THE POINT OF VIEW (NASA ET AL. 2016: 9)



Services, however, can also be provided **inside the community of climate experts**: when raw data provider interact with intermediaries, or when intermediaries among themselves dealing with various kinds of climate data that are not at every organisation' disposal or that not every organisation has the capacities for further processing. So, service is both oriented toward "inside" community as well as "outside" customers, and "translators" may be useful on both sides.

Striking in this diagram (Figure 7) is the reduction of climate services to the actual interaction. From a system point of view, this could be perceived as too simplistic. However, it could also be seen as call for **pragmatic focus**—whatever the broader system is, climate services may come down to such basic interaction, and the actual challenge is to implement such core focus into the service system no matter on which level the interaction takes place and where translation is required.

In summary, section 3.1 discussed the assumption that climate services contribute to greening of industry/society and economic growth. The wide-spread **use of linear models of innovation** (science—translator/science based climate services—market) has been commented and criticised, especially for the black-boxing view on user communities. Need for empirical insights in assumptions, non-linear dynamics of multi-level innovation journeys, articulation of needs of potential users has been articulated.

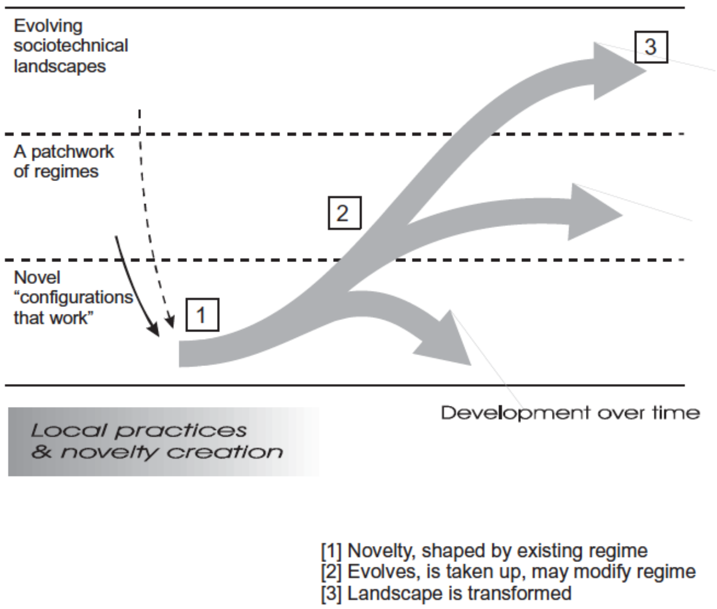
3.2 An explorative multi-layer perspective on climate services market dynamics and services niche management

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).

For the assessment of possible evolutions in climate services in terms of **innovation dynamics** the project employs a co-productionist, institutional, and multi-layered approach (Rip 2012). 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 8 (below) 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.

FIGURE 8: THE THREE-LAYERED MODEL OF SOCIO-TECHNICAL CHANGE, AS SUGGESTED BY RIP (2012: 161)



In the following analysis, we describe the **situation of the climate services** starting from their niche existence, then looking into the incumbent regimes that the climate services target with their innovations, and which in turn in this case also target the niches as test-beds for innovations that are perceived as politically desirable on regime level. Thirdly, we will assess some relevant overarching developments already have or could have (under certain conditions) impact on climate services. Finally, in a brief outlook we will tackle some rather "wicked" problems related to the advancement of climate services.

TABLE 1: 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)

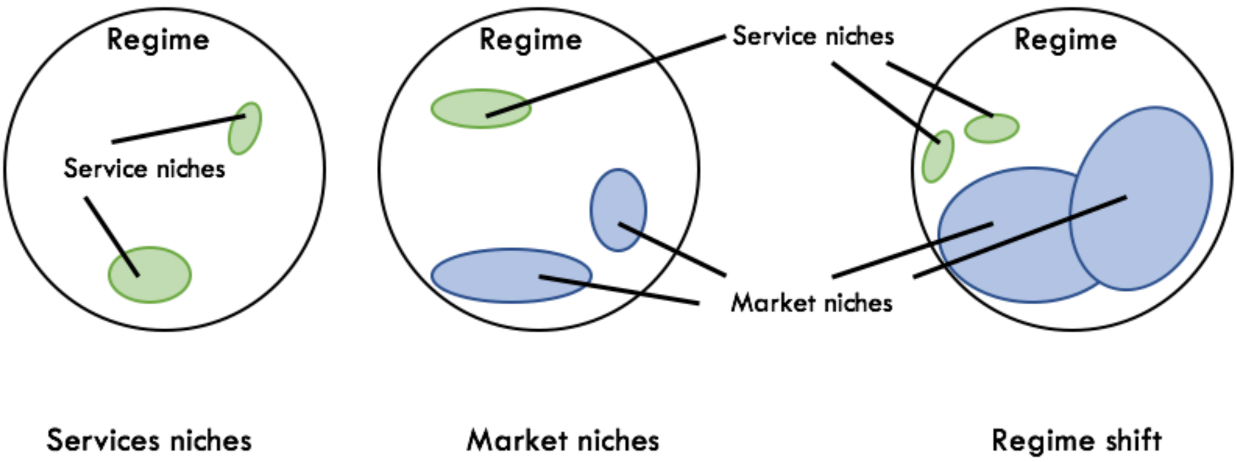
The following reflections are to some extent expressed **in the subjunctive,** as this report cannot yet build on the results of empirical stakeholder interaction. It has a heuristic function of offering a spectrum of aspects and conditions under which these aspects may lead to relevant developments in creating a climate services and a market for them. They also are intended to lead to scenarios that can inspire discussion with stakeholders. It is an exercise in thinking out of the box aiming at inspiration for the sectoral studies (WPs 2-4) to consider aspects and developments of (potential) direct and indirect influence on the emergence and stabilisation of climate services.

3.2.1 Climate services as niche phenomenon in its innovation context

Climate services are still a **niche phenomenon** (cf. Cortekar et al. 2017: 49). Although, there are examples of climate services providers that have been in the business for quite some time (DG Research and Innovation 2015), they have carved out a niche for themselves and are still exploiting a market niche. Still being in a very premature phase, the commercial climate services market underwent significant growth in recent years (Poessinouw 2016).

A. Niches: Service innovations tend not to be utterly smooth in the beginning. There is still a lot of experimentation with user practices, business models, products, regulatory structures, infrastructure and technology, which makes it hard for them to compete on the market against established services (Schot/Geels 2008: 538). The specific market itself might even be not yet fully developed (see Figure 9)—or very small and already dominated by the few services that were able to establish themselves in their niche. Newcomers will thus hardly gain a share, but rather have to find their own niches: "*for many innovations, especially with sustainability promise, market niches and user demands are not readily available because the innovations are not minor variations from the prevailing […] but differ radically from them*" (ibid.: 539). Moreover, clever niche management will require to link niches at some point.

FIGURE 9: FROM NICHE DYNAMICS TO REGIME SHIFT (ADAPTED FROM SCHOT/GEELS 2008: 540)



Niches here are understood as **protected spaces for vulnerable novelties** (Rip 2012: 162). They are typically carved out in selection environments and by some boundary maintenance. One key problem is to find a niche, e.g. by help of benevolent sponsors or selectors, and to enter mini-paths. Another chief problem is to avoid lock-in, which could lead to the risk not to survive in the wider world. Further research and conceptualisation on multi-level transition pathways indicates how important "*the timing of landscape pressure on regimes with regard to then state of niche-development*" is (Geels/Schot 2010: 54):

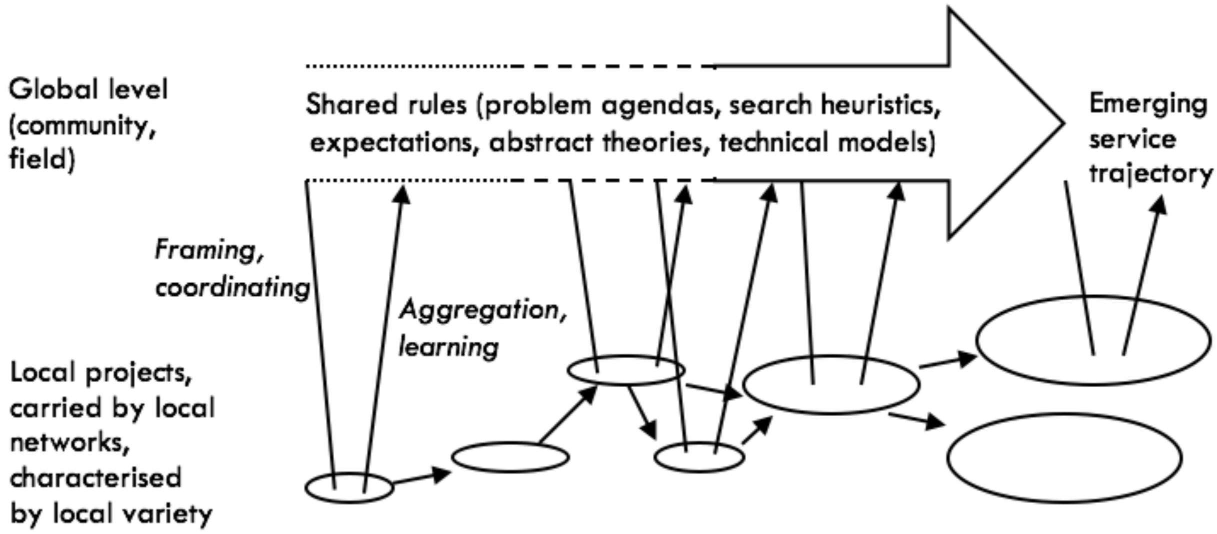
> "*If landscape pressure occurs at a time when niche-innovations are not yet fully developed, the transition path will be different from when they are in fact fully developed. Whether or not niche-developments are fully developed is not entirely an objective matter. Niche-actors may have somewhat different perceptions that regime-actors. Nevertheless, we propose the following proxies as reasonable indicators for the stabilization of viable niche-developments that are ready to break through more widely: a) learning processes have stabilized in a dominant design; b) powerful actors have joined the support network; c) price/performance improvements have improved and there are strong expectations of further improvement (e.g. learning curves); d) the innovation is used in market niches, which cumulatively amount to more than 5% market share. Novelty is always present, but this may be 'hidden novelty' (a term from Arie Rip"), carried by relative outsiders, fringe actors or enthusiasts invisible to the outside world. Niche-innovations in an embryonic state do not pose a great to the regime. At some*

> *point, external landscape developments may create pressure on the regime and create windows of opportunity for transition. But if niche-innovations are not fully developed, they cannot take advantage of this window, which may subsequently close.*" (ibid: 54-55)

The key question here is **which processes foster successful niche development** (cf. Schot/Geels 2008: 538). Niche internal processes, from a niche management point of view (Schot/Geels 2008), typically develop along the lines of the 'articulation of expectations and visions', 'social network building', and 'learning processes'.

Niche development is often **evolving at two levels in parallel** (Figure 10): "*the level of projects in local niche practices and the global niche level. Sequences of local projects may gradually add up to an emerging field (niche) at the global level:* […] *developments may start with one or a few projects, carried out by local networks of actors, who are interested in innovations for idiosyncratic or local reasons*" (Schot/Geels 2008: 543).

FIGURE 10: EMERGING SERVICE TRAJECTORY VARRIED OUT BY LOCAL PROJECTS (ADAPTED FROM SCHOT/GEELS 2008: 544)



Rules that guide local projects are still unstable and diffuse: protected spaces (test beds). Once local projects are compared, aggregated and learning processes occur, the rules stabilise and become more articulated, shared rules (e.g. dominant business models), thus accompanying the movement from service niche to market niche. The **learning process** occurs in a sequence of projects. Service supporting technology and infrastructure may play a crucial role.

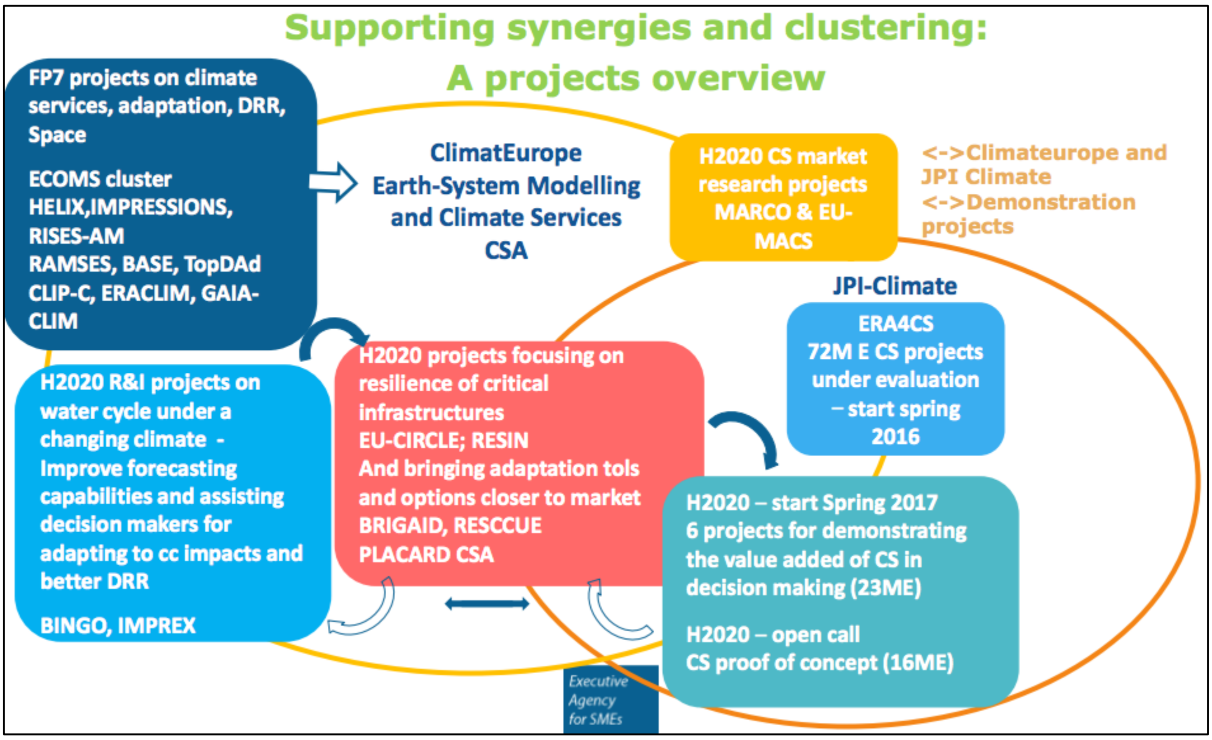
Let's consider some key aspects of **how climate services develop in their niches** and try to embark on journeys to new shores, first, by providing some general observations about **niche dynamics** (1-2), second, with respect to **niche internal processes** of more local character (3-4), and, third, some more **global niche-level developments** contributing to a field of climate services (5-7):

1) **Fragmentation and ambivalence:** Deliverable 1.1 observes that "*the climate market is still very fragmented and real mini-pathways or lock-in effects are not yet visible*" (Cortekar et al. 2017: 49). The entire spectrum of providers, purveyors and users is highly fragmented and ambivalent. The SECTEUR survey lists 18 sectors, which show interest in climate services and for which Essential Climate Variables (ECVs) and Climate Impact Indicators (CIIs) have been identified in order to provide suitable climate intelligence (Alexander 2016b: 53-56; cf. Cortekar et al. 2017: 24-27). JPI Climate (2017) and in interviews further four more are mentioned. There could yet be more, and there could be cross-sectoral overlaps. The way (global) climate governance has been seen as fragmented (van Asselt/Zelli 2014)—and is even more so with all the missed CO2 reduction targets in many contract countries, as well as after the Trump administration in the U.S.A. as a lead player announced to exit

from the Paris Agreement—could lead us to the conclusion that climate policy (with climate services as one instrument and driver of it) is still a somewhat insufficiently developed area, not yet transcended from niche to regime level. Whether or not this radical view is shared, climate services have not so many safe anchor points in such a fragmented and politically ambivalent climate governance regime.

2) **Understanding the demands (mutually):** Fragmentation and ambivalence offer the chance to get to the bottom of what is needed from climate services, for specific effort is necessary to win clarity. In order to establish functioning cooperation and infrastructure at least the providers and conveyors of climate services would have to learn a lot more on user demands and circumstance of their activities—institutional and organizational affordances and constraints, routines, capabilities, and competences, not the least also with respect to the technological and human resources infrastructure as "docking areas" for climate service interactions (Cortekar et al. 2017: 49; Hamaker et al. 2017). So far, purveyors and providers have only limited knowledge about the "true" user demands while users seem to be lacking of orientation about what's there and what for them could potentially be useful in climate services. The chance of being in a niche situation is (a) that those engaged in climate services can be very **close to their "customers"** and thereby get a good sense of what is at stake for them, and (b) the climate services innovators could also **help finding and defining demands** with potential users, provided both sides enter constructive conversation about how climate intelligence could do good in specific contexts of use.

FIGURE 11: AN EU CLIMATE SERVICES MARKET BUILDING POLICY IMPLEMENTATION MAP (PIETROSANTI 2016: 7)



3) **EU niche governance I (promoting useful details):** Compared with the Grand Challenges and with the big portfolios in the Directorate generals of the European Commission, the 'EU Research in Innovation Roadmap for Climate Services' (DG Research and Innovation 2015) is a small detail: a very specific area of activity and aspiration to become more, greater, and more common, but still a tiny aspect of various different policy areas, such as climate change, energy, CO2 reduction, further development of the EU market, integrating more and more parts of enormous the wealth of scientific and technological knowledge with issues of public/societal interest in such a way that the knowledge has an "impact" (articulation of expectations and visions). This EU niche governance is about harvesting available knowledge for public (political, administrative) and private (business, social) purposes (Pietrosanti 2016). EU R&I policy identifies single hot spots, which can profit from increased, substantial attention, and which in turn can let economy in particular and society in general profit

as well. These hot spots are not yet fully developed, not yet mainstream, otherwise they wouldn't need to be supported: not yet matured niche innovations.

4) **EU niche governance II (promoting novel variety, hoping for new synergies):** There is whole array of "*EC flagship initiatives on Climate Services*" (Pietrosanti 2016: 3). The umbrella initiative as such will be discussed below as part of the incumbent regime. Here, at this point, it is important to assess the pattern that can be seen in this exemplary set of "*actors, projects, initiatives*" (Pietrosanti 2016: 6): mentioned are e.g. Copernicus, Climate Change Service, Climateeurope, EIT Climate-KIC, the European Environment Agency, the European Space Agency, the Global Framework for Climate Services (GFCS), JPI Climate, PLACARD interchange, Regional and national Climate Services centers, and the Working Group for the CS Roadmap implementation (articulation of expectations and visions). The latter is some sort of coordination instrument for the CS Roadmap implementation. The spectrum indicates an effort to establish a critical amount of attention, initiative, and "*actionable*" knowledge in a variety of directions: public, non-governmental and private bodies, national, European and global, meteorological input next to agencies contributing environmental and space science and technology, research and application (network building). Pietrosanti (2016) has further provided a map indicating which variety is being promoted and along which links synergies are expected (see Figure 11). This means using many available instruments in a sort of triangulation approach, hoping for economies of scale: doing many bigger or smaller things for climate services and help them to link up, so that they may indeed get connected, established, and flourish:

    a) **Establishing climate impact claims:** In EU Framework Programme 7, several projects had been funded in the areas of climate services, adaptation, disaster risk reduction (DRR; one area of attention of the DG for European Civil Protection and Humanitarian Aid Operations (ECHO)), and space (a sector within DG for Internal Market, Industry, Entrepreneurship and SMEs). Focus of these projects (HELIX, IMPRESSIONS, RISES-AM, RAMSES, ToPDAd, ECONADAPT) was grosso modo to establish a foundation for the claim that climate change has impact on various ecological and economic areas in the EU (network building; learning).

    b) **Establishing basic decision-making instruments:** In FP7 another strategic thrust aimed at providing basic information on instruments expected to be useful for EU climate policy implementation in general and climate services development in particular (BASE with respect to strategic policy-making and assessment under uncertainty; ToPDAd with respect to socio-economic assessment for regional, national, and EU-level adaptation strategies). A first platform for climate information provision was established (CLIPC), as well as a project for the reanalysis of all kinds of relevant data from a global climate system point of view "*to better serve climate applications*"[4] and another one with the task to set up "*a 'Virtual Observatory' facility of co-locations and their uncertainties and a report on gaps in capabilities or understanding, which shall be used to inform subsequent Horizon 2020 activities*"[5] (network building; learning).

    c) **Establishing climate market claims:** With direct focus on climate services, there are three specific project clusters, starting with the Framework Programme 8/Horizon 2020 climate services market research projects (MARCO, EU-MACS), later supplemented by 26 projects across various sectors with a budget of 63 Mio Euro (for the period from summer 2017 until 2020) under the ERA4CS 2016 call, coordinated by JPI Climate, with the declared aim "*to enhance user adoption of and satisfaction with Climate Services (incl. adaptation services)*" and of improving the quality of climate services[6]. Shortly after the market research projects, also a series of projects aiming to show "*the value added of CS in decision making*" (Pietrosanti 2016: 7) worth 23 Mio Euro as well as a climate services "proof of concept" worth 16 Mio Euro have been launched[7] (articulation of expectations and visions).

