A STRUCTURED ANALYSIS OF OBSTACLES TO UPTAKE OF CLIMATE SERVICES AND IDENTIFICATION OF POLICIES AND MEASURES TO OVERCOME OBSTACLES SO AS TO PROMOTE UPTAKE

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Glossary of Terms

Term	Explanation
business model	The representation of a firm's underlying core logic and strategic choices for creating and capturing value; in a more practical sense it are the conditions and assumptions by means of which a provider or purveyor offers products and realizes transactions
climate service	The transformation of climate related data – often together with other relevant information - in to customized information products, offered as such or embedded in consultancy and/or education [condensed version of European Roadmap definition]
climate service: seasonal forecast	A prediction of weather tendencies (often expressed as probabilistic deviations from long term averages typical for the considered period and area) stretching from approx. 1 month to 6 months or more.
climate service: long term forecast	A prediction of climate conditions for a certain area and for typical time units (diurnal to annual) referring to decadal or multi-decadal averages several to many decades ahead
Constructive technology assessment (CTA)	The modulation of ongoing technological developments by 'soft intervention' aiming at a better understanding of the technology in focus and its impacts. There are three generic strategies for CTA: technology forcing, strategic niche management, and loci for alignment.
market	A medium, physically located or virtual, where supply and demand of near substitutes of products and services meet with the purpose to engage in mutually beneficial transactions between suppliers and demanders; a perfect market is fully transparent for all actors in terms of prices and product features, whereas no actor has a dominating position, and new suppliers and users can easily enter
market failure	The situation where a market has imperfections as compared to the theoretically defined state of 'perfect competition' , such as shortcomings in price and/or product transparency, presence of market dominance, and barriers to entry
Meta-data	Description of a data file in terms of its contents, origin, ownership, allowed level of openness, etc.
Public service contract	An agreement between a public* organisation and the central government to provide a certain service at a certain quantity and quality level against an annual payment; the public service contract can assume there is other income (e.g. from service charges) or no other income; *) it can also be a private company with designated public tasks (as is more common for infrastructure based services)
value chain	The pathway of processing stages of a product or service through which value is added; a complex product with abundant economies of scope such as a climate service (for a particular purpose) can often evolve through more than one pathway, while more pathways may be added (and others abandoned) over time;

List of Abbreviations

C3S	Copernicus Climate Change Services
COPERNICUS	Sub-programme in H2020 research programme oriented to earth observation and derived services, including C3S
CS	Climate service(s) (used throughout the report)
ISO	International Organisation for Standardisation; international standard-setting body composed of representatives from various national standards organizations; ISO numbers refer to particular protocols.
NMS; NMHS	National Meteorological Service, National Hydro-meteorological Service (standard abbreviations in WMO context)
SDG	Social Development Goal (UN concept)
SME	Small and medium sized enterprise(s)
WP	Work Package (WPn – Work Package no. n (1 – 7))

EXECUTIVE SUMMARY

This report is the first of the synthesizing work package (WP5). The overall purpose of WP5 is to pull the findings from the focus sector explorations finance, tourism and urban planning together and integrate them with the scanning findings from WP1, so as to identify the most effective public and private policies and measures, upstream and downstream innovations, and climate services business models for engendering a growing and flourishing as well as equitable climate services market.

This Deliverable D5.1 focuses on generating: (1) a systematic overview of obstacles and mechanisms affecting the uptake of climate services, (2) a systematic overview of policies and measures meant to alleviate the obstacles, and (3) a preliminary assessment of the effectiveness of identified policies and measures and their interactions. By generating these three building blocks a preliminary assessment of the possible reduction of market failures ('static level analysis') can be provided. The so-called 'dynamic level analysis', entailing versatile CTA based innovation policies in combination with the market failure reduction measures and assessed by considering alternative plausible packages is reported in D5.2.

We distinguish **four main motivational themes** for the use of climate services, being: **(1) Resilience, (2) Adaptation, (3) Mitigation, and (4) Integrated sustainable development**. These themes are not (entirely) mutually exclusive, but – at least in earlier stages of use of climate services – one theme may take typically precedence in the specification of climate services' needs, and thereby steer (or limit) on what is regarded as relevant, regardless of whether other types of climate services may be relevant as well for the user.

The term 'climate services' can be useful in climate policy oriented publications, but in the context of motivating prospective user groups other terms closer to the relevant vocabulary of targeted user groups seem to be called for. Similarly, the distinction in providers and users of climate services is not optimal, since many midstream and downstream providers of climate services are both users (of climate services produced more upstream) and providers (of their own climate services).

Obstacles, when resolved, can often turn into or create space for new opportunities. Therefore the removal of obstacles should not be framed in a defensive framework (only). The most important obstacles are rooted in shortcomings in the organisation and strategic choices of CS users and providers, sometimes enhanced by external factors, such as legislation, which disincentivizes users or providers. In addition there are obstacles at operational levels, when actors try to match CS offers and CS needs.

The most **important obstacles** for the uptake of CS in the **demand domain** seem to be for the time being:

- (preliminary) impact projections are of minor importance compared to many other risks
- inherently short term oriented business model (ruling out adaptation CS)
- no clue about how such information could be used in decision making (i.e. no risk management)
- lack of awareness of climate change or (seasonal) climate variability or climate information (as regular input for decision making)

The most **important obstacles** for the uptake of CS in the **supply domain** seem to be for the time being:

- available CS information is not really packaged as service (but e.g. rather as R&D project output)
- CS product portfolio is totally or largely out of scope for the user group
- insufficient resourcing of CS product development and delivery

The most **important obstacles** for the uptake of CS in the **matching domain** seem to be for the time being:

- mismatch of provider's and user's 'language' and conceptions
- uncertainty about the eventual relevance of the CS for the user's decision process ('fit for purpose')
- temporal and/or spatial resolutions do not match with other user's data
- insufficient guidance and/or embedded consultancy

Key policy measures

Not all policies and measures need to be pursued as public actions. In quite some cases private (sector level) actions can be even more fitting. Sometimes mutually complementary public and private measures can be implemented.

Most important is to **create sufficient incentives** in hitherto not activated sectors. Moreover, due to the large follow-up effects the take-up of CS by the financial sector (as part of climate change risk disclosure) is to be of high importance in any CS promotion policy package. A second major issue is a systematic and well-founded **application (and regular review) of business models by CS providers**, notably public CS providers, while also including options for cooperation forms between users and providers.

Various informational policies can raise the effectiveness of the main instruments. Especially **market transparency** and consequent **open data policies** are important for better exploitation of service potentials.

In terms of concrete policies the following stand out as important options::

- establish **public service contracts** specifically for CS delivery in otherwise poorly serviced product-market segments, entailing performance elements in terms of volume and quality in relation to earmarked funding, while of sufficient yet finite duration – consider auctioning in later phases, at least for some CS product groups
- apply **climate change risk disclosure legislation** to relevant sectors, with requirements on data quality and tractability
- oblige regional and local authorities, infrastructure companies, and other sectors identified as critical (in relation to societal functioning) to prepare and maintain **climate proofing strategies and declarations**
- provide financial and knowledge support for **exploration of new business & resourcing models** aimed at smooth and lasting CS delivery, under the condition that lessons can be shared with third parties
- **enforce consistent and broad scoped open data policy**, while guaranteeing sufficient funding for good quality data generation;
- consider **adapted pricing of open data** such that the better the openness of follow-up products is the lower the charge of the open data
- promote and support **CS best practice programmes** to boost learning among both user and provider groups
- selectively promote and support CS brokerage (for sectors and/or products with apparent notable underutilization)

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1. INTRODUCTION

The study

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 included several actions in its current research programme Horizon 2020 (H2020). Essentially these actions follow from the logic to implement the European Research and Innovation Roadmap for Climate Services (cf. European Commission, 2015)

EU-MACS and its twin 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, such as the Coordination and Support Action (SC5-05b-2015) called Climateurope. In addition the ERANET for climate services (ERA4CS) is a programme that contains both testing of particular types of climate services in selected sectors and exploration of suitable climate service types for selected sectors.

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

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 economics and social sciences, embedding innovation theories on how service markets with public and private features can develop, and how innovations may succeed.

The scope and remit of this report

This report is the first of this work package (WP5). The overall purpose of WP5 is to pull the findings from the sector explorations in WP2-WP4 together and integrates them with the findings from WP1, with the purpose to identify the most effective public and private policies and measures, upstream and downstream innovations, and CS business models for engendering a growing and flourishing as well as equitable CS market. More in particular, this work package:

A. Compares the findings for the three focus sectors and assesses what the joint effects of the proposed policies, measures, and innovation would be in the immediate (~3 years) and mid-term future (~10 years) for the volume, diversity, and quality of use of CS as well for the CS supply structure – while distinguishing between policies and measures pertaining to the static level of analysis (reducing market failures) and innovations (and related policies and measures) pertaining to the dynamic level of analysis (engendering upstream and downstream innovations)
B. Reviews and discuss the findings with respect to the effects of market evolution and of policies and measures on the respective identified market failures, market characteristics, and quality assurance
C. Assesses the findings regarding the options for dependable resourcing of CS reviewed in WP1, compares them with the experiences in WP2-WP4 and identifies a set of context dependent best business models for CS, judging business models both in terms of financial stability and in terms of enabled benefit potential owing to the use of CS

D. Discusses results with involved actor groups in the CS markets and seeks endorsement of the recommended policies, instruments, measures and innovations
E. Furthermore, during the Grant Agreement negotiations it was agreed to monitor synergies with twin project MARCO and to also produce a common synthesis report as Deliverable.

This report, Deliverable D5.1, covers the so-called 'static effect' part of activity A and the entire activity B. The rest of activity A as well as activity C are dealt with in Deliverable D5.2 (report), whereas (joint) synthesis and external endorsement are handled in Deliverable D5.3 (report) and Deliverable D5.4 (Policy Brief).

This Deliverable in particular focuses on generating: (1) a systematic overview of obstacles and mechanisms affecting the uptake of climate services, (2) a systematic overview of policies and measures meant to alleviate the obstacles, and (3) a preliminary assessment of the effectiveness of identified policies and measures and their interactions. By generating these three building blocks a preliminary assessment of the possible reduction of market failures ('static level analysis') can be provided. The so-called 'dynamic level analysis', entailing versatile CTA based innovation policies *in combination with* the market failure reduction measures and assessed by considering alternative plausible packages is reported in D5.2

The structure of this report

This Deliverable starts with a discussion in Ch.2 on the different, yet partly overlapping, policy frames that function as drivers and justifications for (public) efforts to promote the development and use of climate services. In Ch.3 the theories and methodologies underpinning the work for this Deliverable are presented. Ch.4 presents the the inventory of obstacles and mechanisms affecting the uptake of climate services, in particular, but not exclusively, in the three focus sectors Finance, Tourism and Urban Planning. Subsequently in Ch.5 a rating and ordering of the identified obstacles is presented, as well as an assessment of causal relations between obstacles. Ch.6 introduces the options for policies and measures and list the propositions coming forward from the project experts. Conclusions and recommendations are dealt with in Ch.7.

2. CLIMATE SERVICES AS PART OF OVERLAPPING AGENDAS

The current wave in development and expansion of climate services concerns in particular so-called seasonal climate services as well as services meant to inform climate change adaptation planning and implementation. These two categories of climate services can have synergies upstream in the value chain (see D1.1; ….), but their use contexts and related drivers are quite different, even though there are points of contact. In principle the development and use of climate services is justified as fulfilling an information need with poor substitutes for the following themes:

- Resilience
- Adaptation
- Mitigation
- Integrated sustainable development

In this case **resilience** refers to the ability to cope with current level natural hazards, entailing immediate threats for population and/or critical infrastructure or serious obstruction of one or several economic sectors (e.g. agriculture. Usually higher resilience means also better points of departure for adaptation or less urgent or less extensive adaptation efforts needed (IPCC 2012). Next to long term structural aspects of resilience, which tie in with adaptation planning and implementation, such as effective building codes, resilience entails also *preparedness*, for which seasonal climate services and multi-annual products are an important input, providing indications for elevated risk levels of natural hazards such as droughts, excess precipitation, and persistent temperature anomalies. The policy fields related to resilience are: Disaster Risk Management (DRM), Critical Infrastructure Protection (CIP), and Security of Supply. Whereas DRM is dominated by public policy actors, CIP and SOS can show large variation in public and private sector involvement over countries and service areas (Pursiainen 2018). Furthermore, even within this domain the planning and implementation in the sub-domains is not necessarily always adequately coordinated, whereas the different sub-domains tend to have different gravitation points regarding the time horizon(s) (Lauta and Perrels 2018).