[4] www.era-clim.eu/ERA-CLIM2/ [29 September 2017]
[5] www.gaia-clim.eu/ [29 September 2017]
[6] www.jpi-climate.eu/ERA4CS.activities/jointcallprojects [21 September 2017]
[7] http://cordis.europa.eu/programme/rcn/701967_en.html [29 September 2017]

d) Similar to the global climate service partnership GCSP the **European Climate Services Partnership (ECSP)** represents the ongoing effort European effort to build a climate services community as an umbrella organisation of enactors and selectors: "*that intends to create and grow a community of climate service users, researchers, developers, providers and funders across Europe and build connections between them*"[8]. It currently is less active, as there is ample activity on EU level through all the H2020 and other actions (articulation of expectations and visions; network building).

e) **Establishing climate as corresponding aspect:** The map in Figure 11 links the Horizon 2020 climate services projects to such that focus on critical infrastructure resilience and on water management vis-à-vis (protracting) climate change and (incidental) disastrous events (learning).

5) **On global scale,** global climate governance evolved over time **from centrality to plurality**. Van Asselt/Zelli (2014: 139-143) distinguish the early stages when the centrality of the UN was rather undoubted, the WMO/UNEP Intergovernmental Panel on Climate Change was fostered and the UN General Assembly put the climate change issue on its agenda in 1989, followed by the adoption of the UNFCCC in 1992 (cf. Bodansky 1993)—in contrast to a rather symbolic adoption of the Kyoto Protocol through the EU, which took real action only in the early 2000s (Van Asselt/Zelli 2014: 140). In the 2000s, the global climate governance order 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 Prseident 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). 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.).

Against this backdrop we see the advent of various institutions promising they could over the course of time (mid- or long-term is not sure) establish a global climate services regime (which is not entirely new and goes back to). 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. Therefore, the following activities should still be interpreted as niche developments that strive—since half a century—for establishing a more coherent or at least far better connected community of and a market for climate services:

a) The **World Meteorological Organisation** mentioned services in its 2007 Strategic Plan as one key means to cope with environmental problems. WMO formally decided to start building the Global Framework for Climate Services at its 2009 Geneva conference. Currently, WMO does neither display climate services among their committees nor programme lists on their web site—besides a link to GFCS (for: 'Global Framework for Climate Services'). However, the basic idea can be traced far further back: to the 1970 technical note that elaborates on potential "*Economic benefits of climatological services*"[9] in terms of the "*application of climatological information to various human activities*". In 1995, the Climate Information and Prediction Services (CLIPS) project was installed with a programmatic vision

[8] http://ecsp.wikidot.com/origin [21 October 2017]
[9] https://library.wmo.int/opac/doc_num.php?explnum_id=876 [20 October 2017]

> "*as a new paradigm for climate services based on the vision that socio-economic decisions can benefit substantially from better knowledge of both contemporary and near-future climate conditions […] as an implementation arm of the World Climate Applications and Services Programme (WCASP), to build on the ongoing research advances and evolving operational networks, particularly on the regional and national scales. The principal objective of CLIPS is to develop the capacity of the National Meteorological and Hydrological Services (NMHSs) to take advantage of the recent advances in climate science and to pass along the benefits to improve climate services with a user focus.*"[10]

Within the World Climate Applications and Services Programme (WCASP), CLIPS was closed in 2015 and its activities channelled into GFCS.

b) Harjanne (2017) has reconstructed five **justifying** discourses and three **descriptive** discourses from WMO Bulletin articles indicating the **institutional logics** within the emerging field of climate services from a WMO point of view (cf. table 2):

TABLE 2: WMO INNOVATION DISCOURSE (CF. HARJANNE 2017: 4-5)

	Discourse	General logic
Justifying discourses	Global challenge	Climate services are important in addressing climate change.
	Specific industry needs	Sectors across society need climate services to improve their efficiency or resilience.
	Socio-economic value	The value of climate information is determined by its use.
	Technological potential	Technological development enables new, advanced services.
	Deficient supply and demand	Both supply and demand of climate information are flawed without servitization.
Descriptive discourses	User orientation	It is necessary and beneficial to engage users in climate service development.
	New roles and responsibilities	The actor field diversifies, but NMHS remain the central actors in the new field and need to expand their activities.
	Service portfolio	Climate services bring improved accuracy, tailoring, operationalization and integration of climate data with other environmental and societal data.

c) Both, the **Global Framework for Climate Services** (GFCS) and the international **Climate Services Partnership** (CSP), are early initiatives that since 2012 serve as fora for climate services. The GFCS, "*a UN-led initiative spearheaded by WMO to guide the development and application of science-based climate information and services in support of decision-making in climate sensitive sectors*"[11], is governed by the Intergovernmental Board on Climate Services and meant to support national and supra-national (e.g. European) initiatives building similar structures on their levels. The CSP is presented as "*a platform for knowledge sharing and collaboration aimed at promoting resilience and advancing climate service capabilities worldwide. It is an informal, interdisciplinary network of climate information users, providers, donors and researchers who share an interest in climate services and are actively involved in the climate services community*"[12]. Annual conferences are the main bridging events to bring enablers and selectors together. CSP as an intermediary aims at stocktaking ("*to catalog and share knowledge regarding the science, structure, and institutional arrangements that lead to the development of effective climate services*"; ibid.) and an expanding the stock of knowledge ("*to create new knowledge regarding the design and structure of climate services. This includes establishing the methods and structures needed to provide support in developing the economic value of climate services and establishing best practices for identifying user needs*"; ibid.).

d) There are various research-oriented programmes on global scale that precede and parallel services-related activities and institutions, like

   i. the meteorological **World Climate Research Programme** (WCPR), since 1980 sponsored by the International Council for Science (ICSU) and the WMO, since 1993 also by UNESCO's Intergovernmental Oceanographic Commission (IOC), is nowadays explicitly also aiming at

[10] www.wmo.int/pages/prog/wcp/wcasp/CLIPSIntroduction.html [20 October 2017]
[11] www.wmo.int/gfcs/overview [20 October 2017]
[12] www.climate-services.org/about-us/ [20 October 2017]

the provision of climate intelligence to "*governance, decision-making and in support of a wide range of practical end-user applications*"[13].

ii. **Future Earth** isn't meteorological, but in fact one of the organisations with which climate sciences and services beyond meteorological scope are explicitly linked. It aims at advancing an own kind of science, 'global sustainability science', and it has hybrid focus on science and technology.[14]

iii. In a similar direction, the **Belmont Forum** has in 2009 been established as "*a partnership of funding organizations, international science councils, and regional consortia committed to the advancement of interdisciplinary and transdisciplinary science* […] *International transdisciplinary research providing knowledge for understanding, mitigating and adapting to global environmental change*."[15] The Forum serves, among other things, also as an incubator for practical collaboration on climate services on project level, e.g. through the joint European Joint Programming Initiative (JPI) and Belmont action ('Climate Services Collaborative Research Action on Climate Predictability and Inter-Regional Linkages'[16]), but also in linking ecosystem services with climate information (in 'Scenarios of Biodiversity and Ecosystem Services II'[17]).

e) The global UNFCCC Paris Agreement in 2015, as an example for all the many international treaties and protocols, calls for collaboration between the parties on "*[s]trengthening scientific knowledge on climate, including research, systematic observation of the climate system and early warning systems, in a manner that informs climate services and supports decision-making*" (UN 2015).

Interesting about all these organisations is that they are closely linked to both initiatives from meteorological organisations and governments (as well as supra-national inter-governmental organisations), and that they are led by actors who belong to the meteorological community in the first instance. CSP is however the kind of organisation that is intended to serve as an interdisciplinary forum including also users. So, the need of **linking up for linking climate services in** is recognised. It needs to be seen how far climate services can also establish themselves within other organisation beyond their own, in which they can link into all kinds of activities and knowledge bases in order there to place climate intelligence.

6) **Emergence of soft (sectoral) standards**: In the finance sector, first efforts can be observed to establish common practices that require actors to take climate-related intelligence or climate services into account. Whereas overarching and top-down regulation on the assessment of climate risks is still absent (and there is no certainty whether there will be such), actors themselves are currently discussing advantages and disadvantages.

   a) The Financial Stability Board's (FSB) '**Task Force Climate-related Financial Disclosure**' (TCFD) recommends a framework for organisations, across all sectors, to analyse, evaluate, and disclose their climate risks. In doing so, they are pushing for the acceptance of the nexus between economic decision-making, climate change, and financial implications: "*climate change poses significant financial challenges and opportunities, now and in the future*" (TCFD 2017a: ii). The aim is to "*advance the quality of mainstream financial disclosures related to the potential effects of climate change on organizations today and in the future and to increase investor engagement with boards and senior management on climate-related issues*" (TCFD 2017a: v). As such it is a **novel effort to set climate change openly on the agenda**, yet, still a niche activity that nevertheless might turn out to be a call for climate services on unprecedented scale. The objective of standard development is to shape a regime that facilitates coordination of niche accumulation and growth.

   b) TCFD (2017a, b) establishes a **framework** to develop more specific and ubiquitous scrutiny of climate implications for the global financial system (where this is not yet recognised as a relevant

[13] www.wcrp-climate.org/about-wcrp/about-history [20 October 2017]
[14] http://www.futureearth.org/who-we-are [20 October 2017]
[15] http://www.belmontforum.org/about/ [20 October 2017]
[16] www.belmontforum.org/news/jpi-climate-belmont-forum-climate-services-collaborative-research-action-on-climate-predictability-and-inter-regional-linkages/ [20 October 2017]
[17] www.belmontforum.org/news/scenarios-of-biodiversity-and-ecosystem-services-ii-now-open/ [20 October 2017]

problem issue). This is not necessarily an act aiming at preventing climate change. The statement "*Better information will also help investors engage with companies on the resilience of their strategies and capital spending, which should help promote a smooth rather than an abrupt transition to a lower-carbon economy.*" (TCFD 2017a: iii) can also be interpreted as suggesting to at least nudge other instances beyond finance to avoid hasty societal and systemic change in order not to put investments at risk that could possibly find it hard keeping pace. Next to "*physical risks*", four "*transition risks*" are mentioned: "*political-legal*", "*technology*", "*market*", "*reputation*" (TCFD 2017b: 4). By 'transition risk' TCFD means the risk of sudden and large drops in value of assets which are closely related to high greenhouse gas intensities (and which climate policies try to get out of use); 'transition' is referring to the (fundamental) move away from fossil fuels. The four risk dimensions distinguished in the TCFD report are hard to compare. Political-legal and technology are sort of drivers of the change, whereas 'market' and 'reputation' have more to do with responses (and understanding these responses). In this sense, we might see the TCFD recommendations also as an innovation (TCFD 2016: 4) that tries to **tame** other (niche or regime level) innovations and changes, thus also hoping for economies of scale (just this time not from an EU point of view, but from a sectoral one). The TCFD recommendations also encourage organisations to seek out and identify climate-related **opportunities**.

c) In the finance sector there seems to be strong tendency to **outsource** this kind of quite specific information collection and pre-processing services. In the end banks etc. want some kind of tailored risk indicator service. Over time, the clients (banks, etc.) may demand additions and changes to the indicator portfolio—yet from a climate services provider's point of view the direct user of climate services is the **risk indicator expertise company** rather than the banks.

d) Financial actors may first want **certainty about a level playing field**. So, reporting obligations regarding climate risks should be based on consensus, and solid pre-studies on technical feasibility and usefulness. This could also entail a certain degree of minimum standards regarding underlying data used, transparency of indicator calculation etc. Blockchain technology may be very helpful here, but it will take quite some time before it is widely in use (cf. section B-4-a below).

e) The EU High Level Expert Group on Sustainable Finance indicates there is also a **top-down legal framework being developed** around various aspects of a 'sustainable' European economy, with some relevance for the future uptake of climate services. The 2017 interim report recommends a number of suggested adjustments to the financial system in Europe (High-Level Expert Group on Sustainable Finance 2017). Of particular relevance is the clarification of 'fiduciary duty,' or Recommendation 3: "*The misinterpretation of fiduciary duty as requiring a focus solely on maximising short-term financial returns is still common. The problem is a lack of appropriate standards in some instances, as well as a lack of clarity of some existing rules*" (ibid.: 57). Recommendations 4 and 7 encourage disclosure (by companies as well as financial institutions) on sustainability issues, including climate risks. The aim would be to align with the TCFD recommendations. Recommendation 4 directly hints at the mandated use of climate information, stating: "*[f]orward-looking information such as relevant climate scenario analysis should be encouraged*" (ibid.: 58). Recommendation 7 focuses on the role European Supervisory Agencies (ESAs) have to play in mandating disclosure, suggesting that "*ESAs address sustainability issues within their existing objectives. In particular, they could develop common guidelines and supervisory convergence on ESG* [environmental social governance, including climate] *disclosure by investors and lenders at the EU level, creating a level playing field across borders and investor categories (pension funds, insurance, mutual funds, asset managers, banks and banks' clients). This could be linked to the Non-Financial Reporting Directive and its 2017 guidelines, with the aim of improving ESG-related data to feed into risk assessment processes*" (ibid.: 59).

7) **Emergence of soft (climate services) standards:** Standards help to understand what the climate data means as well as why climate services could be justified. They emerge from practice, partially also set by institutions as result of technical and political negotiations. Transorganisional rules can

only take shape and effect when interaction between organisations leads to standing practices (cf. Hamaker et al. 2017: 45). We find technical standards emerging as well as ethical ones.

a) In the long run, stability of climate services and markets depends on "*establishing and maintaining networks that include information producers and users who can continually interact to refine and revise the necessary information*" (Meadow et al. 2016: 13) and tools. This non-static stability approach, we argue in Hamaker et al. (2017: 44), would help "*institutionalise quality control and co-production, while allowing to continuously answer to change. Data formats are rules about how to form and communicate datasets. They are also about how to use them and who defines the formats by which users communicate and use data. While there is already some convergence in the types of data format used, there is* ***still no gold standard****, although NetCDF in CMIP6 often is the current standard used for climate model data (with some variations)*" (ibid.).

b) Standards and conventions[18] **emerge** through (a) repeated action that works, which first becomes routine and then is habitualised into a social institution—a pattern, a rule, commonly considered to be right (Berger and Luckmann 1966), (b) communication among members of a community sharing similar kinds of data, agreements, and technological aspects that inscribe themselves into an infrastructure practice for at least as long no one changes the technology (cf. Pelizza/Kuhlmann 2017; Star/Ruhleder 1996); even methods (Neshati/Daim 2017) and institutions of normation (DIN, ISO; here recently CMIP5, 6, 7) have been installed to tackle this problem (Vollebergh/van der Werf 2015; cf. Hamaker et al. 2017: 44):

   i. For CMIP5, the community went through somewhat of a revolution in terms of **people talking to each other and defining standards** (structure, content, format of data files)—if data is standardised, it is easy to build software around it. Significant effort went into agreeing these standards, but the result was far from perfect. Standards are in disarray even in a regional context where data standards and conventions have not been clearly agreed. For instance, the Atmospheric Monitoring Facility agreed a few years ago to **review data formats**. This process still underway and is being implemented in an effort to bring the community together. It seems something like this is needed across the board (cf. Hamaker et al. 2017: 44).

   ii. Practices and standards govern individual standards in place: "*These* ***high-level standards*** *have the potential to be developed further, especially in terms of 'quality assessment' (QA; see Deliverable 1.2). Formalised procedures exist from WMO and ISO, whereby ISO 90001 could even play the role of a meta-QA (ensuring the QA of the QA, which is a question of QA and data infrastructure governance in terms of deliberately framing QA through governance). Formalised procedures could also benefit from user satisfaction measurement (as ex-post QA) and co-production of QA while involving users actively in climate services activities (as on-going quality negotiation process)*." (Hamaker et al. 2017: 44)

   iii. **Information and communication technologies** "*are omnipresent in climate data practice, technical codes and algorithms affect the forms of knowledge and directionality of innovation in the entire climate data area. In many ways technology governs, whilst at the same time there are policies and governance approaches inscribed into software, hardware, organisations and climate data technology*" (Hamaker et al. 2017: 44-45): "*... code, protocols, software, and algorithms are not only technologies to be governed but also full-blown governances actors enacting regimes of inclusion/exclusion from innovation process*" (Pelizza/Kuhlmann 2017: 3). "*The opposite of inscription, description, occurs in cases of crisis or rupture: the inscribed rules and other patterns become visible and even negotiable (ibid, 8). Climate services would want to carefully consider whom they (implicitly/explicitly) allow to take part (or not), and how*" (Hamaker et al. 2017: 44-45).

[18] Section 6b, due to its overarching relevance, has been used again from deliverable 1.3 (Hamaker et al. 2017: 50) with slight modifications. It was originally written by Peter Stegmaier.

iv. **Ethical frameworks**[19] inform the building and pursuing of climate services in ways acceptable and justifiable against criticism and when mistakes occur. They can sensitise the climate services community regarding their responsibilities in gathering, processing, and interpreting climate information. They can also be a warrant against inadequate use, underutilization or even neglect of climate services that would otherwise have significant impacts on EU citizens' and societies well-being and wealth (EU-MACS 2016: 20). From a 'climate justice' point of view (cf. Klein 2014; Martinez-Alier 2015; Shue 2014) as well as an 'ecosocial' standpoint (Cahill 2015; Fitzpatrick 2014), it is considered that there could be a human right to be protected against climate change-induced harm (Caney 2008), and it is asserted that this position can be best supported with combined utilitarian, prioritarian and luck egalitarian considerations (Knight 2016).

- A normative framework for climate services can be developed **bottom-up** by the climate services actors themselves (in existing collaborative organisations, such as WMO, who is actively pursuing this approach; c.f. Adams et al. 2015), and/or it can be implemented **top-down** by a government (nationally) or the European Commission (EU-wide). The advantage of the first approach is that climate services providers can define ethics, which take into account what they know about their businesses and clients, whereas the second approach would possibly guarantee a less actor-related, more universal view on climate services ethics. Perhaps both approaches will be started and merged at some point. What is important is that it is recommended for the market building the ethical approach would accept the users as core point of reference. This also means including them enough into the process of designing a climate services ethics.

  The "Call for an Ethical Framework for Climate Services" paper (Adams et al. 2015) outlines a set of values (such as "*integrity*", "*transparency*", "*humility*", "*collaboration*"), on which a set of 10 "*principles of practice*" could be based, as well as four "*principles of product*".

  All these items, as they are coined, can contribute to quality control (e.g. "*communicate value judgments*", "*engage with their own community of practice*" and "*in co-exploration of knowledge*", "*provide metrics of their products*", "*mechanisms for monitoring and evaluation of procedures and products*", "*declare conflicts of interest*") and decency in interaction with other actors ("*communicate principles of practice*", "*understand climate as an additional stressor*", "*communicate appropriately*") (ibid.).

- Further discussion could target issues, which are not explicitly mentioned in these ethical reflections:

  - Would a **more explicit user orientation** ("customer first") help in giving the climate service community a better standing and a more balanced relationship to users, in brief: a more pervasive user orientation?

  - The building of a European market for climate services will repeat both the internal relations and frictions of the economic area as well as those with the world market. Since climate change, as natural process, is a borderless phenomenon, would the climate services community be willing to **be inclusive** when it comes to the Global South, developing economies, (EU or other) national economies in crisis, etc.? Inclusiveness here means **aiding participation** (infrastructural, with service) and **sharing** of products that not all can afford.

  - Regarding the "application" of climate intelligence on people in parts of the world, in which either the institutional, business-economic, or epistemological presumptions of climate sciences are not shared, it could be appropriate "*protecting and sustaining*

[19] Section 6d, due to its overarching relevance, has been used again from deliverable 1.3 (Hamaker et al. 2017: 54-55) with slight modifications. It was originally written by Peter Stegmaier.

indigenous people's traditional environmental knowledge and cultural practice" (Lynch/Hammer 2013) **instead of imposing** an external climate regime through climate services upon them. This could mean to find ways of linking up with their concerns about nature or climate (or related concepts they might use) and **translate** climate issues into their "world views" and back into Northern scientific and business thought (cf. Mazurek 2015; Fitzpatrick 2014; Fruh/Hedahl 2013).

- **Procedural vs. principal responsibility**: A slightly different interpretation of taking on responsibility in climate services could be a governance approach that is less built on ethical principles, but more on **procedure of coordination and collaboration, balancing of powers, interests and knowledge**. In other areas of research and development, approaches of 'responsible innovation' have been coined, which could be translated into the climate services world. For instance, the so-called "Responsibility Navigator"[20] suggests a policy of supporting responsible behaviour that seeks to consider all voices concerned in the process. It is a multi-actor, multi-level, multi-perspective aid for all kinds of contexts, a meta-governance tool, to be appropriated wherever used, and thereby doing more justice to the specific context of use than approaches based on absolute principles or universal procedures.[21]

  Not dissimilar to the aforementioned ethics framework paper, the "Responsibility Navigator" defines ten criteria that should help navigating towards enhancing responsibilities[22] They are, in brief, about the following:

  - **Ensuring quality of interaction**: 'inclusion', 'moderation' and 'deliberation',
  - **Positioning and orchestration**: 'modularity and flexibility', 'subsidiarity' and 'adaptability',
  - **Developing supportive environments**: 'capabilities', 'capacities', 'institutional entrepreneurship', and a 'culture of transparency, tolerance and rules of law'.

  This approach allows for maximum responsiveness and actors' perspectives, and facilitate open debate, multi-faceted negotiation and mutual learning. Especially in a situation where climate services are still far from being an established community and market, such explorative governance would make much sense, also before setting fixed ethical principles.

- Further sources of climate service ethics could be **service ethics** (Sundbo 2010), **business ethics** (Hartman 2014; Hormio 2017), and **climate justice** (Skillington 2017; cf. Zwartenhoed 2017; Shrader-Frechette 2013).