By and large one can observe that for structural resilience, such as embodied in building codes or zoning regulation, long term (adaptation oriented) projections may be of use to make standards climate proof. Also current climate data can be of use in this respect. Yet, such guidelines tend to be eventually very straightforward (i.e. ground floor minimum elevation levels) and are not meant to be revised often. On the other hand if neglect of climate change adaptation becomes ever more a liability, many actors in the building construction value chain will get activated to avoid claims which could raise demand for such information considerably. As regards preparedness and the use of (sub)seasonal climate services there may be more evident reasons for accountable actors to acquire climate services – either as a public duty (protecting citizens) or as private actor obligation to either avoid own costs or avoid litigation by third parties.

All in all the starting hypothesis is that the resilience angle would tend to emphasize (1) rather straightforward indicator oriented publicly available long term projections and (2) a potentially more elaborate palette of (sub)seasonal and multi-annual services, partly public and partly as charged services (when primarily related to private assets). Furthermore, for training purposes for parties involved in hazard management mixed service products could cater this product segment. These foci do not preclude that now and then also broader scoped versatile medium and long term risk assessments are made regarding climate change and climate variability.

Planning and implementation of **adaptation** can be a very information intensive process needing a large array of climate services. On the other hand there is so far little formal guidance regarding the quality and depth of climate services (D1.2 Ch.7), even though in a growing number of countries there are obligations to account for and prepare for climate change effects in land use planning and infrastructure planning. In larger cities and for larger (national) infrastructure planning and maintenance there is mostly sufficient capacity, resources and also accountability to prefer good quality and sufficiently broad scoped CS. For many other sectors and use cases this is as yet not so common practice. An important game changer would be the full implementation of the TFCD[1] recommendations (D2.1, Ch.2) in the financial sector, as it will carry over to most other sectors, either as money lenders or as important actors in affected supply chains. So, if sufficient legal or self-regulating obligations are created, adaptation oriented climate services could really abound, depending on the costs and client need orientation of the services. In this respect it is important to realize that the more the use of such climate services gets mainstreamed the stronger pressure for cost efficiency of the service provision will be.

For the adaptation angle the hypothesis is that a large array of publicly available long term projections would be the prevailing need. Long term climate change (only) projections are already available via various portals (e.g. KNMI Climate Explorer). The large array refers here an adequate selection of midstream and downstream CS products including or enabling translations to end-user relevant impacts and risks. When mainstreaming and integration in policy cycles abounds, monitoring of climate change effects and of measure performance will probably get more important, thereby offering chances for other climate services closely related to observation.

Only for some subsets of **mitigation** policies and measures climate services can be expected to play a role, especially with regard to optimization of planning and operation of renewable energy production capacity, and to some extent for energy efficiency and building management, as well as agriculture and forestry. For all of those both long term projections and seasonal and sub-seasonal services are relevant, and often already existing (except forestry). The energy sector is already used to utilize weather and seasonal services, and probably does not need much incentivization to act at this point. Matters may be less clear for building design and management, even though in non-residential buildings energy management may be well developed or even outsourced to so-called Energy Service Companies (ESCO). Use of climate services in the latter case is very much dependent on energy efficiency regulations for the building sector and energy network management.

All in all there is scope for climate services in relation to mitigation activities, but usually the use frames will be largely determined by the users and technologies under consideration. Especially in the energy sector there is already a high awareness and notable use of climate services. Therefore from the point of view of climate services promotion, for this market segment it will largely a matter of creating good connections, listening well to and cooperating with (prospective) users, rather than just offering options. This market segment has also more potential for use of charged climate services.

In cities and regions start to occur more and more comprehensive forms of sustainability strategies. Also in relation to development planning and international development cooperation (e.g. via the International development banks, such as World Bank, Asian Development Bank and EBRD. In 2017 the UN Sustainable Development Goals were accepted as a basis for target setting and planning in development cooperation. Reference to the UN Sustainable Development Goals has become common practice and an increasing

[1] TFCD – Task Force for Climate Risk Disclosure – stipulates to adopt globally shared reporting principles regarding te exposure to (1) climate policy (= decarbonisation) risks owing to stranded assets and knock-on effects, and (2) direct (physical) climate effects causing damage or productivity losses.

number of urban development plans are even primarily framed in the SDG logic (Rodriguez et al 2018). Especially, but not exclusively for cities with limited urban planning history the adoption of the SDG frame can offer a good basis which also enables quicker progress in planning and its implementation. On the one hand the SDG framework can help local authorities to outline a well-founded set of needs for particular climate services. On the other hand the application of the SDG framework may be expected to widen and deepen the relevant portfolio of climate services. In other words the SDG framework so to say invites to explore innovations in product content and ways of provision. This probably also means that the number of possible new entrants to the CS market would increase as a wider scope of expertise, skills, data and networks can get involved. Next to urban planning, will the use of SDG also be relevant for the ever more comprehensive Corporate Social Responsibility (CSR) support functions in many (larger) financial sector organisations.

SDGs are an emerging factor in the CS field. Probably the most important influence on the CS field is through promotion of diversification and deepening of CS, owing to the diverse nature of the SDGs. The deepening and diversification creates more opportunities for innovations. This means that in contrast to the preceding themes SDGs may be relevant for whatever product-market segment of CS, even though SDG frames can be expected to be in particular relevant in the context of international development cooperation and hence for international development banks.

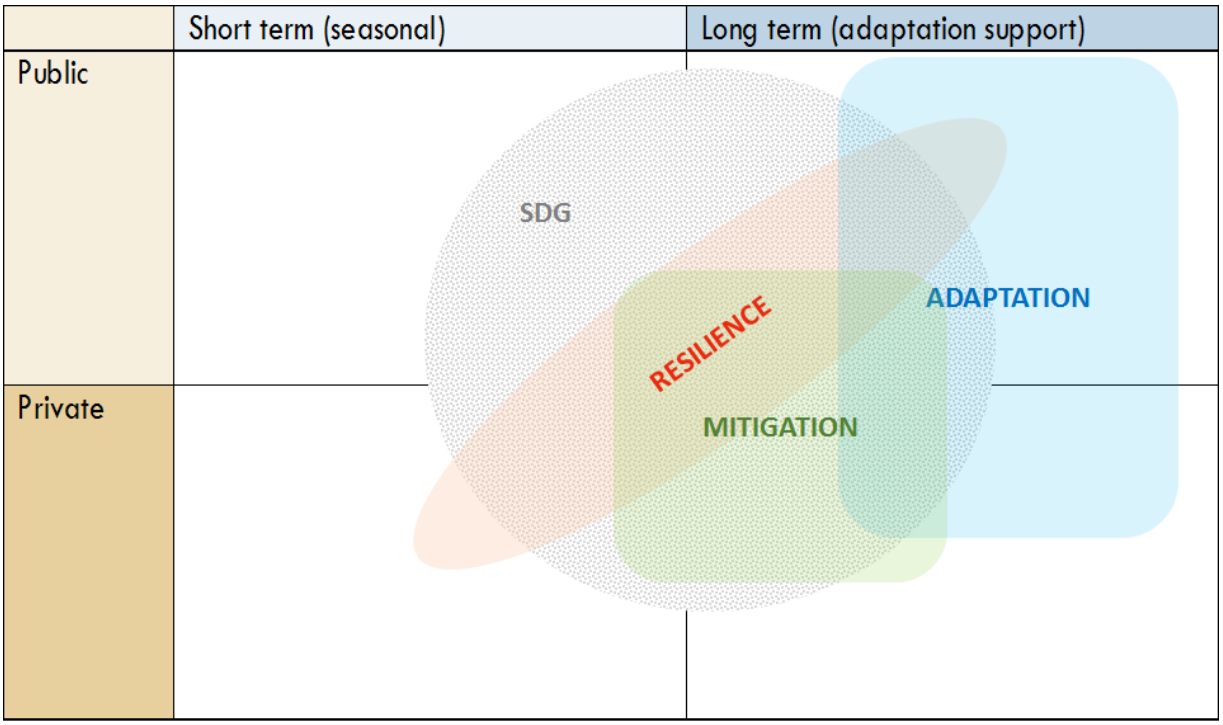

FIGURE 1 MAIN DRIVERS UNDERPINNING INTEREST FOR CS - BY TIME AND FUNDING PERSPECTIVE

The themes presented above are not mutually exclusive, but usually one theme will guide raising interest in the use of CS for a particular user, at least in initial phases. And thereby the initially identified needs for CS may be narrower than the eventual scope of CS potentially beneficial for a user. CS use and underlying planning or risk philosophies evolve over time, and also learning from the use of CS can contribute to expansion of the original portfolio used. Pushing for more than what the prospective user is grasping or ready for, is probably not beneficial. Yet, this should not stop the discourse as it will help prospective users to catch up and expand and sophisticate their portfolio of needed CS.

3. THEORY AND METHODOLOGY

3.1 Considered theories

The theoretical backdrop of the applied analysis is manifold, including transaction cost theory (see also D1.2), public choice theory, theories on product life cycles and market development (maturing), theories of multiple sided markets, and theories on innovation perspectives with special reference to Constructive Technology Assessment (CTA) and multi-layer perspectives (MLP) (see also D1.4).

Transaction cost theory was initiated by Coase (1937), in response to implicit assumptions on frictionless and complete information exchange between market parties in the (then) prevailing economic paradigm on markets. Transaction cost theory has been elaborated enormously since then (Williamson and Cheng 2014), looking inter alia into industrial organisation (e.g. firm size, (dis)integration), market conditions and development (e.g. contract forms, (need for) interventions), while also operationalization was developed (see table 3.1 below) helping to analyse e.g. 'make or buy' decisions, choices between competition and cooperation, and propagation of value chains under alternative market conditions. Transaction cost theory helps us to identify links between the obstacles in the CS market, and to some extent can also help to assess the relative magnitude or decisiveness of an obstacle in terms of demand not expressed or not served. Transaction cost theory and its methods have also been used to analyse (lack of) progress in the achievements of energy efficiency policy (Mundaca 2007; Mundaca et al 2008; Perrels et al 2006) which can serve quite well as a reference policy area for the policies promoting the use of CS (see also D1.2). Transaction cost methodologies are more widely applicable than may be inferred from theoretical discourses, as will be illustrated below. So far, there is preciously few literature about climate (and weather) services based on transaction cost theory, apart from some considerations in preceding EU-MACS Deliverables (D1.2, D1.3, D3.1) and Perrels (2018) the only other publication known to us is by Chungui (2011) referring to consequences of the public monopoly on the evolution of the meteorological services portfolio in China.

Williamson and Cheng (2014) provide a brief overview of transaction cost types in relation to stages in the production process, distinguishing between pre-production (investment; planning), production (incl. sales), and post-production (e.g. customer relations, contract enforcement), while distinguishing production factors in physical and financial capital, human capital, work intensity (utilization; throughput). For information services and potentially networked processes this needs some adaptation as is shown in table 1. It should be realized that this table can be applied to upstream climate service providers (e.g. entailing heavy computing and/or observation capacity), downstream climate services (less heavy but still significant computing and visualization), and purely users of CS (e.g. cities, farmers, pension funds). The transaction cost (kind of friction) in the several phases can cause extra resource use for CS providers (mostly related to unfit or underdeveloped interfaces and/or unfit or underdeveloped understanding of potential customers) or for the CS users (either more effort needed to get the aspired functionality or settling for less functionality and hence less effective information) or for both.

Even though one would expect that CS providers will in the first place try to alleviate their shortcomings so as to raise the use of their products, also many CS users have to adapt as we will show later on, otherwise received CS will produce much less if any benefit as compared to what is possible. The CS provider, and maybe also the CS user, may have to adapt the business model(s), at least for the considered product-market segments. Business models (the way service generation is organised and resourced) and market conditions are crucial background factors for the occurrence and severity of obstacles of uptake of CS.

Furthermore, for quite some shortcomings other actors – often public agencies or sector umbrella organisations – are needed as well, e.g. to formulate minimum obligations or common quality standards.

Table 1 Categories of transaction cost and there relevance in the climate service field (TBE)

Production & utilization factors	***Phases in CS generation and use >>>>>>***				
	Pre-production	**Pre-utilization**	**CS provision**	**CS use**	**CS customer relations**
Physical assets	Implied achievable quality level	Risk exposure → motivation; Presence of adequate equipment (+ 'make or buy')	Mismatches in physical information delivery outfit; Hesitations on choices for standards halting technical choices;		
Knowledge	Capability to link climate & non-climate domains; Sharing / exclusiveness Innovation; choices	Awareness; Risk analysis capability	(risks for) mismatches of delivered information in terms of actual usability owing to non-matching concepts	Apparent fitness for purpose;	Continued training and updating options
Human resources	Prevailing work motivators	Availability of skilled employees; 'Make or buy'	Cultural mismatches between provider's and user's staff → miscommunication	User org. internal capacity & capability	
Managerial and coordinative abilities	Extent & quality of internal communication (early signals)	Extent & quality of internal communication (early signals)	Are all relevant departments / experts involved in the process; division of tasks & responsibilities	Information flow (results) management	
Networks / Relations	Public profile; User and competitor relations	Existing contacts with CS providers; User associations; Sector or regional embeddedness			Client feedback; service maintenance
Trust	Preferred CS provider? QA process	Impressions of CS providers; Impressions of products			Client satisfaction monitoring
Regulatory enablement or disablement	Orientation of p-m segments; Innovation & investment priorities				