B. Neighbouring niches developments: From a niche point of view, further aspects have to be considered: what are other niche services and niche markets, with no or only indirect connection to climate issues and services; which are niche technologies and sciences with no or only indirect connection to climate issues and services, which nevertheless could become **strategic partners** in maturing from niche to regime level; which policy and governance innovations should climate services have on the radar if it wants to ally within niches and/or eventually grow out of niche? Niche innovations to some extent might, however, tend to maintain clear boundaries to other innovations in order not to get confused with them.

1) **Ecosystem services:** Services associated with natural goods and ecosystems are discussed in terms of "*how those services from nature which are in crisis can be valued differently so as to make their uses more sustainable*" (Pröpper 2015: 248). Ecosystem services "*are supposed to function as a protective*

[20] http://responsibility-navigator.eu/ [10 October 2017]
[21] http://responsibility-navigator.eu/navigator/why-what-how/ [10 October 2017]
[22] http://responsibility-navigator.eu/navigator/ [10 October 2017]

mechanism to make nature economically visible, while simultaneously contributing to economic development" (Pröpper 2015: 247), not only in emerging economies, but also in developed world. Ecosystem services could be **relevant for climate services** in at least two ways: (i) as market to link up with, as well (ii) as a lesson in stimulating unintended consequences. Current institutional links to climate services are e.g. via Future Earth and Belmont Forum.

a) Regarding the possibility that climate and ecosystem services could be **linked and reinforce themselves mutually**, one needs to remember that some areas, for which climate services seem useful, are also linked to ecosystem services: all those areas, in which natural goods are at stake, such as agriculture, forestry, costal zones.

b) Regarding the aspect of lessons to learn, however, it would be useful to see which **unintended consequences** a service shaping approach could have:

 "*The breaking up of nature into valuable and priceable market components creates an awareness of these values, but it can also create too great a focus on goods within supposedly beneficial market transactions. Such binary revaluations of components bear new consequences, especially the risk of a capitalization of components under 'messy' live conditions with additional vulnerabilities and externalities*" (Pröpper 2015: 265).

 Applied on climate services and on all corners of the world, not just emerging economies, this means that climate-related issues would increasingly get a price tag. But when putting a price on climate, one could also calculate how it would **pay off not to consider climate** at all or up to a certain point.

 Another lesson from the ecosystem services (discourse and policy) experience is how the **precariousness of the concept itself**, when the question is asked what it actually is to what it refers, characterises these newly emerging service worlds: "*Indeed, given what Sagoff calls the 'mixed up, contingent, fractious, intractable, unexpected, protean, erratic, changeable, unpredictable, fickle, variable, and dodgy' characters of ecosystems, even ecologists find them hard to pin down*" (James 2013: 264; cf. Sagoff 2013). Climate services is itself still a **fuzzy concept**, also in daily practice. Thus, when we observe how climate services may matter in particular contexts, it will not always be under the notion of 'climate services', but rather linked to 'weather' (think of the company "Weatherpark"[23], offering climate services in urban contexts) or 'investment analysis' (as for lift operators and real estate developers), or even anything else far **beyond climate**. In addition, the in-built insecurity about the forecasting of climate developments as well as the great diversity of sector and combinations of sectors where it is considered relevant indicate that climate services (still) very much is a **moving target** for those ambitious to capitalise on it and to make it matter in private and public management. As one can hear from companies in the climate services business for long, they hardly experience any continuity, besides the constant struggle of acquiring new customers and business fields, as well as influencing rather volatile agendas and adopting to all the other changes occurring there besides the climate.

2) **Climate engineering:** A step further than just anticipating probable possible climate scenarios is the **active making of weather** thereby turning the effects of climate trends into more desirable patterns. Another candidate in the neighbourhood of climate services for developing some intrinsic nexus is thus climate engineering (Keith 2000). It has also already been associated with a service idea (Barrett 2014: 267):

 a) In order to better be able to imagine how **solar geoengineering** (a closely related, yet slightly different denoting term), Barrett (2014) has compared real-world analogies (from nuclear testing and global navigation satellite systems) for problems of geoengineering governance[24]: "*how difficult it can be for a treaty to restrain state behaviour [and] how one state's actions may trigger reactions by other states*" (ibid.: 264). Climate services face a similar challenge: although often nationally organised and administered, they rely on infrastructure (satellites etc.) that are based

[23] www.weatherpark.com/en/ [10 October 2017]
[24] The following intends similar.

on international initiatives and coordinated between partnering countries and supra-state organisations (ESA). Their market extends also often beyond national frontiers as well as into rather local dimensions. Pioneering countries can have a bandwagon effect, as can sectors: think e.g. of the current chain reaction of cities announcing plans for prohibiting fossil fuelled cars within the next 3 to 23 years; or of effects of innovation and imitation (Levitt 1966; Godin 2016) in the mobile telecommunication services market (Lee et al. 2012) showing "*that the imitation effect of the first mover was larger than those of the followers in the mature mobile telecommunication services market in South Korea. The innovation effect of the follower was larger than that of the first mover, and the innovation effect was larger than the imitation effect in the market*", and in metaverse services adoption (Lee et al. 2011) showing another case in which imitation effects are actually bigger than innovation effects. **Pioneer**, first mover, follower, spill-over effects—which actors, which sector for climate services will play which role, and what will decide about the magnitude of innovation and imitation effects?

b) Climate engineering has been suggested (Crutzen 2006) and discussed under various notions, of which 'climate engineering' is addressing the **active manipulation of the climate system** only in terms of 'carbon dioxide removal' (CDR) and 'radiation measurement' (RM), whereas the older term 'geoengineering' is broader and also links up to civil, mining, petroleum engineering or geophysics, river diversion, traffic infrastructure facilities, or the modification of coastal areas (Klepper/Rickels 2014; Betz 2012; Corner/Pidgeon 2010; Aukes 2017). Be it for actual designing/planning of weather modifications or for justification—climate services in some form would be needed. In addition, the focus on the feasibility of weather or climate modifications would shift attention to **all sorts of intelligence** around weather and climate, besides the physical-chemical dimension of making weather.

c) Interesting enough, the idea that **influencing of climate through weather**-making could be a useful **strategy** was uttered during a workshop on climate services for **tourism**, and it were those actors who already actively engineer skiing slopes with snow cannons and snow blowers who speculated about climate engineering as an enhanced way of prolonging skiing season. The same actors use climate services now already for the planning of infrastructure investment and staff deployment.

d) In public discourse, arguments have been expressed that (a) climate engineering could counter **negative** effects of industrial sulphur emissions reduction (it is said sulphur reflects solar radiation back into space, while its reduction contributes to global warming; cf. Crutzen 2006) as well as (b) a **cure** for climate mitigation policies falling too short or behind urgently needed (cf. Betz 2012; Greene, et al. 2010[25]).

3) **Platform capitalism:** With the rise of platform-based businesses (since the 1970s), capitalism is undergoing a substantial transformation, Srnicek (2017) claims, although "*phenomena that appear to be radical novelties may, in historical light, reveal themselves to be simple continuities*" (ibid.: 9). Continuity, in this view, consists in major tech companies being "*economic actors within a capitalist mode of production*" (ibid.: 3), and data as a resource "*to be extracted, refined, and used in a variety of ways*" (ibid.: 40) is the new oil (cf. Koh 2017). Platform capitalism addresses the nexus of capitalist economy and digital technology.

a) Four aspects are particular for platforms (cf. Koh 2017): (1) their **intermediary digital infrastructures** within which "*customers, advertisers, service providers, producers, suppliers, and even physical objects*" (Srnicek 2017: 43) as well as platform agents (human and technical) can interact, and eventually even use tools provided to build their own products; (2) platforms use **network effects**, through which enormous growth of value generation from user activity is possible, the more users participate; (3) **cross-subsidisation** meaning "*[b]y offering free products and services, a particular platform could accumulate more users and, therefore, more activities on its*

[25] Put with a sense of urgency: „*To avert dangerous and potentially catastrophic climate change, it has been argued that society must set a goal of stabilizing the atmospheric CO2 concentration at 350 ppm by the end of the twenty-first century. The time window is relatively narrow for society to find workable solutions for achieving this ambitious goal. In our opinion, society will need to employ aggressive emission reductions and geoengineering to stabilize atmospheric CO2 at 350 ppm by the end of the century.*" (Green et al. 2010: 57)

network. Economic gains and losses are balanced out as the platform corporation taps on its multiple arms of business" (Koh 2017); and (4) constant user engagement strategy helps to extract more and more data from users.

b) **FinTechs & InsurTechs:** For the climate service world, FinTech (and more particular InsurTech) start-ups seem to serve as an example par excellence for B2B and B2C innovativeness, as well as **hopeful amplifiers** for climate services starting up. They are often seen as disruptive (=radical) technological innovations, still in search real entrepreneurial business models besides their outstanding technological capabilities, design and coolness (Tiberius/Rasche 2017: 7-14). FinTechs are platform banks: "*nonbanking platform companies targeting the most profitable parts of the banking value chain*" (Dietz et al. 2017), and this is what makes them so challenging for traditional banks:

> "*By creating a customer-centric, unified value proposition that extends beyond what users could previously obtain, digital pioneers are bridging the value chains of various industries to create 'ecosystems' that reduce customers' costs, increase convenience, provide them with new experiences, and whet their appetites for more. Not only do they have exceptional data that they exploit with remarkable effectiveness but also, more worrisome for banks, they are often more central in the customer journeys that include big financial decisions.*" (Dietz 2017)

They are blurring conventional industry and service boundaries with combinations of retail, finance services, asset management, chat-service, and much more. They are appealing to a newly emerging science- and high tech-based service stream eager to create a new market or win shares from existing markets, because, as Hermann put it: "*if successful, a platform creates its own marketplace; if extremely successful, it ends up controlling something closer to an entire economy*" (Hermann 2017). It is also said platform banks still need to work on the trust from (potential) clients (Tiberius/Rasche 2017: 20).

c) Could there be a **climate services model like Uber** or one like Airbnb, Google, Ebay, Facebook, Spotify, or Amazon? According to Srnicek (in Koh's words), there are five types of platforms,

> "*which may exist in various combinations (or in full) within a particular platform corporation. These are <u>advertising platforms</u> (e.g. Google, Facebook), which extract user data and capitalise on ad space; <u>cloud platforms</u> (e.g. Salesforce), which own and rent out hardware and software; <u>industrial platforms</u> (e.g. GE, Siemens), which build the necessary infrastructures 'to transform traditional manufacturing into internet-connected processes' [Srnicek 2017: 49]; <u>product platforms</u> (e.g. Rolls Royce, Spotify), which make use of other platforms 'to transform a traditional good into service' [Srnicek 2017: 49]; and <u>lean platforms</u> (e.g. Uber, Airbnb), which operate on a business model of minimal asset ownership.*" (Koh 2017; Italics in the original are here underlined)

Are there **downsides** to this hyped information technology-driven business mode? Success expressed in increasingly attracting users and extracting their data while pursuing a lean managing of the platform might at some point run into a tension between the need to dominate a market niche and the tendency towards convergence by shared or common interfaces. Solving this problem through enclosure (e.g. proprietary ecosystems with closed apps and exclusive infrastructure) is, however, inconsistent with the openness of digital market interaction (see below, section B-4-d on internet of things).

4) **Technological innovation** is crucial for climate services and their markets, and the same is true for innovations in relevant sciences and governance/management in multiple ways: as instruments of research, as infrastructure, and as means of communications (cf. OECD 2015: 9). Climate services need to observe and probe novel technoscientific trends and possibilities in order not to lose contact with innovation. Here are but a few that are seen to have potential to influence the development of climate services and their markets:

a) **Blockchain technology**, as one of the most recent hypes in information technology, bears first of all the promise that if you link to it whatever you do, your thing will be highly topical and at the absolute forefront of technological progress. Of course, there is also the technological promise of a new type of internet and information management. It is based on the idea of a distributed database without any centralised record, and this database is working like a self-auditing ecosystem with all data transparent throughout the system[26]:

i. UNFCCC expects that blockchain technology could "*boost climate action*", and playing on the above mentioned features it is said:

> "'*Blockchain could contribute to greater stakeholder involvement, transparency and engagement and help bring trust and further innovative solutions in the fight against climate change, leading to enhanced climate actions,' said Alexandre Gellert Paris, Associate Programme Officer at the UNFCCC.*"[27]

ii. The UNFCCC lists then "*Improved carbon emission trading*", "*Facilitated clean energy trading*", "*Enhanced climate finance flows*", and "*Better tracking and reporting of greenhouse gas (GHG) emission reduction and avoidance of double counting*" (ibid.) What is striking is the **expectation** that—besides increased trust through transparency and efficiency as another socio-economic goal—the technological possibility of **better connecting and representing** everybody within the system would basically alone lead to "*greater stakeholder integration*" (ibid.), if with this is meant that the social interactions would improve. In addition and by contrast, if it "*could improve governance*" (ibid.), 'integration' would also denote **better control**.

iii. With regards to business, the expectation is uttered blockchain technology would allow for "*enhanced creation of global public goods* […] *currently viewed as the main potential benefits*" (ibid.). This would mean a potential limitation to climate services for profit—unless, ways are invented how **information exchange** *from users* to experts can be free and information exchange *to users* be priced.

iv. Blockchain technology has a **quality assurance** aspect (cf. EU-MACS Deliverable 1.3), as a quality assurance and risk management company explains:

> "*When a certificate is issued, the data is digitized and a digital identity is assigned to each certificate. All certificates are tagged and traceable, and the original is safely stored in the network of computers in the blockchain, commonly referred to as nodes. The certificate data is in parallel managed in our production system. In total, this creates an immutable transaction, secure and highly transparent, making it easy to uncover fraud as the technology will expose any outdated or forged certificates.* […] *all new and re-issued certificates will have a QR code embedded that can be scanned by a device with a QR scanner. A lookup will be performed on the blockchain and certificate details will be presented. Anyone can at any time check and verify a company's claims and certification scope and validity. The validity of the certificates can also be checked through a lookup on our public certificate checker.*"[28]

b) **(Web-based) Information brokerage:** Knowledge brokerage is a widely-used concept in research on science-policy-relations, science communication, the role of intermediaries, etc. Michaels (2009) distinguishes several strategies of knowledge brokerage: rather linear ones like 'informing' and 'consulting' work better with moderately or fully structured problems (cf. Hoppe 2010), next to more interactive ones like 'matchmaking', 'engaging', 'collaborating', or 'capacity-building', suitable for unstructured or even wicked problems. The first group may often be associated with "*improving the uptake and transfer of evidence in policy*" (Reinecke 2015: 514), while a facilitating orientation in knowledge brokerage would usually work more integrative and acknowledging differing perspectives (ibid.). Oasis HUB, for instance, offers catalogues for risk and catastrophe analytics tools.

[26] Cf. https://blockgeeks.com/guides/what-is-blockchain-technology/ [20 October 2017]
[27] http://newsroom.unfccc.int/climate-action/how-blockchain-technology-could-boost-climate-action/ [20 October 2017]
[28] www.dnvgl.com/assurance/certificates-in-the-blockchain.html [21 October 2017]

c) **Risk visualisation:** Larosa/Perrels (2017: 64) note that visualisation "*is moving into 3D application (e.g. relevant for urban climate issues) as well as widening the use of dynamic representation (video); this enables the representation of multifaceted scenarios in timewise compact formats for policy makers*". NASA, for instance, hopes to help better assessing data sets increasing in size. It offers software allowing for interactive visualisation and analysis, called 'Ultrascale Visualization—Climate Data Analysis Tools' (UV-CDAT).[29] Visualisation (or: imaging, a term preferably used in brain science and nano tech) can also have a popularising aesthetic effect making things visible and appealing that would otherwise remain opaque to broader publics. Visualisation that streams climate models may also profit from trust in visuality: in a visually dominated culture, what we see moving seems real and objective—one tends to belief what can be seen on a picture. As DKRZ puts it: "*Visualization is one of the key technologies for understanding and communicating the results of extensive numerical simulations*"[30]. Hogg[31] gives three reasons why visualisation might play a key role for climate services: outreach, scientific communication, scientific understanding; one should add also science communication. DKRZ emphasises also the (local) service function of visualisation. Ruivenkamp/Rip (2011: 185) describe three areas of an entanglement of imaging and imagining, here applied to climate science and services: (1) production practices and use of **visualisations of the climate scale**; (2) **imag(in)ing** the future and the present; and (3) entanglements of climate science/services and **art**. The latter can indeed help enormously for hyping climate issues and (doomsday or salvation) visions—it already did so successfully in brain science and nano technology, two areas where location, scale, and prospects of the things at stake would otherwise be far beyond visibility.

d) The IoT or **internet of things** (Sterling 2005)[32] follows the approach of sharing information as broadly as possible in order to achieve optimal operability of an all-encompassing network. The expectation that comes with IoT: "*The concept of the Internet of Things and Services envisions physical devices and appliances to be used as easily as a web service and seamlessly integrated into networked applications with required functionality.* […] *Using this approach the business activity can be reduced to its core elements, which in the simplest case comprise the value proposition, distribution channels and the customers of the company, explaining how a multi-actor network creates, distributes and consumes value by production of a good or providing a service.*" (Glova et al. 2017: 1122) As side effect of internet technology, services have shorter life cycles and business models are changing faster.

   i. In terms of **technology**, this affords identification through RFID or QR code for information about actors in the network; when actors themselves need to process information (e.g. local climate data or environmental data measuring in urban context) they need to be equipped with data processing hardware (ideally of the type 'system-on-a-chip' which reduces energy consumption, effort for maintenance, and acquisition costs).

   ii. Questions concerning climate service markets are, e.g., which limitations regarding the enormous **amount of data** for climate-related problems there are, how they can be pushed, as well as how far business models require some sort of **limitation to informational openness** ('*intra*net of things') or **limitations to business** models for-profit due to functional requirements of openly sharing information.

   iii. From a technological perspective, there is **overlap** with a long list of **neighbouring technological fields**, such as 'industry 4.0' often associated, among other things, with data-driven digital services (PWC 2016; Bauer/Wee 2015; Forschungsunion/acatech 2013), 'ubiquitous computing', 'pervasive computing', 'internet protocol' (IP), 'wireless sensor network', 'cyber-physical system' (CPS), 'embedded systems', 'web 2.0' (Yeritsian 2017), 'internet of citizens', and last but not least 'data protection', to name a few. One essential task for climate services might be to develop a good practice concept about tailored and personalised consultancy,

[29] https://cds.nccs.nasa.gov/tools-services/3d-model-analysis/ [21 October 2017]
[30] www.dkrz.de/services/vis [21 October 2017]
[31] www.climatescience.org.au/sites/default/files/visualisation_andy_hogg.pdf [21 October 2017]
[32] Cf. www.itu.int/osg/spu/publications/internetofthings/ [18 October 2017]

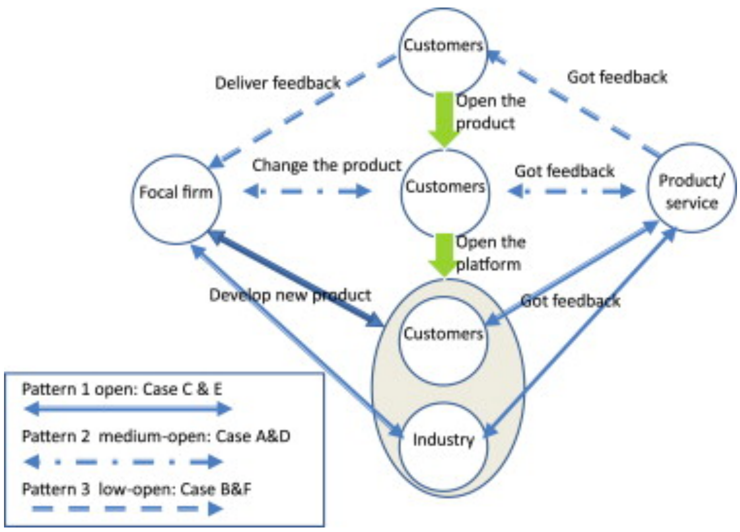
perhaps even in mobile formats (for on-the-spot-data collection and contribution into a bigger "climate intelligence cloud", used by users that share information or/and in exchange with professional expert consultants that know to do "more" with the data).

iv. '**Participatory sensing**' is another new field, in which environmental conditions are measured and documented by **interested citizens using cheap IoT technology** (e.g. radio activity around the nuclear power plant Tihange in Belgium). Such activities do not only enlarge the data basis on environmental issues, but also render the data into (sub-) political knowledge (cf. Brown 2017; Loreto et al. 2017; see also citizen science on climate change, in section C-8-b). The link to climate issues is made explicit, and the service come from citizens as technology users: "*Fruiting is a key event in the life cycle of many plants. Large-scale citizen-generated information on the timing of such key events can be an indicator of climate change.*" (Goldman et al 2009: 11) Citizens capture the changing patterns in the living environment, and thus climate change.

- The IoT can be seen as a business ecosystem, not just a supply network. Rong et al. (2017) reconstructed a set of typical patterns (figure 12). These patterns could be instructive for climate services interactions by offering a key to assessing the impact of IoT style technology on climate services interactions (what was discussed in terms of 'service infrastructure' in Hamaker et al. 2017: 42-64):

> "*In Pattern 1, highly open, customers as well as many other stakeholders, such as industrial players, are allowed to obtain data by using the products. They then get together to enhance the products, with assistance from the focal firm.* [...] *In Pattern 2, semi-open, customers receive feedback by using the products and can then engage in changing the products themselves. The focal firm opens the product interface to other stakeholders in the business ecosystem.* [...] *In Pattern 3, less-open, customers use the products and then deliver feedback to the focal firm. The focal firm then decides the next step in product development.*" (Kong et al. 2017: 51)

FIGURE 12: THREE PATTERNS OF AN IOT-BASED BUSINESS ECOSYSTEM (RONG ET AL. 2015: 51)



- To which extend can this also be realised with climate services data? What does it mean for the nature of the services?

e) The spectrum of '**apps**' (application software) available is unprecedented. New technological applications go hand in hand with new social practices and new business ideas (or new technological framings for existing business models). Mutual relationships of control and self-empowerment, of information gathering, sharing, and providing flow together. Apps enable actors (users, purveyors, providers) to interact with novel forms of collaboration. Climate services are into this development with many new tools: based on websites, such as EPA's National Stormwater Calculator (SWC)[33], EcoCities Spatial Portal[34], STAR tolls (Surface temperature and runoff tools for assessing the potential of green infrastructure in adapting urban areas to climate change)[35], and the Green Infrastructure Valuation Toolkit[36], as well as apps for mobile devices: e.g. National Stormwater Calculator Mobile Web Application[37].

f) Climate science and data is already **big data**. However, when this has to be intermingled with data from user contexts (be it user collected data or relevant other scientific data, e.g. geographic or socio-economic), we are looking at even bigger, more complex big data. This is a challenge for climate services, which can only be met when technological and transdisciplinary capabilities and capacities are linked.

Technological innovations have also a **symbolic quality**. Climate services may need to embark on certain hyped technological trends in order to demonstrate how modern they are.

C. The regime view: When climate services is a niche level innovation currently going on, what is then the **incumbent regime** into which the niche innovation wishes to advance? One would look into directly climate related areas and find a number of organisations that do in fact already or could most likely at some point embark on climate services. There might be competing rationales on regime level, when, on the one hand, climate services are introduced as instrument for climate change mitigation and adaptation, while, on the other hand, in the EU Climate Services Roadmap hardly any mention of environmental protection can be found (which might lead to a lack of legitimation). At least, the following nested regimes of immediate relevance for climate services should be considered:

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 above 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 budget of 80 billion euro for research and technology development (RTD) and has become a serious policy entrepreneur providing targeted funding. Funds fostering climate services come from several framework 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). 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*

[33] www.epa.gov/water-research/national-stormwater-calculator [21 October 2017]
[34] www.ppgis.manchester.ac.uk/ecocities/ [21 October 2017]
[35] http://maps.merseyforest.org.uk/grabs/ [21 October 2017]
[36] http://urbanwater-eco.services/project/using-the-toolbox/ [21 October 2017]
[37] https://swcweb.epa.gov/stormwatercalculator/index.html [21 October 2017]

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.

b) 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.

c) 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 CS sectors; cf. Appendix 1).

d) For an assessment of climate services markets chances, **structural obstacles or helpers** need to be taken into account, 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)[38]

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

2) **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). For climate services market building and using policies/frameworks this could mean both pioneering into innovative paths, or (from an EU point of view) more peculiar lock-ins, cultures of non-use, or ideological abstinence/ignorance due to perceiving climate policy and services as rather irrelevant issues (see section E-2 below on public opinion).

3) (Big) **Consultancy** firms like McKinsey have long discovered climate change. Climate services are topical for them in a dual sense: They offer **advice** to those who run business and govern public entities, and they themselves **need** climate intelligence as input for more integrated consultancy products (cf. Howells 2006), which link climate-related knowledge with such that is related all other relevant dimensions. One prominent example is the Economics of Climate Adaptation Working Group (2009), in which the question how to get "*adept at adaptation*"[39] providing some sort of service in form of decision-making tools that link climate with other policy issues. Climate services are not mentioned, but provided in a very general form, not yet applied to the specific locus of policy. Consultancy plays often an intermediary role in bridging user needs and supply side (Bessant/Rush 1995), be it for technology or service transfer.

4) Another form of intermediary playing a role in climate policy with a quite similar de facto dual climate service orientation are (bigger) **public intermediary agencies** like OECD (seeing itself as a forum of countries, or being portrayed as "*a consultative assembly that pursues its program through moral suasion, conferences, seminars, and numerous publications*"[40]) and IEA (seen as platform for cooperation, in own words "*at the heart of global dialogue*"[41]): consuming climate services as input and emitting it when addressing their clients (both governments and corporations):

   > "*help member countries develop their energy policy so they can effectively address climate change. This includes finding and sharing examples of best practice, for which the IEA maintains databases of member countries' climate, efficiency and renewable energy policies. The IEA supports the effective co-operation of countries through expert events and technical analysis for climate change negotiations*"[42]

   The climate service these kinds of organisations offer **is policy-oriented** with technical and practical components. What the IEA with respect to climate change is providing goes **without actual climate data** or more sophisticated intelligence. In this sense, it is 'climate service without climate data', or 'proto-climate service' that basically needs to be augmented with climate intelligence only for very particular contexts of use. Since such is not included, however, one lesson could be that once climate change is accepted as a scenario the detailed climate scenario is not always requested. The task is seen as a policy problem, not a climate problem: "*the long-term climate objectives of the Paris Agreement requires urgently tackling energy-related greenhouse gas emissions*"[43] More empirical research is necessary to check how far more detailed climate data-based scenarios for policy advice are actually neglected, avoided, or not trusted, and if so for which reasons: what the rationality stands behind looking at climate change from a policy perspective without a deep understanding of specific climate circumstance. This may be the case in many more policy-related areas, in which climate services hope to transact business.

5) **Weather services[44]** are further developed and have several potential synergies with climate services (data infrastructure, extreme weather prediction), but may also be confused with them. While climate services are still not established, weather-related services are incumbent; they are used by

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[39] http://mckinseyonsociety.com/tag/climate-change/ [20 October 2017]
[40] www.britannica.com/topic/Organisation-for-Economic-Co-operation-and-Development [20 October 2017]
[41] www.iea.org/about/ourmission/ [20 October 2017]
[42] www.iea.org/topics/climatechange/ [20 October 2017]
[43] www.iea.org/publications/freepublications/publication/solutions-analysis-and-data-for-the-global-energy-transition.html [20 October 2017]
[44] Weather services are here filed under 'regimes beyond climate services'. It is basically an empirical question how disentangled or how entangled they are with climate services—maybe this is different from case to case. However, actors do quite some boundary work in demarcating a line between short-term weather and mid-/long-term climate foci. Therefore, we analytically separate both services in this report.

almost every person who has weather app on the smartphone or who watches weather forecast in TV, besides special purpose users.

6) **Law:** So far, we have to note the **absence** of any legal regulations that explicitly require actors to use climate-related intelligence as of yet, but first efforts to establish common practices (such as in finance, see above on TCFD, section 3.2.1. A-5); cf. Cortekar et al. 2017: 32-33; Larosa/Perrels 2017: 53-54; 62). Other than for energy-using consumer products there is neither framework regulation (ecodesign) or specific directives (as for energy labelling). In analogy, this would for instance be some kind of 'climate impact assessment' required for various kinds of economic activities. The use of climate services as such would rather not be prescribed in any way, but one could think about at which level of regulation for a climate impact assessment would professional climate intelligence become necessary to such an extent that climate service business would flourish and eventually get established as mainstream.
    a) However, there is an entire spectrum of **law related to climate change and protection** that is applicable to all member states[45]: Greenhouse Gas Monitoring and Reporting; EU Emissions Trading System, Effort Sharing Decision, Carbon Capture and Storage, Transport/Fuels, Ozone Layer Protection, Fluorinated gases, Forests and Agriculture. None of them has a notion of climate intelligence or services, which means climate services are not (yet) considered to be a policy or policy-related instrument of binding character.
    b) **Urban planning:** In quite some member countries cities have already **obligations** to explicitly pay attention to climate change in relation to urban planning (land use, infrastructure, public health/DRR). The general drivers in the background are safety and damage avoidance, sometimes leading to or necessitating to recast design approaches. For example, integrating river water in land use rather than purely defending against it, which may—over time—affect the demand for climate services (e.g. water quality concerns getting more important in addition to the original focus on water levels/volumes).

7) **Standards:** Standards in eco-innovation refer to "*a document that specifies characteristics of technical design or rules of behaviour*" (Vollebergh/van der Werf 2014: 231) playing different social roles: for measurement and reference, for (minimum) quality and safety, and for compatibility and interface properties, linked to processes of standardisation[46] typically along four ways: unsponsored, sponsored, on voluntary basis or by government intervention (ibid.: 231-232). Eco-innovation are such "*innovations that reduce environmental impacts, whether or not that effect was intended*" (Vollebergh/van der Werf 2014: 230; cf. OECD 2009).
    a) **Quality standards** for climate services emerging along with the further development of the services. EU-MACS deliverable 1.2 has elaborated on this in great detail (Larosa/Perrels 2017).
    b) Standards beyond climate services themselves, for other things that require climate intelligence, which can be provided through climate services, can be found regarding investments in specific sectors, administrative and legal approval procedures e.g. in urban planning, civil engineering, tourism, or other sectors, or applied by independent consumer organisations when evaluating products, manufacturing processes, or service quality, e.g. through the magazine Ökotest and the organisation Stiftung Warentest in Germany, which addresses issues of **Corporate Social Responsibility** (CSR) and **environmental compatibility** (Stiftung Warentest 2016). Applying standards to product testing may itself be affected by climate change, when Austrian testers of winter tyres are move to Finland, because there is no longer enough snow in Austria at the right time[47].

8) There is a movement to establish a **discipline of climate sciences**. The term has been used to distinguish from the study of rather short-term weather conditions. The term is often used in the singular, as 'climate science', while the heterogeneity of contributions from many related fields would actually justify to speak of plural 'climate sciences' as a bundle of disciplines still growing together and a

[45] Cf. https://ec.europa.eu/clima/about-us/climate-law_en [10 October 2017]
[46] According to David (1987: 212) "the action of bringing things to a uniform standard".
[47] www.konsument.at/cs/Satellite?pagename=Konsument/MagazinArtikel/Detail&cid=318902383202 [28 October 2017]

new discipline by far mot yet integrated into one whole. Besides the relative newness of the science and the dominance of attention for short-term weather conditions, one key issue with many consequences is the fact that climate sciences are dealing with **uncertainties** in climate projections (Enserink et al. 2013).

a) Uncertainty about what belongs to climate, whether and how far there is climate change, and whether and how politics embark on the very **concept** that there is climate change to such an extent that political attention and action is needed, perhaps even with a sense of urgency, is what makes climate sciences quite open to critical, value-loaded, and controversial debate.

   i. **Discourse wars:** Some observers see it even as one expression of a bigger **fight** over "gaia"—earth as whole organism with quasi-mythical meaning for many activists (Latour 2015). Climate change and the sciences investigating and thereby confirming it, have been and still are among the most heated issues in modern society, science, and politics. If one wants to understand the chances and limitations to climate services, one has to see the discourse "wars" (Mann 2012: 254) about climate and hegemony over how to deal with it, if climate change is assumed to be true at all. Overly simplistic argumentation come from both sides, those in favour of the idea claiming many things, events (like severe storms) are connected to climate change, and so do those claiming there is no need for rush or no global warming at all beyond normal deviation from averages.

   ii. **Framing politics:** Lakoff hints at struggles dealing with the different world views behind politicians (and voters) from conservative vs. progressive camps in U.S. politics, listing such topoi as (1) man seen above nature being there for human use and exploitation, (2) Let-the-market-decide ideology instead introducing environmental regulation, (3) favouring direct over systemic causation by conservatives, (4) deducing the value of the environment through services that environment can provide to humans and (5) discretisation of liberal elite "science behind reports that establish the existence of and impact of global warming" (Lakoff 2010: 74-75). Lakoff also reports about a memo by Frank Luntz advising the Bush administration with the title "Winning the Global Warming Debate: An Overview":

      "*It's time for us to start talking about 'climate change' instead of global warming* […] *''Climate change' is less frightening than 'global warming'* […] *Stringent environmental regulations hit the most vulnerable among us the elderly, the poor and those on fixed incomes the hardest* […] *Job losses […] greater costs* […] *American corporations and industry can meet any challenge, we produce the majority of the world's food,* […] *yet we produce a fraction of the world's pollution.*" (Luntz 2003: 142)

   iii. There is also the incident called '**Climategate**' in course of which emails and other documents of climate scientists and their work were leaked to the public through internet. As Garud et al. analyse:

      "*The contents of the files prompted questions about the credibility of climate science and the legitimacy of some of the climate scientists' practices. Multiple investigations unfolded to repair the boundary that had been breached. While exonerating the scientists of wrongdoing and endorsing the legitimacy of the consensus opinion, the investigating committees suggested revisions to some scientific practices. Despite this boundary repair work, the credibility and legitimacy of the scientific enterprise were not fully restored in the eyes of several stakeholders.*" (Garud et al. 2014: 60)

   Boundaries between established scientific expertise and competence claims from non-science backgrounds clashed once the window went open and everybody could look into actual scientific practice that was no longer protected by a boundary drawn by scientists themselves. Now, in climate services, boundaries will again be transgressed for the sake of opening up to user demands and eye-level collaboration (including knowledge exchange with local data possessors). The **convergence work** (Stegmaier 2009) that is necessary for this will from time to time turn out be a walk on the tie trope. Climate sciences and services may have learned from Climategate, although Climategate will continue to cause **irritation** and trust issues (Garud et al. 2014; Shrader-Frechette 2013; Ravetz 2011).

iv. **Accuracy** of validation and forecasting is a big issue, and problem of action, within climate sciences (cf. Fildes/Kourentzes 2011; Keenlyside 2011) and are thus busy with refining methods of climate data analysis and model testing (cf. Beenstock 2016). In so far, climate sciences are in the making.

  - Research has shown that climates scientists **handle uncertainty** in climate information differently than policy-makers regarding their perceptions of uncertainty: while climate analysts would try to reduce uncertainty "*by generating more information and by improving the knowledge base*", policy-makers would minimise the risk of for making political mistakes (Enserink et al. 2013: 1). "*[M]iscommunication happens in the entire policy making process because policy makers have their own reality and way of dealing with uncertainty, but also* […] *scientists themselves struggle with uncertainty, sometimes taking the role of policy advocates wanting to influence decision-making*" (ibid.). It is still an open empirical question which dimensions of uncertainty climate services are facing, e.g. such in terms of the quality, location or degree of uncertainty, as well as such of normative or cognitive nature (cf. Enserink et al. 2013: 3), with or without user involvement.

  - Moreover, there is a broader dispute about how accurate science can be in times of increasingly perceived uncertainty ("*the complexities of the system under consideration, including technical, scientific, and managerial aspects and the ranges of possible outcomes*"; Turnpenny et al. 2011: 291) and decision stakes ("*potential costs and benefits to concerned parties*"; ibid.). Climate sciences have become enormously **politicised**, which could be seen as a renunciation of what Kuhn has called 'normal science' (Kuhn 1962/1970). Many sciences have been politicised, but climate sciences are particularly affected: on the one hand, 'climate change' or formerly 'global warming' have as concepts been propagated with a lot of effort, thus turning the 'climate' into a political object par excellence; on the other hand, climate sciences have been heavily criticised for no longer being bound by truth, but by a political agenda of fighting for 'the climate' (while those opposing this view on climate use climate and other scientific expertise to challenge the climate sciences claims of urgency emphasising their lack of accuracy—a flaw, which cannot be ruled out entirely). Climate sciences are thus in an **accuracy dilemma**.

b) **Between climate self-service and community involvement:** Beyond the established academic sciences of the climate, as for many other conventional sciences, there is nowadays **citizen science** (Irwin 1995; Bowser/Shanley 2013; Riesch/Potter 2014) as a companion and counterpart. In some cases it has even been argued it can contribute to compensate for budget cuts in universities by involving the community[48]. The promotion of this "community science" approach called 'Weather@home' reads like this:

   "*Australians and New Zealanders can now use their computers to help scientists discover if climate change has contributed to record heatwaves, droughts and flooding across both countries. The Weather@home project, launched in Australia and New Zealand today, is the latest stage of what has been dubbed "the world's largest climate modelling experiment", started in the UK a decade ago. Anyone with a computer and access to the internet can take part by volunteering their computer's spare processing power to run climate and weather modelling simulations, even while continuing to use their computer normally. There are 20,000 people worldwide currently helping with similar climate prediction experiments for Europe, USA and southern Africa. Over the past decade, people in 138 countries with nearly 100,000 different computers have been involved. In the UK, that has enabled the equivalent of 20,000 years of simulations to be run in just three weeks, testing the likely contributing factors to this year's devastating floods.*" (ibid.)

[48] www.climatecouncil.org.au/the-rise-of-citizen-science [20 October 2017]

At the same time, this collaborative approach is a chance to **diffuse** the ideas of climate change and climate science into society, and show citizens how climate effects the environment and the people's lives (cf. Martin 2017; Cormick 2012; Powell/Colin 2009):

> "*Climateprediction.net is a volunteer computing, climate modelling project. We run climate models on people's home computers to help answer questions about how climate change is affecting our world, now and in the future* […]"[49]

Citizens science on climate might contribute to **climate science literacy**, while citizens indeed provide **service to science** (cf. Clavero et al. 2017).[50]

9) **Economic dimension:** Niche climate services and climate issues are discussed as economic factor (cf. Cortekar et al. 2017: 29-30) in many ways—here is just a rough indication of the breadth of this ongoing discourse:

   a) **Socio-economic benefits (SEB):** There is a stream of argumentation that suggests that **social and economic value** can be added through utilisation of weather and climate services (Katz/Murphy 1997; World Bank 2008). The approaches of appraisal of benefits of weather-related services (analyses of cost-benefit ration, willingness-to-pay, and weather service chains) are still developing, with only few studies available, and even more so for climate services (Perrels et al. 2013: 68).

   b) **Job creation:** A key report 'Joint Business Declaration—Increasing Europe's climate ambition will be good for the EU economy and jobs'[51] finds: "*Job creation will result from the expansion of demand for low-carbon energy. But this expansion will not happen accidentally: it will be driven by government policy.*" (GCN 2009: 6). Low-carbon jobs are also defined **service jobs**:

   > "*low-carbon jobs as those that are created either directly as a result of the expansion of the low-carbon energy economy or indirectly through supplying sectors with in that economy with goods and services*" (ibid.: 4)

   The report recommends governments to create job opportunities by (1) being consistent with and targeted with the government policy, (2) robust financing, (3) training of new workforce, and (4) adjustment policies for innovation losers during transition (ibid.: 7). The EU procurement of climate service market innovation is one example for how the European Commission has adopted this view.

   c) **Economic risk:** The World Economic Forum (2015) has identified in its Global Risk Report 2015 the failure of climate change adaptation as one of the biggest risks humanity and its natural environment might be facing.

   d) **Contested space:** The official integration of economic and ecological policies in EU context is not uncontested, as such a sharp comment by Greenpeace from 2010 reveals referring to the 'Joint Business Declaration' (2010):

   > "*Greenpeace EU climate policy director Joris den Blanken said: 'Industry lobbyists shoot down attempts to boost the EU's climate ambition, but they no longer represent the whole sector as more and more companies across Europe want greater climate action. Smart companies want to see the EU lead the global race for green technology and break free of business as usual. Dirty lobbyists in Brussels present climate action as a choice between the environment and the economy, but they are denying people and businesses new opportunities for jobs, green tech and services.*'"[52]

10) **NGOs:** In most regimes contexts, there is nowadays one or more NGOs part of the network of relevant actors. Some of them have a stronger ecological/environmental/sustainability orientation.

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[49] www.climateprediction.net/ [20 October 2017]

[50] See also the Cornell University Lab of Ornitology providing a list of citizen science projects climate change (www.birds.cornell.edu/citscitoolkit/climatechange/citsci). National Geographics informs readers about SciStarter (https://scistarter.com/), a web database for people who want to get involved in citizen science (https://news.nationalgeographic.com/2017/04/citizen-science-projects-environment-climate-change-weather/)

[51] www.theclimategroup.org/sites/default/files/archive/files/Business-Declaration-on-Increasing-Europes-Climate-Ambition_1.pdf [21 October 2017]

[52] www.greenpeace.org/eu-unit/en/News/2010/top-companies-call-for-more-e/ [21 October 2017]

Directly or indirectly climate services related, or even dependent, is hardly one. Greenpeace lobbied already for climate-related services in business context (see above footnote 52).

11) "**Framing champions**" as charismatic opinion leaders and institutional entrepreneurs (Garud et al. 2007) should not to be forgotten in 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.

D. Climate services impact on regimes: Growth of climate services in terms of performance, increase of scope, and political or sectoral relevance would be a typical situation, in which a regime or even landscape could be affected. Climate services help to speed up the transition to a sustainable (and risk aware) society by making long-term, abstract climate threats manageable at the level of local decision making. It may also have impact on the direction of science and technology development (by eliciting user needs and valorisation impact, and stimulate new linkages), and potentially change some structures in the consulting industry (although it is hard to imagine a wave of climate consultants that will have a huge impact). Climate services need to fit this top-down stimulated transformation on a regime level, but it is rather unlikely that climate services themselves will result in disruption of the current regime or major threats to incumbents. Here are three hints (basically linked to niche innovations discussed above), how climate services could at least contribute to regime developement:

1) **Impact on technoscientific and economic innovations:** For all the landscape trends mentioned above, there can be one way of impact on climate services so that they would become more relevant or less required (just remain on the level they are), or the other way around, that climate services while becoming more important and mature, they would be pulling other along, too (like blockchain technology or more holistic consultancy that has an eye on climate, ecosystem, green technology innovation, etc.).