Business model selection and development has close links with transaction cost theory, while it is also strongly interacting with (technology driven) market innovations, such as two-sided or multi-sided markets (see below). Yet, Teece (2010; 2018) indicates that business models do not have a clear theoretical basis in economic theory, at least not in the mainstream theory. At best they are the result of systemized use of common sense and market conditions. Yet, business models often also arise in conjunction with innovations or even include innovations themselves as part of disrupting traditional business models. From a pragmatic point of view business model selection could be seen as using a template in a creative consultative process

(www.businessmodelgeneration.com). That is for example what has been used in EU-MACS during various interactive sessions with stakeholders (e.g. Damm et al 2018) and also in MARCO (Pawelek 2018). We nevertheless conjecture that the links with transaction cost theory, market models, and innovation models provide a sufficiently underpinned framework for understanding why – in a particular case – only some business models seem feasible, and what would be the consequences of BM implementation choices in terms of success risks. These links also enable to evolve chosen business models by means of a longer term strategy in order to maintain viability. Teece (2010) deems this combination as vital.

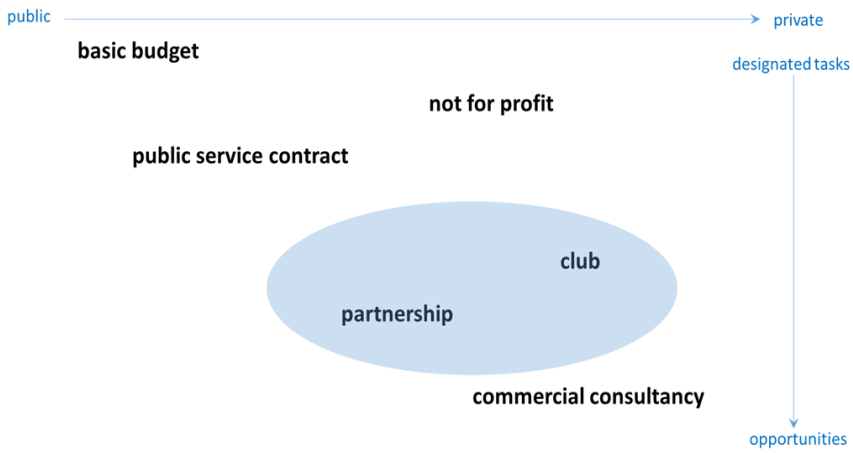

FIGURE 2 FIGURE 2 BUSINESS MODELS BY DEGREE OF PRIVATE FUNDING AND ACTIVITY SCOPE

Business model choice is steered by the market conditions and the extent to which an organisation has an imposed or self-chosen activity scope. Fig.2 illustrates this. Public provision of services is usually accompanied by a limiting perspective in terms of designated services (and customers). This is inter alia to enable control over public resource allocation. The extreme case is the basic budget option. In a public service contract there are often elements to promote improvement of the service, e.g. by means of so-called yardstick competition. Moving diagonally other options provide more leeway for exploiting opportunities. In the mid-sections public-private cooperation can allow for effective sharing of information, but often only for the ones inside. Pure private companies have still more flexibility, but the (free) sharing aspects gets gradually terminated in those cases.

In an evolving market with advanced information products, cooperation seems to be called for in one way or the other. These and other alternatives evolve depending on the market regulation on roles of public and private actors, and on the ease to combine similar products. This results in a subset of feasible business models for a given context, while the remaining business models can be further reviewed regarding their fitness for selected p-m combinations. The business canvas (fig.3) can subsequently be used to check the viability of a selected business model, including alternative models of delivery and other details. Information on transaction cost risks (table 1) can be used to further tune the model and try to avoid or alleviate transaction cost.

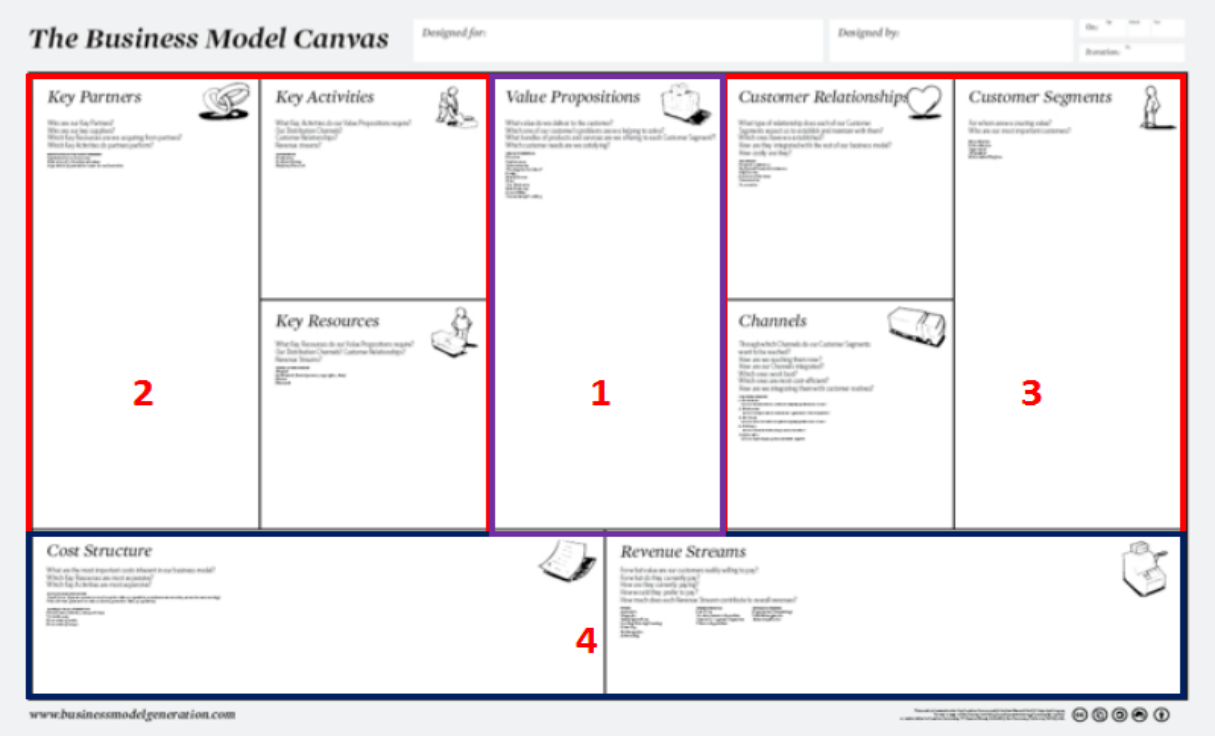

FIGURE 3 BUSINESS MODEL CANVAS (CHECK BOARD)