2) **Self-commitment setting example:** The TCFD initiative mentioned earlier, highlights interesting links between climate change and (abrupt or smooth) change of economy, as well as between (self-) interest and (self-) commitment in transparency about climate-related implications for e.g. investments. TCFD introduces this rationale quite publically—not as a topic that could undermine trust in finance products, but as one that could undermine the quality of the products if not addressed properly. In fact, as an innovation journey this means to first establish the issue as a new agenda in finance, cultivate a set of processes that stabilise habit of (more or less) overtly taking climate implications into account (establish a micro-path that grows to a major path the more organisations get committed), and ultimately evolve into the mainstream of finance. In such a way, even the TCFD innovation, once taken up by many other initiative, could rise to having impact on landscape level: for instance, in the way orthodox finance is taking on climate change mitigation and adaptation as a more general focus once having accepted the issue as such. Other sectors could copy this attitude or use it as further justification for their own existing efforts in that direction.

3) **Further commercialisation of common goods:** Next to the emergence and stabilisation of some ecosystem services, climate services may pave the way for the marketisation of other common goods, natural resources, and natural phenomena.—In sharp contrast to this first scenario, climate services could eventually become another trigger of scepticism (or even critique) of turning hitherto non-commercial things into commercial ones.

E. Landscape impact on climate services: Finally, which **overarching developments** (could) have impact on climate services? In this respect, we use to look for developments in the broader landscape of a regime and a niche. Landscape is conceived as to shape activities and interactions by a backdrop affordances with enablers and constraints (Rip 2012: 160-163).

1) **Ending the fossil fuel era** is both a political and a technological endeavour (Princen et al. 2015). Huge socio-technical innovations are necessary, as well as huge governance innovations, as we have shown for the discontinuation of various kinds of incumbent socio-technical systems (Stegmaier et al. 2012; Stegmaier et al. 2018). Energy production through renewables, in particular in smart local energy systems with/without community basis (Koirala 2017) and technology for mobility using renewable energy sources (in combination with the destabilisation (and increasingly politically driven discontinuation) of the internal combustion engine, fuelled by diesel and petrol) are further areas with enormous potential for change. Climate intelligence could become one of the essential "barometers" for assessing the impact of such changes.

2) **Exit from climate governance:** There were always governments, which didn't ratify climate-related international treaties or not didn't comply with the aims accepted. Now, the U.S.A. may withdraw from the Paris Agreement, the issue 'climate change' is erased from government's websites and policy strategy, and the U.S. Environmental Protection Agency (EPA) is led by a declared opponent or adversary of climate governance, systematically de-aligning and demolishing the agency's capacities and capabilities to play a role in climate governance—the (economically) most powerful and riches country in the world undermines the international climate governance through treaty **withdrawal** and **deinstitutionalisation** of its own national climate governance, which is closely linked into international networks. In principle, two kinds of consequences are important for the further climates services development: other countries could follow the example and thus limit the market for climate services, or at least weaken the public, corporate, and political concern for climate change; whereas in the U.S. cities and federal states seem to get ready to take over responsibility for climate governance that has been abandoned on federal level.

TABLE 3: RELEVANCE GIVEN TO CLIMATE CHANGE IN PUBLIC OPINION (EPCC 2017: 15)

Table 1. *What would you say will be the most important issue facing [France/ Germany/ Norway/ the UK] in the next 20 years? (Question 1, unprompted responses)*

France	Germany	Norway	UK
1. Unemployment (36%)	1. Refugee crisis (14%)	1. Unemployment (17%)	1. Immigration/ Immigrants/ Integration (26%)
2. Economic situation (9%)	2. Immigration (13%)	2. Pollution/ environment (11%)	2. Economic situation (11%)
3. Immigration (7%)	3. Poverty/ inequality (9%)	3. Immigration (11%)	3. National Health Service (NHS) (9%)
4. Pollution/ environment (6%)	...	4. Climate change (10%)	...
5. Climate change (6%)	...	...	...
...	10. Climate change (3%)	...	...
	...		...
	12. Pollution/ environment (2%)		12. Pollution/ environment (2%)
			13. Climate change (2%)

3) The **relevance of climate services** goes hand in hand with the **relevance of climate change** in public opinion. After all the efforts, since decades, to establish climate change as 'danger to humanity' in policy discourse, climate change as an issue is still not high in public opinion. Recent post-electoral surveys in Austria and Germany showed that climate change didn't rank very high on voters' list of issues influencing their voting behaviour. On public opinion and climate services in the US, Hamilton (2016) found disparity between opinion and voting behaviour:

> "*Although public acceptance of ACC rose over the years studied, it remains well below the level of agreement among scientists. Public concern also has not translated into voting behavior because parties have become social identities in the United States.*" (Hamilton 2016: 9)

European Perceptions of Climate Change (EPCC) Topline findings of a survey conducted in four European countries in 2016 March 2017 (see also Table 3) shows that lots of other things tend to be more important in the short to medium term:

> "*Climate change was only mentioned by 2% of respondents in the UK (in the month before the EU referendum), by 3% of the respondents in Germany, and by 6% of the respondents in France. In Norway, climate change received more attention than in the other three countries with 10% stating climate change as the most important issue for their country and 11% stating pollution/environment. With these scores climate change was the 4th most mentioned issue in Norway and Pollution/Environment the 2nd most mentioned issue. In France unemployment dominated the responses (36%), while the refugee crisis (14%) and immigration (13%) were the most frequent responses in Germany, and immigration was the most commonly expressed concern in the UK (26%).*" (EPCC 2017: 14)

This could mean climate change should not be (largely) separated from the **other topics**. For instance, winter sport tourism demand for climate services is **related to business continuity** of the sector. Yet, for some regions with reasonable to good prospects also the relative position compared to others counts (i.e. some areas may gain from the demise of other winter tourism areas). How well companies and regions want to consider this is also a matter of attitude. We heard claims that in (parts of) a region in Austria climate change is kind of forbidden topic (on the other hand seasonal forecasts are probably acceptable in that area as far as it is just a pragmatic business support service). One may wonder whether such basic awareness raising is a task of climate services providers—but it hints at the significance of awareness raising activities in various sectors with hitherto low interest in climate services. Some successful climate services providers (e.g. Acclimatise) are very active in communicating urgency e.g. via their websites and newsletters into their networks.

4) **High-Performance Computing** (HPC) is a key to such complex and data-intensive work, as it uses to go into climate sciences and services. Just as advancement of computing only allowed for complete genetic sequencing at some point in technoscientific history, climate sciences and services will always struggle with computing limitations and advance into new territory once another level of computing becomes real. EU High-Performance Computing strategy is thus explicitly linked with EU climate services policy (Pietrosanti 2016). Which next thresholds need to be taken before climate services can actually go a step further, become more precise, affordable, or attractive in another way?

5) **Technology for climate mitigation and adaption** is becoming visible in various fields, most prominently in energy, water, civil engineering, and agriculture, e.g. the latter explained as "*precision agriculture technologies that have the potential to mitigate greenhouse gas emissions*" (Balafoutis et al. 2017). In the Helsinki workshop on climate services for urban planning, and the research in preparation for it, we heard also a lot about how municipalities and local real estate developers try to react with adopted house construction and sewage technology. Climate services contribute to tackling issues in real estate and urban planning e.g. in terms of 'microclimate': "*By analyzing the specific geographic situation and local wind conditions, the influence of future buildings on city ventilation can be calculated and simulated.*"[53].

6) **Social movements** are a sign of issues being strong enough to mobilise individuals and form a self-conscious collective. For climate services are those of interest that have some connection to service, technosciences, or/and climate change/environmentalism.

[53] www.weatherpark.com/microclimate/ [19 October 2017]

a) A recent one with an environmental focus are, for instance, the **no waste** movement[54], which is mentioned here since it shifts the focus from re-cycling to pre-cycling (Zukunftsinstitut 2015), as well as, put in related terms regarding resource life cycles, from ‘cradle-to-grave’ (linear model of materials economy) to ‘cradle-to-cradle’ (no waste through avoiding that things are thrown away). As such, it may represent a form of environmentalism that would hardly seek such forecast as on climate patterns (except perhaps for general legitimating purposes), for it would concentrate on a more principle **approach of avoiding what hurts the climate and the fight against global warming**. ‘No waste’ web sites (and local meetings) usually offer a mix of lifestyle information and services directly related to how to easy on resources in many areas of daily personal life (Black/Cherrier 2010). e.g. regarding traveling[55]. Such a movement of (non) consumption differs from classic concepts of collective action, as usually perpetuated in social movement theory in so far as it represents a form of politics expressed in everyday life behaviour. For this, Beck coined the notion of ‘sub-politics’ (Beck 1997). Besides sustainability orientation, there are also cases in which life style movements have religious backgrounds (Haenfler et al. 2012).

b) **Social manufacturing** is a new phenomenon that goes in line with user-co-production (see section 3.2.2-1 below) in service industries and digital content production and means basically two forms of individual-firm: “*(1) social cloud manufacturing, in which firms outsource manufacturing to individuals, and (2) social platform manufacturing, in which firms provide manufacturing services to individuals*” (Hamalainen/Karjalainen 2017: 796); digital maker-entrepreneurs (Troxler/Wolf 2017) This is of interest because it stands for users being not just put central due to generous providers keenly interested in their demands, but due to their **own initiative**. They are co-creators that invited themselves. The open empirical question: Is this happening anywhere in climate-related contexts, or even with a link to climate services?

c) Older movements that achieved standing in some areas and countries are e.g. the **green parties** (with dedicated climate policy agendas)[56], or **vegetarianism** where climate focus comes down to the idea ‘less cattle, emitting greenhouses gases’ (cf. FAO 2010; Stoll-Kleemann et al. 2017); also think of the ‘**slow food**’ movement putting also some emphasis on ‘shorter transport distances, better climate’ (Slow Food, n.d.). Climate services so far are, however, rather used by big famers (industrial wine production), who do not necessarily have a generic interest in the preservation of natural environment and climate, but in coping with the consequences of agricultural and other mass production (including that of energy) for their intensive farming.

These older and more recent movements are mentioned here because they indicate **social life style and consumer milieu trends** that at least indirectly also affect the three focal sectors of this project: tourism, finance, and urban planning. In all three areas, sustainability-oriented life styles are winning ground, and those making business with such people (in positions of selectors or enablers) have to take climate change into account—be it as a **legitimating** or **de-legitimating** factor for products and management orientations, be it as **constitutive part** of the products themselves.

Services belong to everyday life. Some services are provided by non-professional, non-commercial, bottom-up initiatives. There are specialised and broadly focusing, trivialised specialist and refined trivial services. A climate change or even climate services-related movement is not in sight. The existence of one would mean climate services is in the heads of “normal” people (non-stakeholders, but politically not irrelevant) and has entered consumers consciousness. If neither trivialised climate services nor a social movement backing or promoting the everyday use of climate intelligence is thinkable for the time being, this tells a great deal about the substantial **gap between climate**

[54] Bea Johnson is seen as founding mother of the movement, https://zerowastehome.com/; as European network e.g. https://nowaste.eu/; national e.g. www.zerowastelifestyle.de/category/aktuelles/, www.goingzerowaste.com/; for an overview on no waste bloggers, see http://wastelandrebel.com/en/zero-waste-bloggers/ [18 October 2017].

[55] www.goingzerowaste.com/zero-waste-travel [18 October 2017]

[56] For a list, see https://en.wikipedia.org/wiki/List_of_green_political_parties [18 October 2017]; cf. also to https://en.wikipedia.org/wiki/Green_party.

services and the ordinary citizens' threshold and economy of attention (see E-3 on public opinion).

The list could be longer. Purpose of this exercise was to shift **attention** to various forms of regimes that could have impact on whether climate services as regime component can get established in a world of already established regimes. Citizens science, though not a social movement in the conventional sense, could be exactly one arena, in which climate is in fact adopted by "normal" people outside climate science and climate-affected business (see C-8-b).

The aspects introduced and discussed so far, can and will not be the last word about actual and possible **developments** of and around climate services for a market and a market for climate services.

3.2.2 Outlook: Chances and risks in the context of the climate services innovation journeys

An **innovation journey** can lead through hard-to-travel area. Actors on that journey not only need to know or figure out sooner or later how to handle rough terrain, but also how to appreciate the more enjoyable parts of the journey. The multi-layer perspective gave us a set of angles on climate services innovation. In this final section of the analytical part, we will discuss some chances and risks in the light of the previous analyses. Speaking of 'chances' and 'risks' doesn't in our view doesn't imply that there would be two distinct sets of "factors" that stand either for 'chance' or 'risk'. Rather, we point at some aspects that can turn out either ways. The following is structured along key aspects of an innovation journey associated with (1) taking demand into account, with (2) avoiding lock-ins, and with (3) seeking to link into what helps climate services to stabilise and eventually grow. Traditionally, lock-in is clearly linked to a journey perspective. For demand, we want to mention explicitly that demand is not the treasure that is envisioned at the start of the journey. It co-evolves with the service development.—There can't be final answers in all the questions raised before and now with this conclusion. Rather, it is an outlook on what needs chief attention during the stakeholder interactions and when we draw lessons from them.

1) Overall one may say that the unfolding of the climate services market is a **semi-chaotic process**, which can be facilitated and supported, but not exactly planned (making the notion of a 'road map' for climate services a bit ambitious; cf. DG Research & Innovation 2015). The MARCO idea of a climate services observatory is very useful in this respect, provided it includes a lot of tools and information that promote learning, sharing of information, and enablement of keeping overview and transparency.

2) **Knowledge of demand—demand of knowledge:** A realistic analysis on opportunities and barriers of creating a new market has one first and foremost point of reference: **demand** (Capela Lourenço et al. 2015). It is useful to understand demand both in order to shape supply that answers demand, or in order to create demand in such a way that existing supply lines can tie up. Either way, supply and user sides need to be integrated. The value chain model has its limitations, as it starts from the supply side, but it takes the value created for end-customers to define the chain (versus a supply chain). The question always is how (in which form and in which cases) and to which extent (in terms of frequency and depth) would anybody need climate services. **Knowledge** is needed in order to understand demand: knowledge about users and all other relevant actors involved from supplier (and purveyor) side, and vice versa. This is consensus in so far, as almost all more recent climate service-related (EU) projects start from the assumption that the user perspective should be the main point of reference. —Still what could be **barriers when taking the user central**?

    a) **Indirect vs. direct user focus:** There are, on the one hand, **indirect** forms of gathering such knowledge, such as surveys and estimations above the heads of the users, where users answer to given categories without any guarantee that these categories realistically reflect what users need and about what they are concerned, and there are, on the other hand, more **down-to-earth** ways of getting to know user demands, which would typically mean to get involved with (potential) users in direct collaboration on a boundary object, which can necessitate translation in all directions, and thus create remedy for the mutual knowledge deficit problem.

b) **User-climate services relationship plus additional expertise:** Thus, it may not simply be about knowing what potential users in a specific sector might **need as such**, but one would have to dig deeper and get **data on the situation** of a particular user, gathered where a user operates, and this data needs to be analysed for what impacts of climate may be relevant under which circumstances. User demand can thus only be fully understood when the broader user situation becomes part of the equation. This could mean to look **beyond mere climate aspects**, and it would mean to assess user demand in collaboration with experts on non-climate issues. Such **additional expertise could lead to links** that in the end justify the inclusion of climate aspects.

c) **Demand for intermediaries:** It is however possible that neither users nor climate experts alone would be able to draw the connection. Intermediary expertise is needed: the ability to know both sides, think them together and communicate in plausible how a connection would be useful.

   i. Organisations providing climate data services might find it useful to take on the **role of intermediaries**: with a broadening scopes of tasks that allow them to develop closer interactions between demand and supply sides (Howell 2006; UNEP FI/SBI 2011: 51-52). Intermediaries in the climate services data infrastructure context have been defined as follows: "*People or organisations who work as intermediaries assisting stakeholders in decision making. They help them in specifying information requirements, applying information and sharing experience. They can also help to jointly generate new knowledge. Intermediaries are sometimes referred to as intermediaries or knowledge brokers. Organisations such as the EEA but also consultants, national environmental protection agencies, research institutes providing policy support, and managers of national and international climate and climate adaptation portals as well as facilitators of climate discussion fora can be considered 'intermediaries'*" (Groot et al. 2014: 12).[57]

   ii. Intermediaries format data "***that's easiest for target users to understand***" (NASA et al. 2016: 28; bold text added here). Intermediaries help make sense of data and their role of seems absolutely crucial. Intermediaries should not only be considered as organisations, but also as organisational units or persons within climate data generating and handling organisations, tasked with facilitating communication with providers and users (communication infrastructure). Users, of course, are multiple and have diverse levels of knowledge, which is why intermediaries need to be highly flexible in adapting to diversity in users. In many organisations, there are people that could serve as intermediaries. However, funding is needed to create these positions or to give intermediaries the time to do their work.[58]

d) **Multi-layered user demand structures:** User demand shouldn't be understood as a mono-dimensional or single-layered problem. Rather its demands, concerns, and interests can be **nested** or **ambivalent**, as for instance when a municipality finds some kind of climate intelligence useful for urban planning from a city planners' perspective, but citizens (house owners, real estate developers, tenants, …) would need additional information; or think of local tourism, where various different actors might only be able to afford climate services in a locally valid resolution, but the broader spectrum of users would imply a broader spectrum of information than standard climate services could offer; differences between small or big, incumbent or new actors may lead to similar questions.

[57] Section 1c/i., due to its overarching relevance, has been used again from deliverable 1.3 (Hamaker et al. 2017: 48) with slight modifications. It was originally written by the same author as one those of this deliverables (Peter Stegmaier).

[58] Section 1c/ii., due to its overarching relevance, has been used again from deliverable 1.3 (Hamaker et al. 2017: 50-51) with slight modifications. It was originally written by Peter Stegmaier.

Furthermore, when thinking of user collectives e.g. in tourist regions, different actors may aim at **different objectives** with using climate intelligence: some for investment planning (climate change as a thread to business or public infrastructure), others rather for the protection of the environment (climate change as a thread to environment) – this doesn't need to be a contradiction, but it has such potential. One more specific example would be the existing conflict of interests between lift operators and alpine farmers about how far skiing season should be extended into alpine farming season.

Finally, there is might be a tendency when bigger public or private organisations act (like using services) that focus is more on the **majority** needs or a **statistical average** interest, but not so much on **minorities** or actors with **exceptional** interests (including children, indigenous people, socially marginalised groups like homeless in urban contexts, or small savers and policyholders in finance that will not enjoy the fruits of their institutes having used climate intelligence in the same way as would clients with big corporate assets; or another friction might be unconventional forms of tourism like eco-tourism in relation to the local mainstream).

e) **Blurring of design and use:** Climate services most often entail the use of technology to some degree: portals (Hamaker et al. 2017: 29-37), data infrastructures (Hamaker et al. 2017: 57-59), apps (cf. below 4.2.2), and so on as forms of **user-technology relationship**. In various ways, the production and the consumption of goods, technologies, and services has been blurred in the past. There is the "*creative capacity of users to shape technological development in all phases of* […] *innovation*" (Oudshoorn/Pinch 2008: 554), which needs to be seen also regarding services that could over time face redefinition through **what users really make out of it** (and providers and purveyors would have to make sure they catch up with these developments). Moreover, there is hardly any actor that could claim to be **provider or user only**, since most providers themselves depend in some respect from what others provide them, and users can hardly avoid being providers of input (knowledge, data, values, funds, criteria of relevance, etc.) at some point of a service interaction (Hamaker et al. 2017: 57-59). One might thus consider concepts of 'use' and 'design', 'provision' and 'demand' rather artificial; alternatively, Toffler (1980) introduced the concept of the active 'prosumer', and Elgaard Jensen (2012) speaks of the 'participating user'. Users may fear the complex science behind climate data, but it needs to be seen at which points and in which respects they (can) take the matters into their own hands during the further processes of climate service innovation and diffusion (most likely beyond the usual marketplace).

f) **Non-use and resistance:** User-related service innovation will have to analyse carefully what leads actors not to use (Oudshoorn/Pinch 2003) climate services or to even reject them. Resistance is a common feature of change and innovation processes (Kline 2003), which cannot be reduced to deficiency and an involuntary act, but rather could, at closer inspection, turn out to be perfectly rational, voluntary, and capable (Laegran 2003; Summerton 2004). Wyatt (2003) has identified four different **types of non-users** of technology:

> "*resisters (people who have never used the technology because they do not want to; rejectors (people who do not use the technology because they find it boring or expensive, or because they have alternatives); the excluded (people who have never used the technology because they cannot get access for a variety of reasons); and the expelled (people who have stopped using the technology involuntarily because of cost or the loss of individual access).*" (Oudshoorn/Pinch 2008: 555)

This spectrum can be enriched by four more categories Melby/Toussaint (2016) have suggested (activist, avoider, saboteur, sceptic) and that introduce a more organisational level perspective:

> "*The activist is an active* […] *actor who has knowledge enough about the system to provide constructive criticism. In principle, she is not against the system, but argues that before she uses*

it, the system must be improved. […] *The avoider* […] *is rational in the sense that, when asked, she has many arguments for why she is not using the system without questioning the need of it. However, contrary to the activist, she applies a passive strategy* […] *to ignore the system and keep up with old routines and practices* […]. *The saboteur* […] *sabotages and misuses the system and demonstratively shows her attitude towards it (e.g., in training).* […] *The sceptic can be characterised first of all by her ability to see through – what she considers to be – the espoused goals of the implementers* […]. *She suspects a hidden agenda from management* […]. *The sceptic questions [also] both the trustworthiness of the information that is provided and the overall usefulness and value of the system* […]" (Melby/Toussaint 2016: 261-267)

This second set of categories is crucial for understanding the **organisationally situated refusal** in a typical work environment, within institutional biotopes, and requires us to account for micro-politics and tensions in organisations, instead of too simplistically presuming coherent actors as a whole. It's the employees, the working personnel that has to adopt and appropriate (to) climate services with all the data, computing, and service communication this entails, at the end of the day. In this sense of multiple user-layers, users are not simply the service consuming organisation, but those working there are.

g) Now, if today we need to state that users are (still) rather inactive in co-shaping or even pre-shaping climate services as it is the case with advanced contemporary innovations (Hyysalo et al. 2016), then what tells us that about climate services? Are they—as assemblages of users, providers, technologies, sciences, infrastructures, policies, institutional arrangements, market interactions, perceptions of challenges through climate change (Pinch 2016)—perhaps far behind other service innovation areas? Is the current understanding of climate services an old hat, water under the bridge? Or would it come with **maturation of climate service innovation** that users would be actively pre- or co-shaping specific climate services and their socio-technical infrastructures? This is another open empirical question.