For quite some time **Public choice theory** was in particular identified with the work of Buchanan and Tullock (1962) and its elaborations, which as point of departure tends to perceive public intervention and public instead of private provision of goods and services as suspicious or at least needing justification owing to likely extra cost to citizens (based on assumptions and partial evidence that – *in general* – public provision entails lack of competition and limited cost awareness). We employ here a wider concept of public choice theory encompassing all theories and tools to assess governance choices for which some kind of coordinated (i.e. public) action and probably funding seems to be a valid option, albeit sometimes not the only one. The actual coordination can take several forms, centralized / decentralized, bottom-up or top-down initiated, self-financing or from general means (tax receipts), etc. For example, Ostrom (1990/2015; 2005) illustrated that cooperative solutions differentiated by local circumstances tends be more fruitful than centrally imposed interventions, even if these acknowledge the commons dilemma. This approach also suggests more leeway for market regulation in terms of private and public service domains. Shreshta et al (2011) illustrate how transaction cost methodology can be applied to public choice issues regarding (the resulting) degree of inter-communal cooperation. Possible cooperative forms of CS acquisition and/or use are comparable and equally relevant matters in the CS market development (see D1.2, D3.1, D4.1). To some extent this also ties in with the use of formalized stakeholder network analysis (SNA) as illustrated in D4.1.

The Institutional Analysis and Development (IAD) framework developed by Ostrom and colleagues over time offers a good point of departure to think about resolving some of the identified problems in the *field* ('action arena' in the IAD approach) climate services (2005). She also points at effectiveness dilemmas for services which can only be partly regarded public goods, i.e. being common-pool resources or club goods or closely related market forms. If relevant product-market regulation and/or applied business models do not correspond with these features, undesired market outcomes result (rent seeking, under-provision, etc.).

In fact it can be asserted that information as embodied in CS is often a common pool resource. In economics there is a first crude distinction between public and private goods and services (in short usually just referred to as 'goods'). Private goods are provided to identifiable clients, who cannot act as free riders, i.e. no pay – no delivery. Furthermore, in the private good case the use of a unit of good or service diminishes the total available stock of sellable goods. Pure public goods have opposite characteristics, use of a public good by one user does not diminish or degrade the service delivery to others (non-excludability), whereas the service provider cannot exclude users from sharing in the use. There are however also goods that often are or were provided by the public sector, but are not pure public goods. These are *common pool resources* and *club goods*. For a common-pool resource it is not easy or unattractive to exclude users, even though use by client is identifiable and also subject degradation effects if use grows (beyond some level). In the case of information services however also the opposite effect (synergy benefits from more users) can occur especial during early phases of take-up of a (new) service. Club goods tend to be only delivered to members of the club and within the club degradation effect of use are small or absent. The challenge with respect to organising the market for climate services and its evolution is that climate services delivery can take the form of each of these types (figure 4 below). In the assessment of the financial sector (D2.1) it became clear that the more downstream the CS purports to be the more likely club good arrangements are preferred over common-pool resource arrangements.

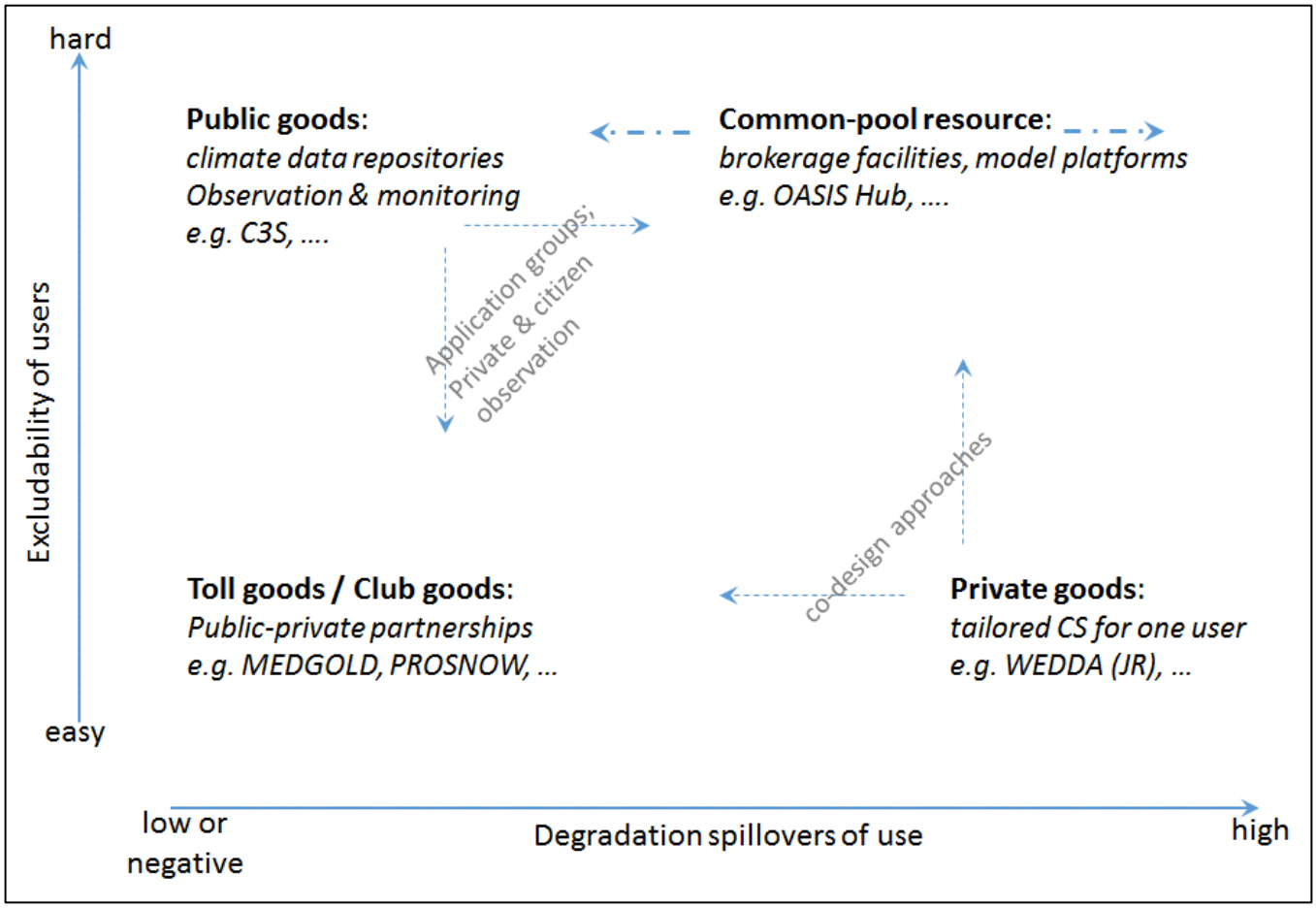

FIGURE 4 CLIMATE SERVICES TYPES BY PUBLIC - PRIVATE GOOD TYPOLOGY

Ostrom (2005) states, on the basis of studies in the US, that five property rights can be distinguished with respect to common-pool resources, of which several, but not necessarily all, could be activated. These are

(with adaptations towards information goods): **(i) access, i.e.** the right to actually search, select and retrieve (copies of) information (cf. the PSI and INSPIRE directives,) **(ii) withdrawal**—the right to obtain specific information products for own use (there may or may not be value degradation or synergy effects with multiple users), **(iii) management** - the right to affect further development of the information resource (R&D programmes and innovations, standards, quality assurance), **(iv) exclusion**—the right to decide who will have access, withdrawal, or management rights (organisational form of provision & use), and **(v) alienation** - the right to lease or sell any of the other four rights (the tradability of the information, as such or after reprocessing; extension to other collaborators).

The rights mentioned under i, ii, iv are quite common for several types of cooperation for provision and use of climate services. The rights mentioned under iii and v are more sensitive as these especially affect the value generation process of others and/or the potentials of the future value generation process of a climate service product (cluster). When observing the value chains in the CS market (see section 4.2) the CS in the upstream part of the value chains will often have a public good character. When moving further in the value chain to intermediate and end-user oriented CS are also provided as club goods and common-pool resources, and – especially for end-user products – as private goods. Similarly, the product-segment matrix approach introduced in D1.4 and applied in D2.1 (finance) and D3.1 (tourism) defining the CS product market by four main typologies can also be associated with the public-private good typology discussed here. There is a degree of association between the significance of the four main product market typologies and the public-private good typology and the positions in the value chain. This is discussed in section 4.2 and further taken up in D5.2. Since it is 'only' a certain degree of association and not a strong simple correlation, it makes it understandable to find indeed tendencies in organisational solutions, but within a context of significant diversity as acknowledged by IAD framework approach. Some of this diversity may be less efficient and would merit changes (in product design or offer, in business model, or market organisation). In other cases the diversity is just an efficient answer to specific circumstances.

Ostrom (2010) has also emphasized the significant role of building trust when a society wishes to overcome social dilemmas.

Whereas the above mentioned theories refer to the organisation of markets and firm structures, **product life cycle** theories refer rather to evolution and innovation in products and how that affects market development (e.g. via economies of scope and scale and via the emergence of two or even multisided markets in information). Climate services are subject to many sorts of innovation (growth in observation and data sourcing alternatives, information content (modelling capabilities), representation/visualisation, communication channels, forms of cooperation). This can mean that trends can be reverted several times, making planning of CS infrastructure and even of business models quite difficult. In purely technical sense, when just mechanically applying tools such as the business canvas, solutions will be created. Yet, these may not be viable after some time or (unintentionally) prevent realization of a significant part of the benefit potential.

The tendency to offer ever more open data is very important for climate services development as it will change repeatedly viability perspectives for commercial CS providers, whereas it will also affect resourcing prospects of open data generating activities. A particular tricky aspect in this respect is the understanding of **two sided markets**, which is an important market form in internet based information portals. On the one hand these platforms should be attractive enough for CS providers to offer their services (also) through (selected) platforms, whereas on the other hand these platforms should be attractive for CS users to be chosen the focal point of CS selection. It will depend on the positions of relative market dominance who is charging who. Initially platforms benefit from sufficient diversity in offered CS, but beyond a certain level

attraction of new C S providers may ignite departure of others as the degree of competition is likely to rise. Even if the CS providers are public agents, the prospect of significant reduction in the use of offered CS may have ramifications for resourcing of these agents. Portals can entail significant reduction in transaction cost for CS users, provided the portals have not attained an eclectic status. On the other hand for CS that tend to involve continued co-design activity portals may become less essential over time, as own producer-user clubs may be born under those circumstances. Furthermore, two-sided market conditions are often at best meta-stable, significant new innovations may entirely flip market set-ups (Rysman 2009).

Last but not least, **innovation theory**, in this case in particular built around **Constructive Technology Assessment** (CTA) can help us to put some structure in the myriad of initiatives and trends that can be witnessed in the evolving climate services field. Innovations usually appear first in **niches** where certain novelties proof more or less successful. Sufficient success will engender adoption elsewhere as well as follow-up innovations operating in a patchwork of **regimes**. If several of these innovations proof to be particularly versatile and beneficial these become ever more the (aspired) standard and new **sociotechnical landscape** emerges. This is the so-called **multi-level perspective** (MLP) in a nutshell (see also D1.4). As regards climate services it is important to realize that not only innovations in the technical and scientific basis but also modes of delivery and forms of cooperation count in this respect.

3.2 Applied methodology

A heuristic approach is applied based on the insights of the theories presented in §3.1. Typical elements of transaction cost approach were used to identify and classify barriers in conjunction with observations made during from surveys, interviews and workshops. This led to an initial list and structure tested in an internal workshop in December 2017. This was further refined in continued interactions leading to edited and slightly restricted list.

The list presented in this report has partly different items than the list of possibly obstructing factors used in the web-survey (based on PESTEL) reported in D1.1. The D1.1 list covers the situation where users have used or at least acquired CS. In the present list we aim also to capture the factors behind latent demand and latent supply, i.e. the structural factors causing that demand is not arising or a CS supply not realized. Another difference is that the list of D1.1 indicates types and sub-types of obstacles, but is for a part of the issues less pertinent in what the obstacle exactly is. Last but least in the interviews and other types of interaction more differentiation is added, e.g. regarding conditions or product-market segments where the obstacles is relevant. This illustrates the difference between surveys and personal interview and workshops, where the latter two elicitation methods allow for more precise answers (thanks to elaboration on questions). In chapter 4 we will return to a comparison with the list of obstacles of D1.1.