3) **Lock-ins:** There is also a risk of lock-ins on pre-mature stages of development. In this project, we should ask whether and how lock-ins could be avoided, if there is no positive side to it; and by which strategies this could happen.

   a) **Quality and doability:** As discussed above, the impulses set building a market for climate services will most likely—like most other EU policies and business fashions—follow a sort of innovation hype cycle. The major challenge is to use enough time and precision as to arrive at sufficient results in creating climate services infrastructures, quality assuring regimes, and business models that work. Too little effort can lead to **failure** due to lack of quality and doability. However, when it takes too long until infrastructure is harmonised, potential users identified and fit of services co-shaped with them leading to suitable business models, the climate services **hype** might be gone.

   b) Lock-ins can also result from **wrongly adjusted focus** in terms of business models or scope of collaboration:

      i. Climate services could be not flexible enough to offer **payment schemes, collaborative formats, and business models** for all potential and important private and public customers. This may include considerations about how to create collectives of customers, who as single users wouldn't be able to afford climate services.

      ii. **Political, economic geography:** Climate services could too narrowly concentrate on EU, while key developments are global (or at least beyond EU) in terms of collaboration, harmonisation, demand, and usage. Demand and use could link other regions with Europe (value chains beyond EU, within or beyond greater Europe). When climate and business goes beyond national and political boundaries, it could turn out be a mistake not to share climate intelligence e.g. with poorer global South (like immigration pressure on EU due to economic or/and ecological disaster in the South). This might also have to do with wrongly insisting on business models that don't fit with the global scale of climate and climate-related problems.

iii. When opportunities are missed of linking up with the right other, lock-ins can occur. This can mean other services, e.g. related to forestry water, natural disasters or specific sectors; other disciplines, e.g. architecture for saver, more functional, sustainable or/and affordable housing; or higher level or more holistic services like ecosystem services (see section B-1 above).

4) **Cross-sectoral infrastructure:** How will climate services **link into** developments that could amplify, second, or transform one of them or both (besides the above discussed neighbouring niche, regime, and landscape developments)? One form of linking in could be facilitated a lot by strengthening, temporally extending, and quickening inter-/transnational efforts to coordinate and to some extent harmonise climate intelligence production across Europe or beyond. Projects such as Copernicus (C3S) could, if successful, play a crucial role in building a cross-sectoral infrastructure. As the SECTEUR survey found, a

> "*wide range of climate information and impact indicators are currently in use across sectors. Much of this information is shared across sectors, particularly climate-orientated information and information relating to extreme events/trends. Cross-sectoral indicators include for example, mean precipitation, mean temperature, intensity of windstorms and flood frequency. Our findings also indicate that even users not aligned to a specific sector may have an interest in insurance, tourism, agriculture etc. related indicators. This raises implications for designing user-interfaces, such as the C3S climate data store, and suggests that rather than thinking in sectoral terms, it could make more sense to provide information thematically.*" (Alexander 2016b: 50)

For this project (EU-MACS), this observation (and also programmatic vision in the second half of the quote) should encourage to extent finding, probing, and appraising for **links** between the three sectors under investigation (urban planning, tourism, and finance). Another direction for investigating potentials for linking in would be to test collaboration with other (emerging or already established) services in order to get embedded in mainstream chains of knowledge and value creation.

5) **(Trans-) Sectoral intelligence:** When in this project we assess the chances that climate services might play a role and gain some relevance in specific sectors, we nevertheless find it is an issue that overlap between sectors, such as tourism and finance in case of local or regional investments into tourism infrastructure, is connected on business level, although climate intelligence may not necessarily be a direct focus considered for all involved. Climate services seem to either be used unilaterally only, either just by one actor or by actors for themselves. Actors use climate intelligence from different angles for different purpose: lift or skiing slope operators will use it for short- or mid-term staff and investment deployment planning, while banks would either not consider climate change issues at all or perhaps have a rather long-term perspective.

6) **Business models for user collectives:** satisfying a variety of actors in an area (e.g. of local tourism), with climate intelligence provided through climate services that are integrated into a broader consultancy approach

7) **Role of extra-institutional entrepreneurs:** role of this mountain weather cam guy in Austria; role of TCFD; extra in a double sense, first, external to incumbent, orthodox sectoral institutions set of actors, as well as, second, extra in terms of particular figure or organisation, playing a new, unorthodox, or challenging role, possibly even almost ready to become an institution of its own right; can blockade (agent of conventionalism/retention) or try to trigger (agent of change).

8) **Quantifiability:** Market in the conventional sense will only emerge for those parts of climate services that can be realised as businesses (Callon 1998). The question is whether all services and service

aspects will be quantifiable. The further leading question, of course, will always be how far climate services can be commercialised.

Creating or answering to real user demands is a demanding challenge. Demand often has a multidisciplinary character, since (1) a whole variety of professions, technologies, usages, and payment scheme preferences need to addressed, (2) the same also applies for having numerous more or less different organisations, and (3) there are varying levels of emphasis laid on climate-related issues and intelligence for tackling such issues in all these cases (NRC 2009; Meadows et al. 2016: 13). The scenarios used for the workshops echo this diagnosis.

4. A SUITE OF INTERACTIVE FORMATS

Innovation in services needs to take into account, according to de Vries (2006), that "*providers combine their competencies and technological characteristics in a network of organizations to provide new service outcomes or* […] *clients use their own technology to co-produce and to get access to the technology and competencies of a network of providers*". This describes very much the situation in this consortium and the broader CS world. **Customer integration** is therefore crucial both in building a broader CS market and in studying it through this project (Hipp/Grupp 2005; Fox 2011; Zeiss/Groenewegen 2009); Constructive Technology Assessment (CTA) is an adequate means to achieve meaningful collaboration with and substantial input from all sorts of actors involved, especially from those interacting in potential market environments.

Service provision, co-production of services and technologies, and the exploration of market potentials—in a knowledge-intensive economy and an evidence- (or better: knowledge-) based policy-making realm—is a question of **knowledge** (Hipp/Grupp 2005; Felt et al. 2007): 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.

Task of this deliverable is to carve out and suggest a CTA- and multi-layer-perspective oriented **suite of interactive formats** to feed stakeholder engagement in the work packages 2 to 4. In this chapter, we outline the contours of interactive formats and make suggestions about how to keep the various activities in all three stakeholder engaging work packages coherent enough, on the one hand, and how to be sensitive enough to the affordances and constraints in the three distinct fields, on the other hand.

Work package 4 launched a first set of interviews and a workshop in Helsinki on 19 June 2017 as a sort of **pilot** for the entire project. Experiences from there inform this chapter essentially. The description of the approach in WP4 as well as of the other planned interactions, however, includes also newer insights from research and preparation done in the period since the Helsinki workshop. At this point, enough of the contours of the entire suite of formats has already become visible and can now be further stabilised through this reports' integrative effort.

The overall approach is characterised by a **non-standardised** methodology that does its utmost to appropriate individual methods and techniques to the specific qualities and necessities of each field (tourism, finance, urban planning) in each the geographical, cultural, business, and political contexts. As the WP2-4 reports will reveal in more detail, tourism in Austria and Lapland are run under quite distinct circumstances; the same is true for finance when compared in e.g. private banking, pension funds, and reinsurance, as well as in continental Europe and United Kingdom; and, of course, the city and urban area of Helsinki in Finland looks at climate services with different eyes than the city and urban area of Bologna in Italy facing quite different climate challenges (cf. Wenz et al. 2017).

Speaking of 'interactive formats', we address both the methodologies used at stakeholder workshops *and* the interviews carried out with stakeholders (some of which are currently still under way) in preparation of the workshops throughout all three work packages. Especially, the interviews served and still serve a lot for getting acquainted with views, positions, actors, and their networks both on thematic and on personal level. Based on the interviews, stakeholder were/are being invited, or put differently: the access to the three sectors tourism, finance, and urban planning and the selection of interview partners is mainly achieved through speaking to them during the interviews. Not only what they have to say and think about climate services usually becomes clarified in the interviews, but also what they can expect from taking part in EU-MACS workshops. Another important source of information for the preparing the stakeholder interactions is also the prior experiences, connections, and expert overviews among the WP2-4 consortium partners dealing with the actors from the sectors. Finally, the Deliverables 1.1, 1.2 and 1.3 results offer additional insights and questions to be further addressed in the WP2-4 interactions.

4.1 The overall suite of formats in EU-MACS and its variations

In this section, we briefly give **overview** over the spectrum and commonalities between workshops and stakeholder situations in all three work packages 2-4, which focus on engaging with stakeholders.

Table 4 indicates the **general patterns** regarding the methods we used or plan to use in the first workshops and thereafter (in the order of their appearance during the workshops). The table starts with work package 4, since the workshop in this context was held first, on 19 June 2017, in Helsinki). It was attended by all consortium members in order to get a first-hand impression of the interactional practices. For workshops in WP2 and WP3 workshop formats have been developed that, on the one hand, share some elements that allow for comparison, while, on the other hand, tailoring interaction for the specific fields and stakeholder groups:

- All first workshops in WPs 2-4 share the preparation through open non-standardised in-depth **interviews** with stakeholders, of which some will also attend the first workshops.
- They also share some sort of mapping that seemed appropriate for the specific fields:
  - in urban planning (WP4), a set of rather closely connected actors in one greater city area context were identified and their network relations reconstructed with particular emphasis on the knowledges, demands, and practical interests in climate services
  - in tourism, where we find a far broader and rather scattered picture of more or less directly collaborating or connected actors across the country (while a full set of naturally actors from one focal region couldn't be gathered), it was the broader institutional constellation in which actors would consider or are currently using climate services; and finally,
  - in finance, where many actors wouldn't be available for talks in groups with competitors, the diversity of business contexts and models, in connection to which climate services would potentially be used, have been mapped (also since the field of finance is a rather diverse one and local, regional, or European connection wouldn't be accessible).

TABLE 4: OVERVIEW ON WORKSHOP COMPONENTS

WP 4: Urban Planning	**WP3: Tourism**	**WP 2: Finance**
Interviews: with stakeholders (open, in-depth)	*Interviews:* with stakeholders (open, in-depth)	*Interviews:* with stakeholders (open, in-depth)
Mental map: discussion of interview results regarding barriers and enablers in stakeholder comparison	*Institutional map*: discussion of interview results regarding barriers and enablers in stakeholder comparison	*Business map*: discussion of interview results regarding barriers and enablers in stakeholder comparison
Living Labs: development & group discussion of ad hoc relevancies of citizens	*CTA*: discussion of scenarios for implementing climate services into institutional/organizational context in different socio-technical formats	*Expert talks:* getting from user demands to specific business models
CTA: discussion of scenarios for implementing climate services into institutional/organizational context in different socio-technical formats	*Value Proposition*: getting from user demands to specific business models	*CTA*: discussion of scenarios for implementing climate services into institutional/organizational context in different socio-technical formats

Most of the workshops will be audio recorded and the recording used for gathering stakeholders' perspectives in detailed manner. In addition, rapporteurs will take notes during the workshop sessions (a) in order to capture more of the interpersonal dimension of the interactions and (b) get a rough overview of topics already as first orientation of the more detailed analyses.

As an example, this is the more detailed outline of the Helsinki workshop set-up with three interactive parts after a general introduction:

FIGURE 13: THE SUITE OF INTERACTIONAL FORMATS FOR THE HELSINKI WORKSHOP

SUITE OF INTERACTIONAL FORMATS FOR THE HELSINKI WORKSHOP

Peter Stegmaier, Raffaele Giordano, Raffaela Matarrese, Klaasjan Visscher, Ines Vaittinen, Atte Harjanne, Riina Haavisto

9 June 2017

The workshop day will consist of three main phases of moderated interaction.
The three phases follow three different formats, but are linked contentwise.
They also should result, for the participants, in a sequence of encounters with CS that allows them to see CS from three different angles:

- First (MM), look at the process of decision-making in urban planning in Helsinki; the aim is find out how to mainstream this process.
- Second (LL), encounter some existing examples of CS tools already available; the aim is to work with stakeholders to make the tools more suitable.
- Third (CTA), finally should combine foci of the first to workshops into discussion a set of complete CS "packages"; the aim is to finally find which prototype model/scenario (eventually one or more of the tools tested in the LL session) should be further probed in the coming months with the participants.

General intro:
Adriaan Perrels: Intro to CS idea <u>in general</u>

WS part 1: Mental maps
– the CS process (urban planning decision making process; how to mainstream)

1) 10 min Intro: What is CS? Introduction to idea of <u>CS in UP</u>
   a. Presentation of results (in English by RG)

90 min interaction

2) Validation of results: interaction + barriers
   a. List most important elements (variables) to be checked (Ines, FIN)
   b. List most important elements (barriers) to be checked (Ines, FIN)
3) Collection of suggestions about how to integrate CS in UP
   a. For each barriers: participants asked to describe the kinds of CS that need to implemented in order to overcome the barriers
4) … how to improve the information provided by CS
   a. P describe how to change the organisational structure in order to facilitate the flow of information

WS part 2: LivingLabs
– placing the citizens at the centre of collaborative service development, the Living Labs workshop utilized service design tools in exploring the role of the citizen in CS

1) Persona building
   a. Identifying the stakeholders: citizen groups
   b. Building the citizen profiles (personas)
2) Brainstorming
   a. Identifying needs of the citizens in relation to weather & climate data
   b. Identifying needs of the citizens in relation to CS
3) Citizen journey mapping
   a. Ideating on & developing CS models based on the needs identified
   b. Exploring the role of the citizen as an information provider in CS

WS part 3: Constructive Technology Assessment
– the assessment of CS models' implementation into workflow (put results of 1 + 2 in socio-institutional context and find suitable business models)

1) Intro to models (10')
2) Discussion of models (20')
3) Sorting of scenarios on desirability and doability (5')
4) Discussion of desirability and doability of scenarios (20')
5) Discussion of barriers and enablers (30')

The moderators should be able to give also content-related impulses in the discussion; for CTA, we will provide her with some notes. In addition, it would be helpful to for the moderator to have read (1) the interviews made in Helsinki (in order to get familiar with the situation, the institutions and the persons attending the workshop); as well as (2) to

familiarise herself with the major issues reported in Deliverables 1.2, 1.2, and 1.3. This should help her understanding what all the talks are about at the end of the day.
For the LL workshop and follow-ups, it would be wise to study also the tools collected in the excel sheet and the table connecting tools and CTA scenarios also attached to this mail.

This is the detailed script for the CTA part of the workshop, which offers a set of specific angles to consider scenarios of using climate services, while at the same time giving ample space for discussion of aspects stakeholders find important:

FIGURE 14: THE CTA WORKSHOP FLOW FOR THE WP4 HELSINKI WORKSHOP

EU-MACS Helsinki CTA workshop flow

Klaasjan Visscher, Peter Stegmaier

14 June 2017

Time (minutes)	Activity	Intended outcomes	Work forms, materials, questions, etc.
0-5 5-15	Introduction (1) Introduction (2)	• Shared understanding of the goals and set-up of the CTA-workshop • Shared understanding of the main differences between the four scenarios	• Plenary presentation (English) • Presentation of slides 5, 7-8, • Printed slides (in particular slides 7-8, 10-17 and 19; see next page below)
15-35	Discussion of the content of the scenarios	• Further understand and concretization of the four scenarios	• Moderated discussion in 1 sub-group (Finnish) • Questions for each scenario: ○ Which concrete climate service (discussed in the morning session or a new one) would fit as an example for one of each of the four service scenarios? ○ Who takes the lead in developing and providing these services (e.g., FMI, climate consultants, other consultants, local government)? ○ What are the most important requirements for this scenario to become reality?
35-40	Sorting of scenarios on desirability and doability	• Articulation of individual preferences and assessment of the scenarios by different stakeholders	• Individual assignment (Finnish) • Materials ○ A flip-over or whiteboard with the scenarios on it ○ Per participant two A4 (b/w print) sheets of paper with the scenarios on it (one for desirability and one for doability) ○ Pens of two colours (e.g. red for desirability and yellow for doability) • Each participant <u>divides 6 points</u> over the scenarios (pens in 2 colours for desirability, doability). NB Their <u>name or organization</u> should be put on the paper as well! • The moderator makes a round to <u>collect</u> the outcomes (<u>orally</u>, so other participants can hear it) and calculates the <u>sums</u> for desirability and doability of each scenario on the flip-over.
40-60	Discussion of desirability and doability of scenarios	• Articulation of arguments and counter-arguments for scenarios. • Argued choice of preferred and doable scenario.	• Moderated discussion (Finnish) • Questions: ○ For the scenario with the most points on desirability: Why is this kind of climate services preferred? Why not? What would be an ideal climate service for urban planning in Helsinki? ○ For the scenario with the least points on desirability: Why is this kind of climate services not preferred? Why should it be valued more? What would be a useless climate service for urban planning in Helsinki? ○ The same for doability/likelihood. ○ How are the two scenarios in between valued and assessed? • Which (combination of) scenarios should be prioritized in order to incorporate climate change mitigation in urban planning in the next 5-10 years? Let people vote orally and calculate a winner.

60-80	Discussion of barriers and enablers	• Articulation of required actions and potential barriers in the innovation ecosystem	• Moderated discussion (Finnish) • In order to realize the prioritized climate services, what needs to be done? ○ By people around the table. ○ By others (local government, national government, science, IT companies, construction companies, consultants) ○ How should collaborations be shaped? ○ Which technological developments should be prioritized? ○ Which policy developments should be prioritized? ○ Which barriers are expected and how can they be dealt with? (e.g., climate sceptic politicians, lack of international collaboration)
80-90	Reflection	• Articulation of learning experiences • Identification of improvement points for the workshop design	• Plenary discussion (English) • Questions: ○ What is the most important insight you gained from this workshop (related to climate change mitigation, climate services, the differences in perspectives, the complexity of the system, etc.)? ○ Which actions will you take on the basis of these insights? ○ How could this workshop be adapted to be (even) more effective (time, format, content)?

For the WP4 workshop in Bologna, scenarios will be translated into and discussed in Italian language.

The second example is the structure of the workshop in Graz:

FIGURE 15: THE WORKSHOP FLOW FOR GRAZ (WP3)

DAS ERWARTET SIE

PROGRAMM

09:15	Get together
09:30	Begrüßung & Vorstellungsrunde
	EU-MACS Projektvorstellung und Einführung: Klimadienstleistungen im Tourismus – Anwendungsbeispiele und erste Erkenntnisse aus den Interviews
	Interaktives Format zum Austausch über Wünsche und Bedürfnisse, Möglichkeiten und Grenzen von Klimadienstleistungen
12:45	Mittagspause (Buffet)
13:45	Innovative Klimadienstleistungen im Tourismus – Designen wir uns unser Wunschprodukt!
	Abschluss & Ausblick
16:00	Ende des Workshops

The CTA part is similar to Helsinki. The only variation is that the four service scenarios in Graz had been introduced in German language while in Helsinki discussed in Finnish with scenarios described on handouts in English language. The afternoon part of the workshop was dedicated to discussing two typical business cases, one specifically with regards to lift operators views and one regarding the situation and demands of local tourist offices (find a more detailed outline in section 4.7 below).

The last example is the basic plan for interactions as developed for the WP2 stakeholder interactions. These will entail both group workshops and more individual in-depth conversations. This exhibit also shows how examples have been used to concretise scenarios for further discussion. The same has been done for the WP4 Helsinki and the WP3 Graz workshops.

FIGURE 16: THE WP2 CTA STAKEHOLDER INTERACTION

EU-MACS WP2 CTA SESSION FLOW

Time	Activity	Intended outcomes/ goals	Details
0-5	1) Introductions and review EU-MACS project	• Review CS definition and shared under-standing of overall goals	• Acclimatise presenting • Use EU Roadmap for CS' definition of CS • Short review of early feedback on CS use in the sector (from short survey, pre-consultation interviews) • Short description of the below agenda
5-10	2) Introduce CTA exercise	• Shared understanding of the goals and set-up of the CTA-workshop • Shared understanding of the main differences between the four sce-narios	• Acclimatise presenting • If necessary, create hypothetical situations for the participants to think through why actors in a specific finance sub-sector or across several sub-sectors would suddenly embark on using CS • Review the four quadrants of the 'climate service scenario ma-trix' • Review specific examples for each quadrant – relevant for FS sector – see table below
10-20	3) Discussion of the content of the scenarios	• Further understand and concretisation of the four scenarios	• Moderated discussion • Questions for each scenario: o Which concrete climate service (discussed in the morning session or a new one) would fit as an example for one of each of the four service scenarios? o Who takes the lead in developing and providing these ser-vices (e.g., FMI, climate consultants, other consultants, local government)? o What are the most important requirements for this scenario to become reality?
20-30	4) Sorting of sce-narios on de-sirability and doability	• Articulation of individ-ual preferences and assessment of the sce-narios by different stakeholders	• Individual assignment • Materials o A flip-over or whiteboard with the scenarios on it [if doing in person] o Per participant two A4 sheets of paper with the scenarios on it (one for desirability and one for doablity) o Pens of two colours (e.g., red for desirability and yellow for doablity) • Each participant <u>divides 6 points</u> over the scenarios (pens in 2 colours for desirability, doability). NB Their <u>name or organisa-tion</u> should be put on the paper as well! • The moderator makes a round to <u>collect</u> the outcomes (<u>orally</u>, so other participants can hear it) and calculates the <u>sums</u> for desir-ability and doability of each scenario on the flip-over.
30-40	5) Discussion of desirability and doability of scenarios	• Articulation of argu-ments and counter-ar-guments for scenarios. • Argued choice of pre-ferred and doable sce-nario.	• Moderated discussion • Questions: o For the scenario with the most points on desirability: Why is this kind of climate services preferred? Why not? What would be an ideal climate service for an asset manager [in-sert other segments]? o For the scenario with the least points on desirability: Why is this kind of climate services not preferred? Why should it be valued more? What would be a useless climate service for an asset manager [insert other segments]? o The same for doability/likelihood. o How are the two scenarios in between valued and as-sessed? • Which (combination of) scenarios should be prioritised in order to incorporate climate change mitigation in asset management in the next 5-10 years? Let people vote orally and calculate a winner.

40-55	6) Discussion of barriers and enablers	• Articulation of required actions and potential barriers in the innovation ecosystem	• Moderated discussion • In order to realise the prioritised climate services, what needs to be done? o By people around the table. o By others (local government, national government, science, IT companies, construction companies, consultants) o How should collaborations be shaped? o Which technological developments should be prioritised? o Which policy developments should be prioritised? o Which barriers are expected and how can they be dealt with? (e.g., climate sceptic politicians, lack of international collaboration)
55-60	7) Reflection	• Articulation of learning experiences • Identification of improvement points for the workshop design	• Plenary discussion • Questions: o What is the most important insight you gained from this workshop (related to climate change mitigation, climate services, the differences in perspectives, the complexity of the system, etc.)? o Which actions will you take on the basis of these insights? o How could this workshop be adapted to be (even) more effective (time, format, content)?

Examples of types of climate services relevant for financial services include:

MAPS AND APPS	**EXPERT ANALYSIS**
EXAMPLE An FI is interested to invest in the development of a mining operation in Belarus. The FI is interested to know if the operation is exposed to climate change threats. To assess the potential level of exposure to climate risks, the FI decides to investigate by itself what the climate conditions in the asset location would be under future climate scenarios and what level of risk these conditions pose to mining economic activities. **OPTION 1**. The FI request a member of staff who understand climate operational thresholds for mining operations to investigate what climate conditions will look like in the area for the operation and to determine if these pose a risk. This information can be derived from open source online climate portals such at the World Bank Climate Knowledge Portal (http://sdwebx.worldbank.org/climateportal/) **OPTION 2.** The FI request a member of staff who is not familiar with the climate change operational threshold of mining operations to run a quick high level climate risk screening on the operation to determine if it could be affected by a changing climate. To do this, the staff member could access an online climate risk assessment tool, such as Aware for Investments http://www.acclimatise.uk.com/index.php?id=4&tool=1	**EXAMPLE 1.** As part of its internal capacity building strategy, an FI wants to ensure its members of staff are aware of the type of climate risks that could affect the institution´s portfolio. To do this, the FI decides to access available guidelines and information available online outlining potential risks for the sector and request staff members to familiarise themselves with this content. One example of this type of publication is the IFC document "Climate Risk and Financial Institutions: Challenges and Opportunities" available at: http://bit.ly/2yqJq5d
SHARING PRACTICES	**CLIMATE-INCLUSIVE CONSULTING**
EXAMPLE An FI is interested to learn best practices to climate change adaptation in Asian cities to accommodate lessons learnt into future investments in urban development in the region. To do this the FI decides to explore existing case studies on climate resilience in cities in the region, investigating case studies shared online by other actors. This can be done for example through the Asian Cities Climate Change Resilience Network (ACCCRN) interactive website (https://www.acccrn.net/map).	**EXAMPLE** An FI is interested to invest in the construction of a new cargo terminal in a port in the Pacific coast of Mexico. Before it embarks in the negotiations with relevant parties, it wishes to examine the specific climate risks that the port is exposed to and how these risks may affect the economic performance of the port in the future. To do this, the bank may for example commission a study analysing potential impacts to ports.

More workshops are planned and scheduled. They will all include some element of dialogical scenario assessment, on the one hand, but also adapt to the specific situations and stakeholder groups involved.

4.2 Constructive Technology Assessment (CTA) on Climate Services

Socio-economic approaches have been developed, which experiment with **interactive environments** for the adaptation of emergent technologies so that users' preconceptions or lack of knowledge do not prevent them from adopting innovations (Hoogma/Schot 2001). Similar studies focused also on the practices that allow a better matching of supply and demand by creating mutual learning fora (Pinch/Trocco 2002). In the climate data sector specifically, Science and Technology Studies literature has shown that market creation is two-way process whose goal is exactly to define "data" and "services" (Edwards 2010). These **co-productive dynamics** (Jasanoff 2004) uncover the generative role of feedback and learning processes, that should therefore be taken into account (cf. EU-MACS 2016).

4.2.1 CTA as constructive dialogue

Constructive Technology Assessment (CTA) aims at making innovations benefit with concepts from Science and Technology Studies and from Innovation Studies. It is an approach for the **prospective shaping** of technology. The main rational of CTA is to get all concerned actors together at an early enough stage of a development (when modifications are still possible) on the basis of sound research about the subject matter and its context "insert" considerations into developmental process that "improve" what is emerging (Rip/te Kulve 2008; te Kukve/Rip 2011). This is called "*soft intervention, attempting to modulate ongoing […] developments*" (Rip/te Kulve 2008: 50), in this case: building of services and of a market for them through "constructive dialogues" between all relevant (usual and unusual (!) suspects) in a given field/sector (offer them additional insights and networking opportunities besides whom they normally would talk to). CTA is essentially open for adjustments to different contexts of use.

For the purpose of this project, CTA has been **appropriated to contribute to the shaping of services and markets** in a series of national, European, and worldwide efforts to promote climate data and climate intelligence in various areas of policy-making and business. It is expected this can be achieved through seeing it from a variety of different angles, not just business: such as roles of technology, institutional/regulatory frameworks, organisational barriers, users knowledges as input (when they know better what is needed) and as obstacle (when they don't see the potentials of climate services yet, for whatever reasons), social formats of exchange around climate services (market places where providers and users can meet, social media the can use, business models they can co-create, and many things more beyond service as such), infrastructure issues, broader context trends, niche innovations with direct or indirect relevance (e.g. blockchain technology), political obstacles and enablers, and many more) (cf. Harjanne 2017). Thus, in this case, CTA is used as a constructive *technoscientific services* assessment: services fuelled by (climate and other) sciences and (meteorological and other) technologies, and based on infrastructure encompassing a broad array of information and communication technologies.

CTA starts from four crucial angles (cf. Konrad/Stegmaier/Rip/Kuhlmann 2014; Stegmaier 2018): first, the Collingridge Dilemma; second, the assumption of typical patterns of anticipation among differently positioned actors; third, from findings about various patterns and processes of technoscientific dynamics and the co-evolution of technology, science, research, and society; fourth, the experience that "constructive dialogue" on innovations is possible and has positive effects. The **Collingridge dilemma** is a methodological quandary, in which efforts to control technology face a double-bind problem: (a) an information problem, for impacts cannot easily be predicted until the technology is extensively developed and widely used (first horn); and (b) a power problem, since control and change is difficult when the technology has become irreversibly entrenched (second horn). There is yet a third horn: an orientation problem, around such questions as in which direction one should go (Rip 2002), and how to cope with **polyvalence** of emerging science and technology (Nowotny 2015); the same is true for services. CTA action fosters anticipation among differently positioned actors with different roles and views on developments and potentials. However, it cannot be assumed that all the various actors would **anticipate the positions and views of the actors**—be they insiders or outsiders in a field of innovation—on their own initiative (Garud/Ahlstrom 1997). With Rip (2006), we focus on those, who actively pursue a particular technological (or service) development, while the latter takes centre stage in their world views ('enablers'), as well as on those, for whom the very technology (or service) is nothing else but one among other options ('selectors'). Furthermore, we find that while there is a lot of variability and limitation to anticipation, the co-evolution of technosciences (and services) in their social embedding nevertheless seems to follow some **patterns**. These general dynamics can be used to develop and probe realistic scenarios in **communicative interaction**.

Here it is not so much about "better society through a better technology" (this is where CTA originally comes from), but rather about "**better services for better markets for a better fighting of climate change**". The aim is to bring a necessary wealth of different views into the active developing of markets for climate services. Much of this will help to look beyond the confines of mere business models and appreciate the contexts of making climate services a business more systematically and which a broad spectrum of relevant issues. Much of this will be fruitful for building market structures and business formats that better fit into practical, infrastructural, organisational, and political circumstances in which they are embedded. Never the less, there is always also the chance and ambition of CTA to help efforts of building new things by **sensitising for concerns and red lines** that can arise from broader society or from specific groups in society. This doesn't mean CTA plays an ethicist's role in shaping innovations, but it makes aware and translates existing objections or such that can be expected to occur. CTA in this respect works like a **search tool and amplifier** for all kinds of relevant discourses around climate services. It's a reflective device that helps triggering constructive debate.

4.2.2 CTA scenarios on climate services

Four scenarios have been developed: the 'maps & apps scenario', the 'expert analysis scenario', 'climate-inclusive consulting scenario', and the 'sharing practices scenario' (cf. tables 5 and 6). Along five different categories, the scenarios allow for distinguishing constellations that are typical for contemporary service practice. Besides specific characteristics of 'users' and 'service providers', these scenarios also include more context-sensitive **dimensions**: (a) technological features of climate service provision and therefore a dedicated appraisal of socio-technical circumstances under which climate services could function for various specific users and providers; they also focus on (b) requirements for value creation and therefore allow for reflection on underlying business models; finally, (c) with the category 'potential tensions', we include attention for further practical, institutional, organisational, or other influences on what counts as and could be used as a climate service in specific contexts.

Underlying the scenarios are two dimensions, the first related to 'customization', the second related to 'integration'. The **customisation** dimension differentiates between services that are tailored to the needs and wishes of a specific customer, and services that are developed as a generic offering to a larger group of customers (Lovelock 1983). The **integration** dimension distinguishes services that are offered as specialized climate services, from services that integrated in a broader package. In the European research and innovation roadmap for climate service (DG for Research and Innovation 2015), both dimensions are mentioned to characterize services for different kinds of customers and the complexity of decision making situations (next to other characteristics, which are more content related). They are particularly useful because they do not only distinguish between different kinds of customer needs, but also between alternative business models for service providers, and – to a certain extent – different sets of barriers and enablers.

TABLE 5: OVERVIEW OF SCENARIO CORE CHARACTERISTICS

	Generic	*Customised*
Focused	**Maps & Apps:** • Generic climate services • Freely or cheaply available … • … to all users	**Expert Analysis:** • Scientific, professional, commercial, monodisciplinary climate services • Tailored to specific decisions and decision-makers
Integrated	**Sharing Practices:** • Mutual services on … • … adapting and mitigating climate change in specific environments • Available to all users	**Climate-inclusive Consulting:** • Professional, commercial and … • … transdisciplinary climate services • Tailored to specific decisions and decision-makers

In **the 'maps & apps scenario'** users themselves incorporate climate data into their decision making. All users (civil servants, politicians, entrepreneurs, citizens) have in principle the same climate data available, typically in the form of digitalized dynamic maps. Public meteorological institutes and universities provide meta-services (measuring, modelling, integrating models) and commercial application designers take the lead in making user interfaces (e.g., 'Google Climate'), which are made available to a large audience. The data infrastructure must be unified and preferably global to enable these applications. Open source and other forms of open data play an important role. Value creation depends on good user interfaces and users that are knowledgeable enough to handle the information they get. Although the models are generic, sufficient accuracy on local situations is required for climate change informed decision making. The services build on EU or global collaboration and public support. Tensions could arise from when 'one size' does not fit all decisions and decision makers. Even when applications would differentiate between user groups and situations, it is still the question whether the generic data is sufficient for the complex decision making situations, and whether all users are competent to interpret the data (and the uncertainty in the models). Another risk is that – when this service market would become interesting from a commercial perspective—large (Silicon Valley based) IT companies would come to dominate the climate services industry and control the data provision to decision makers. The question is whether this is desirable.

Opposed to this focused and generic approach, the **'expert analysis scenario'** would entail users making decisions based on expert analysis of the effects of climate change for their specific location and problem. Services would be focused and customised. Users would pay for accurate data and a highly contextualized interpretation of the consequences of climate change. Public meteorological institutes and universities provide generic meta-services (measuring, modelling), while a range of specialized commercial firms deliver tailored climate advice. Data infrastructure would remain heterogeneous, with a variety of measuring grids, adapted to the local situation. Value would be created through specified user questions being answered by specialized and professionalized climate service providers. Government would support expertise development, disciplinary professionalization and climate entrepreneurship. Potential tensions would arise when climate expert analysis leads to biased analysis and suboptimal solutions for complex problems, not taking into account expertise from adjacent disciplines. Another risk is that the focus will lie too strongly on the accuracy of the local analysis, potentially leading to a 'drowning in details' and 'paralysis through analysis' among decision makers.

The **'climate-inclusive consulting scenario'** stands for a customised climate service integrated in a broader consulting service, for instance aimed at financial risk management, urban planning, or regional development. Service would be provided by public or commercial organizations that integrate local climate data and analyses into their services. Cross-disciplinary commercial firms would deliver tailored climate advice, based on what public meteorological institutes and universities deliver as meta-services (measuring, modelling). Data infrastructure would have to be moderately homogeneous and rooting in a dense, locally adapted measuring grid. User-oriented cross-disciplinary consulting engineers would create value by using climate knowledge that is integrated with other knowledge (e.g., geology, civil engineering, sociology). Government would support climate knowledge development in established consulting and engineering firms. This scenario might hamper the professionalization and the development of relevant expertise of climate services. Besides, climate issues might become marginalized in cross-disciplinary services, which take a broad range of other issues into account.

In the **'sharing practices scenario'**, decisions and designs for climate change mitigation would draw on publicly available databases with best practices and peer-to-peer exchange by people in similar situations that feed their experiences into data-bases. Users would here also be the producers of climate services. The focus would lie on anticipation and mitigation strategies. Public meteorological institutes and universities would provide additional meta-services (measuring, modelling, integrating). Commercial platform providers and brokers facilitate sharing, e.g. along more or less popular social media formats. Technically, this approach would rely on open source and open data in a unified data infrastructure (on climate change and mitigation practices). Value creation would depend on knowledgeable and engaged local governments, entrepreneurs, civil servants, and company employees as pro-sumers of climate services. Accurate local climate data would also be an essential prerequisite. Support for sharing platforms would come from governments on national and from European level. This scenario may hamper the development of relevant expertise. With a lack of professional climate service providers, climate change mitigation may become overly dependent on local politics or individual company strategies.

With respect to the typology of **non-users** (as in section E-1-g above), we assume for **Maps & apps** neither exclusion nor expulsion, but possible resisters or rejectors, if not fitting users requests, or lack of accuracy. Regarding **Sharing practices** the situation may be likewise, but one may need to share oneself before getting relevant input from others. **Expert analysis** may face all forms of non-use, either because they are too expensive, or not considered relevant enough. The **integrated consulting** may have less resisters or rejectors (climate services get in through the services clients already use), but they will expensive, especially when integrated in boardroom consulting (think of McKinsey, for instance, as mentioned above in section C-3).

TABLE 6: DETAILED OVERVIEW OF SCENARIO SKETCHES

	Maps & Apps	*Sharing Practices*	*Expert Analysis*	*Climate-inclusive Consulting*
Users	• Users themselves incorporate climate data into their decision-making • Same climate data for all users	• Decisions & designs draw on public databases with best practices & peer-to-peer exchange by people in similar situations • Experience fed into databases	• Users decide based on expert analysis of climate effects for specific location & problem • Pay for accurate data & a highly contextualised interpretation of consequences	• Users receive integral advice on how to cope with climate change in decision-making
Service providers	• Public meteorological & university institutes (PM&UI) provide meta-services (measuring, modelling, integrating) • Commercial applications designers make user interfaces	• Users also as producers of climate services • PM&UI provide meta-services (measuring, modelling, integrating) • Commercial platform providers & brokers facilitate sharing	• PM&UI provide meta-services (measuring, modelling) • A range of specialised commercial firms deliver tailored climate services	• PM&UI provide meta-services (measuring, modelling) • A range of specialised commercial firms deliver tailored climate services • Consultancy may accompany implementation
Technology	• Unified data infrastructure • Open source, open data	• Unified data infrastructure (on adaptation/mitigation practices) • Open source, open data	• Heterogeneous data infrastructure • Dense & locally adapted measur-ing grid	• Moderately homogeneous data infrastructure • Dense and locally adapted measuring grid
Value creation	• Good user interfaces • Knowledgeable users • Global data infrastructure • Sufficient accuracy in generic models	• Local governments and civil serv-ants knowledgeable as pro-sumers of climate services • Accurate local climate data • Government support for sharing platform on national and European level	• Specified user questions • Specialized and professionalized climate service providers • Government support for expertise development and measuring infrastructure	• User-oriented cross-disciplinary consulting engineers • Climate knowledge integrated with other knowledge • Government support for climate knowledge development in established firms
Potential tensions	• Does 'one size' fit all decisions & deciders? • Will Silicon Valley dominate the climate services industry?	• Will climate change mitigation become overly dependent on local politics? • Will the development of relevant expertise be too dispersed?	• Risk of 'drowning in detail', of 'paralysis through analysis'? • Risk of biased expert analysis or suboptimal solutions?	• Will climate issues come too short in transdisciplinary services? • Professionalization of CS & expertise-building hampered?

4.3 The empirical assessment of social networks interested in climate services in urban planning (WP4)

A series of interviews with stakeholders was done from were the connections among the three main elements in an organizational network, i.e.: agent, knowledge and tasks (Carley 2005) were reconstructed. For this purpose, the organizations risk analyzer (ORA) approach was adopted (Carley 2002). In order to implement this approach, we considered the whole set of actors involved in flood risk management as one heterogeneous organization (Leskens et al. 2014). The ORA method theorizes that the effectiveness of a social network is not limited to the way the different actors interact with the others. The meta-matrix framework allows to analyse the complexity of the emergency interaction network accounting for the role of knowledge and tasks, and of the interconnections among the key elements – i.e. agent, knowledge and tasks. The individual interviews were also used to define the other matrices. A network map has been used to analyse and unravel the complexity of interactions, allowing the identification of the key elements in the network and the main vulnerabilities. To this aim, graph theory measures are implemented by adopting the measures for the identification of the key actors, their definition according to the graph theory and the meaning in urban adaptation (Freeman 1978; Carley et al. 2007). Considering the complexity of the urban planning network, the vulnerability elements are identified through the combination of different measures. More detail and results will be presented in Deliverable 4.1.

For the Helsinki pilot workshop we selected a couple examples of climates services tools (table 7), sorted them into the climate service typology (see tables 5 and 6) and discussed during the workshop.

TABLE 7: EXEMPLARY TOOLS FOR SERVICES TYPOLOGY

	Maps & Apps	**Sharing practices**	**Expert Analysis**	**Integrated Consulting**
Users	- EcoCities Spatial Portal - STAR tool - Green Infrastructure Valuation Toolkit	- Climate Central - Inhabitat - Roof Chicago Green	- EcoCities Spatial Portal - Disaster Alert	- Green Infrastructure Valuation Toolkit
Service providers	- Copernicus - Disaster Alert - EcoCities Spatial Portal		- EcoCities Spatial Portal - Disaster Alert	-
Technology	- Adaptation Support Tool (AST)		- Storm Water Management Model (SWMM) - EPA's National Stormwater Calculator (SWC) - STAR tool	- Storm Water Management Model (SWMM) - EPA's National Stormwater Calculator (SWC) - Adaptation Support Tool (AST)

4.4 The empirical assessment of climate service-related frameworks in tourism (WP3)

A literature review and semi-structured interviews with climate service providers and (potential) end-users from the tourism sector form the foundation for **identifying the different types of stakeholders** and their perceived climate risks, the current use of CS, perceived barriers and user needs. The information is prepared and classified for the purpose of the subsequent stakeholder interactions.

Figure 17 shows a map of the **institutional framework and arena** of relevant actors: tourism businesses, tourism associations, public administrations, various other interest groups, related sectors; on local, provincial, national, international levels; broad network view of the institutional situation in Austria with focus on potential climate services users. More detail and results will be presented in Deliverable 3.1.

FIGURE 17: A PRELIMINARY SET OF THE INSTITUTIONAL FRAMEWORK WITHIN WHICH CLIMATE SERVICES OPERATE IN AUSTRIA (DAMM ET AL. 2017)

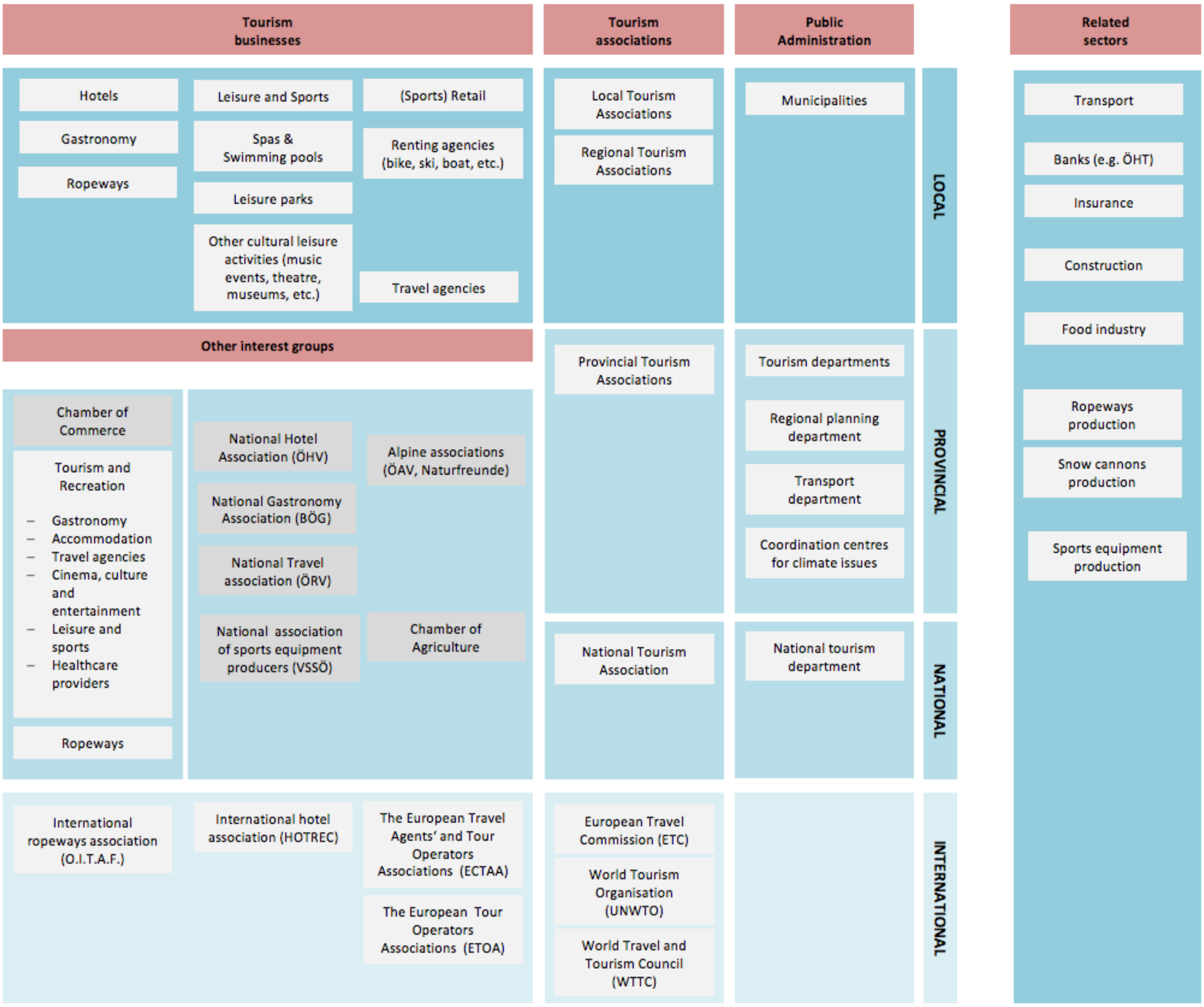
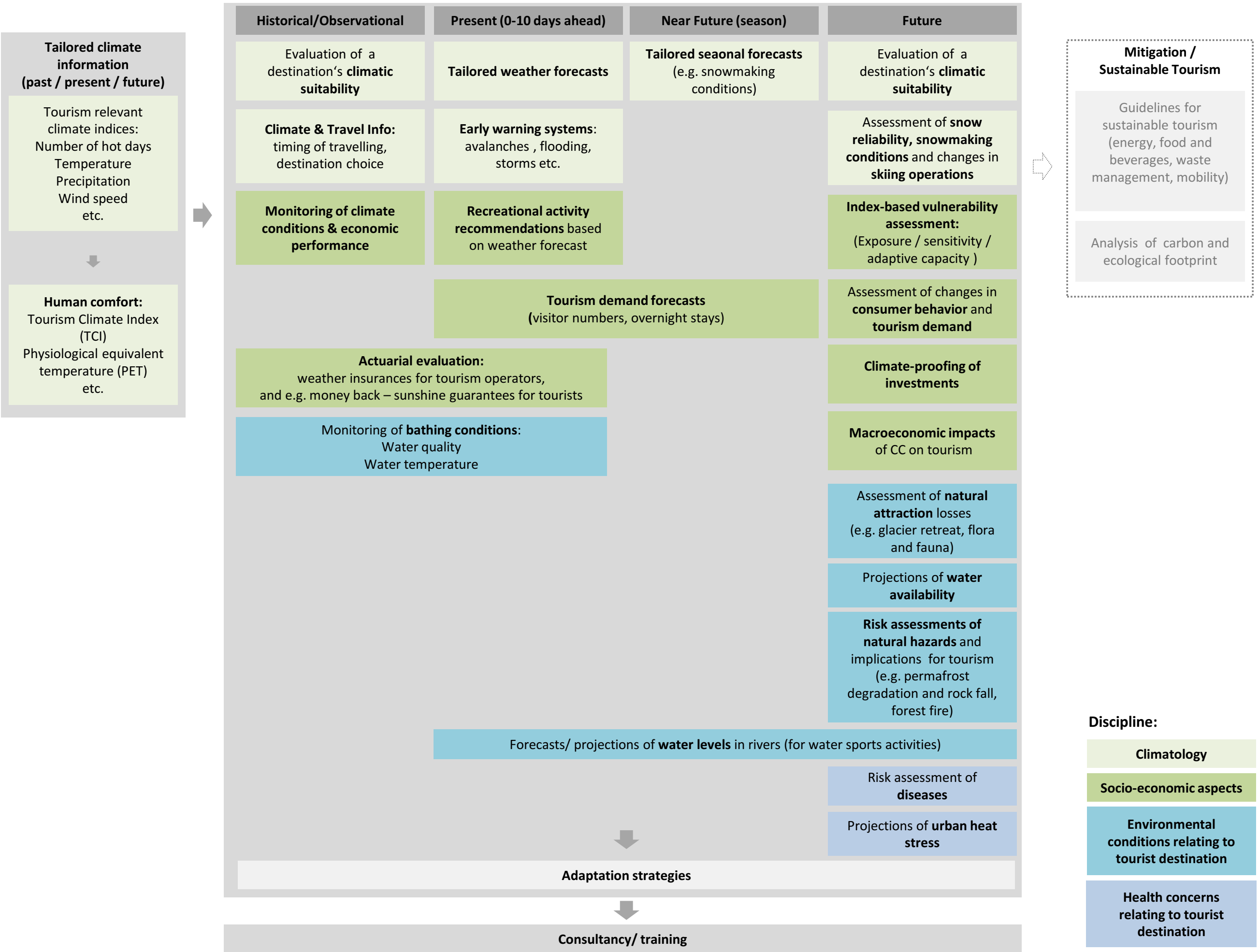


Figure 18 shows a preliminary set of **themes for climate services** in the tourism sector, based on tailored climate information and human comfort indices/measures: with respect to past, present (0-10 days ahead), near future (seasons, years), and more distant future; in the context of climate adaption and mitigation/sustainable tourism strategies.

In a first workshop bringing together the different types of **stakeholders**, previous findings and assumptions are verified and an initial portfolio of existing and desired climate services is discussed. Building on the results of the interviews and the workshop, subsequent sets of existing and potential future climate services 'packages' are proposed, rated and discussed with the participants either bilaterally or in the form of small focus groups in the period between December 2017 and January 2018. New obstacles and enablers as well as innovation opportunities may be identified.

FIGURE 18: A PRELIMINARY SET OF THEMES FOR PROVIDING CLIMATE SERVICES IN TOURISM (DAMM ET AL. 2017)



4.5 The empirical assessment of climate services uptake in the financial services sector in Europe (WP2)

Early consultation with existing contacts within the sector establishes the wide range of financial services providers present in the sector. Table 8 provides this breakdown, which allows for deeper investigation into events, meetings, workshops, and umbrella groups relating to each of the sub-groups. A literature review of the historical application of climate data and information allows for development of a baseline of current and historical CS use within each of the sub-sectors. A literature review specifically looking at the governance of climate risk in the sector allows for important new developments around the calculation and disclosure of climate risk (and therefore climate services' use)—both voluntary schemes such as the Task Force on Climate-Related Financial Disclosure (TCFD) Recommendations, and regulatory schemes such as France's Article 173. In-depth interviews based around CTA methods, either on an individual or small group basis are scheduled for October 2017 – January 2018, by leveraging existing contacts in the sector, as well as through new connections made by attending a number of targeted industry events. Short interviews or a questionnaire is conducted before these sessions. The survey/questionnaire is designed to elicit perceived climate risks, the current use of CS, perceived barriers and user needs. The in-depth sessions are designed to elicit preferences for certain types of climate services products as well as tease out longer discussions one barriers and enablers to the use of climate services products. Semi-structured interviews with climate services providers to the sub-sectors of the financial services sector allows for specific feedback from stakeholders to be provided, and a chance to gauge whether or not the providers may be able to respond to these demands.

TABLE 8: FINANCIAL SERVICES SUB-SECTOR BREAKDOWN

	Ratings agencies	Development Banks	Retail Banks	Commercial Banks	Investment banking/houses	Insurance and reinsurance	Asset Management	Asset Owners	Other non- bank financial firms	Others
Activities	Assign a letter grade to each bond, which represents an opinion as to the likelihood that the organisation will be able to repay both the principal and interest as they become due	Lending, project development	Checking and savings, mortgage, credit cards, currency exchange.	Asset finance, project finance, general purpose credit lines	Cap ex financing, broker investment, manage mergers and acquisitions, equity, IPOs	Asset and investment management, investment analytics; insurance and re-insurance	Hedge funds, private equity banking; mutual funds; exchange traded funds; wealth management	pension fund owners	Credit unions, savings and loans, fintechs	sector associations, academics, special advisory firms, financial services consultants, think thanks, CS providers
Examples	Standard & Poor's, Moody's, Fitch ratings	EBRD, EIB, World Bank, IFC	Barclays, HSBC, Lloyds, Nationwide, Santander, RBS; community level banks, national banks	Barclays, HSBC, Lloyds	Barclays, Deutsche Bank, JP Morgan, CitiGroup	Aviva, Axa, Munich RE	Merrill Lynch, UBS, Fidelity, Charles Schwab	Church of England, Public employees' pension funds	Klout, Lending Club, Affirm, Betterment	

4.6 Living Labs: the dialogical assessment of citizens' viewpoints

Living Labs (LLs) are defined as **user-centred, open innovation ecosystems** based on systematic user co-creation approach, integrating research and innovation processes in real life communities and settings. LLs are both practice-driven organisations that facilitate and foster open, collaborative innovation, as well as real-life environments or arenas where both open innovation and user innovation processes can be studied and subject to experiments and where new solutions are developed. LLs operate as intermediaries among citizens, research organisations, companies, cities and regions for joint value co-creation, rapid prototyping or validation to scale up innovation and businesses.

The Living Lab (LL) approach is applied in WP4 stakeholder interactions. The focus of these stakeholder interactions centres around interactive market exploration and collaborative service development as well as real life experimentation. The Living Lab approach **places citizens at the centre**, pivoting around the citizens point of view in iteratively matching the supply and demand of climate services. While the role of all triple helix actors (government, industry, academia) is considered throughout these interactions, the shift towards a quadruple helix model (government, industry, academia, citizen) is emphasized.

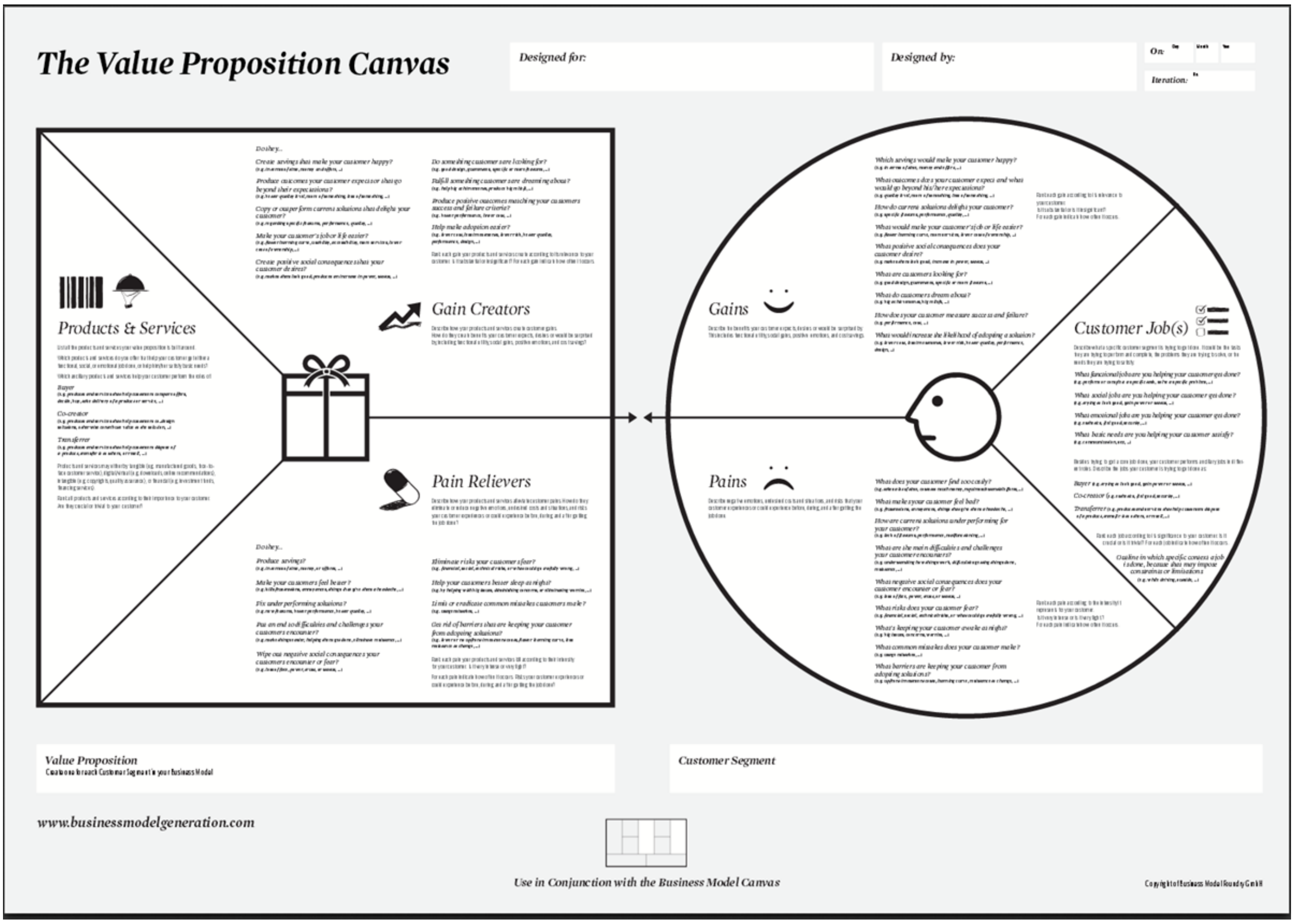
Following the exploration phase, the collaborative development of virtual climate services aims at creating the right preconditions for climate services, while Living Lab framing aims to support the remaining phases of the LL. This support is provided by a **plan of activities** to be implemented in the two participating cities, while building on existing climate plans. Furthermore, an evaluation framework is developed in order to assess the effectiveness of the LL approach that is to be implemented by the local stakeholders in their co-creation processes.

4.7 Value proposition: the dialogical assessment of business designs

The WP3 Graz workshop in September 2017 was co-moderated by UnternehmerTUM. UnternehmerTUM is a centre for innovation and business creation as an enabler for innovation. Moreover, UnternehmerTUM is an associate Institute of Technische Universität München. It uniquely develops and connects talents, technologies, capital and customers focused on several topics—in this case climate services.

It conveys concepts to seize entrepreneurial opportunities and build sustainable businesses on those foundations.

FIGURE 19: THE VALUE PROPOSITION CANVAS



The purpose of the 'business design' approach is to develop a 'problem solution fit' in the climate services field. For this, the **customer and user demand** needs to be analysed to finally find a successful 'business model'. This will be based on standard business modelling methodology using a part of the 'business model canvas'[59], so called the 'value proposition canvas'. This approach is a widely used strategic tool for **facilitating business model innovation** for start-ups and corporate companies on the one hand and the other hand it is used for analysing and visualizing existing innovation. The 'value proposition canvas' has its focus on the customer dimension and the product dimension.

[59] www.businessmodelgeneration.com/canvas/bmc

FIGURE 20: THE GRAZ WORKSHOP FLOW REGARDING BUSINESS DESIGN/VALUE PROPOSITION (WP3)

EU-MACS GRAZ BUSINESS DESIGN/VALUE PROPOSITION WORKSHOP FLOW

Patrizia Pawelek

26 September 2017

Time (minutes)	Activity	Intended outcomes	Work forms, materials, questions, etc.
0-25	Introduction + Input	• Shared understanding of the six principles of Business Design • Shared understanding of the main benefits of Business Design • Explanation of the Value Proposition Canvas in detail	• Plenary presentation (German) • Presentation of slides contain description, examples and literature recommendations • Value Proposition Canvas (Customer Jobs, Pains, Gains →Product/Services, Pain Reliever, Gain Creators) • Slides will be shared after the workshop
25-30	Dividing the group into 2 working groups	• Deeper understanding of the customer segment; developing specific new ideas for the field	• Group 1is developing ideas for the scenario: Skiing management • Group 2 is developing ideas for the scenario: Tourism regions
30-90	Working groups	• Discussing the status quo and developing new solutions by discussing with different stakeholders in the group	• Materials ○ Value Proposition Canvas per group ○ Pens ○ Post its • Each participant can write down his/her idea on a post it and put it on the canvas; the group is discussing the ideas • The moderator (each in every group) makes notes, asks questions and leads the group through the canvas
90-120	Presentation and Reflection	• Presentation and Discussion of the outcomes	• Presentation by one speaker of each group • Moderated discussion (German) • Reflection of working with the tool

4.8 Web based explorations – structured choice experiments

Based on analysis of the stagewise identification, selection, specification and use process a climate service chain analysis (CSCA) concept is formulated, which is reminiscent of, but more complex than weather service chain analysis (WSCA; Nurmi et al 2013; Perrels et al 2013). On the basis of interview material from Tasks 2.1 and 3.1, WP1 survey results, and the CSCA concept a sequence of questions and CS product feature choices will be tested with selected stakeholders from WP2 and WP3.

5. IMPLICATIONS FOR THE PROJECT

Instead of conclusions, at this stage we prefer to close with additional suggestions for the workshops derived from the above analysis. They carry key ideas for better enabling climate services by overcoming major barriers. Their assumptions could be probed in stakeholder interactions and analyses throughout work packages 2-4.

Implication 1—limitations of sectoral focus: *On top of sectoral analyses it is relevant to identify cross-sectoral, sub-sectoral, trans-sectoral or even non-sectoral phenomena that might already have or win impact on climate services markets in the future.* (Referring to findings in sections 3.2.1-A-1, 3.2.2-3 and 3.2.2-4)

Implication 2—roles of technology for climate services market building: *Technology and sciences play a crucial role for climate services in multiple ways: as instruments of research, as infrastructure, and as means of communications. Climate services need to observe and probe novel technoscientific trends and possibilities in order not to lose contact with innovation.* (Referring to findings in sections 3.2.1-A-4, A-7, B-2, B-3, B-4, C-1, E-1, E-5, 3.2.2-1-e-f)

Implication 3—anticipating the end of subsidies: *Providers, purveyors, and users (or: enablers and selectors) of climate services need to develop plans to become independent of subsidised projects (getting out of the protected space), while public procurement might remain an important segment of the market.* (Referring to findings in sections 3.2.1-E-1, E-2, E-3)

Implication 4—trade-off between ecological and economic targets: *Climate intelligence by climate services may lead to more sustainable management and policy, but not necessarily; it could also foster strategies that push the limits of avoiding climate protection until profitability can no longer be claimed.* (Referring to findings in sections 3.1.1, 3.2.1-A-4, A-4-c, A-6, 3.2.1-B-3, 3.2.1-C-8-a, C-9)

Implication 5—allowing for a variety of climate services: *Specialized, tailored services provided by climate experts receive most attention, but also climate services integrated in management consulting, policy consulting or engineering consulting, climate services shared by knowledgeable users, climate services embedded in technology based consumer services, as well as packaged in insurance products and other risk management service products should be considered in the interaction with stakeholders.* (Referring to findings in section 4.2.2).

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