The draft list of December 2017 was used as the basis for an internal questionnaire, while benefitting from the experiences in WP2-WP4. In April 2018 the project-internal experts were asked the following[2]:

- To judge whether still any obstacle was missing or conversely whether any of the obstacles was irrelevant (never encountered)
- To rate the identified obstacle in terms of their approximate frequency of occurrence among designated groups of actors
- To rate the identified obstacle in terms of their approximate significance (weigh/impact) if the obstacle was active

[2] The questions and guidelines are presented in Annex 1.

- Partner HZG received a few additional questions pertaining to stakeholder feedback on resource limitations as an obstacle

The expert feedback was used to generate

- a tentative profile of obstacles in terms of overall significance (frequency x impact).
- Coherent causal clusters of obstacles per main category and identify possible interaction between clusters

In a second round of internal expertise consultation partners were asked[3] to indicate policies and measures for each of the acknowledged obstacles, based on ideas that arose during the stakeholder interactions as well as on own insights the alleviation of shortcomings.

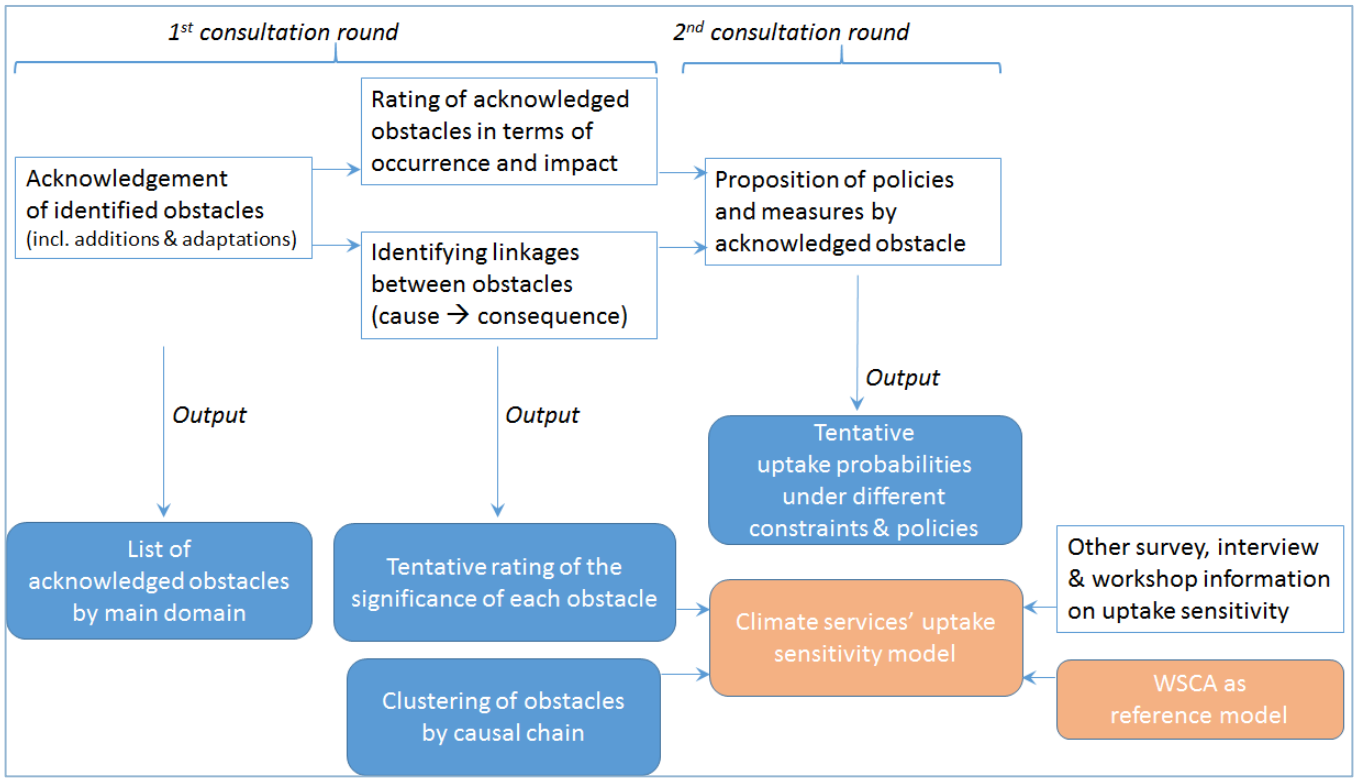

FIGURE 5 SUMMARY OF APPROACH IN THIS REPORT

In the PESTEL based survey reported in D1.1 (Cortekar et al 2018) several barriers for uptake were reviewed by sets of questions concerning political, economic, technical, social, ethical and legal aspects. Particularly important barriers were: (1) funding (resourcing) limitations – both for providers and users, (2) shortfalls in CS relevant technological equipment and know-how among users, (3) information accessibility for users, (4) difficulties for providers to involve different stakeholders, and (5) limited understanding among providers of target (user) sectors. Somewhat important were for example: timeliness (actuality) of CS development and provision (according to providers), communication between different actors within and around a CS project (both users and providers), and unclear legislation (what providers area allowed to provide; what are (legally) necessary precautions for users requiring CS).

In the interviews, workshops and other interaction formats all these elements came forward, and could partly be more differentiated, interlinked, and linked to underlying causes at the supply or demand side.

[3] The questions and guidelines are presented in Annex 2.

Interestingly, from the interviews, workshops and other interaction formats arose a picture that funding is in some respects a less crucial obstacle than the survey results suggest. Our hypothesis is that on the one hand respondents have been somewhat inclined to at least not understate resourcing limitations, while on the other hand it seems indeed that funding for CS development and piloting as well as for climate modelling can be found. In contrast, funding for continuation of once proven CS, e.g. via climate services and adaptation portals, appears to be less easy to find. Furthermore, for users from the public sector short term budget flexibility is small, which may curtail use of CS in the short run. Last but not least, in sectors with a lot of small firms, such as tourism, willingness to pay will be small for such services which are not directly vital. Interestingly, the survey suggests that lack of transparency of CS provision options (for users) and data declaration difficulties (for providers) were not much of an issue, whereas the direct interactions with the three focus sectors and with CS providers suggested that these aspects do need really attention.

All in all the PESTEL based survey results and the more differentiated feedback from the interviews and workshops are pretty well in line with each other. This is important because it indicates that the results from the focus sectors have wider bearing for the respective sectors, i.e. many sector representatives recognize themselves in the sector specific results. It also means that we can concentrate on the use of the lists obstacles distinguished by 'supplier', 'user', and 'matching' domains, which allows for more elaborate assessment of causalities and severity of obstacles. The distinction in domains is summarized in Figure 3 below.

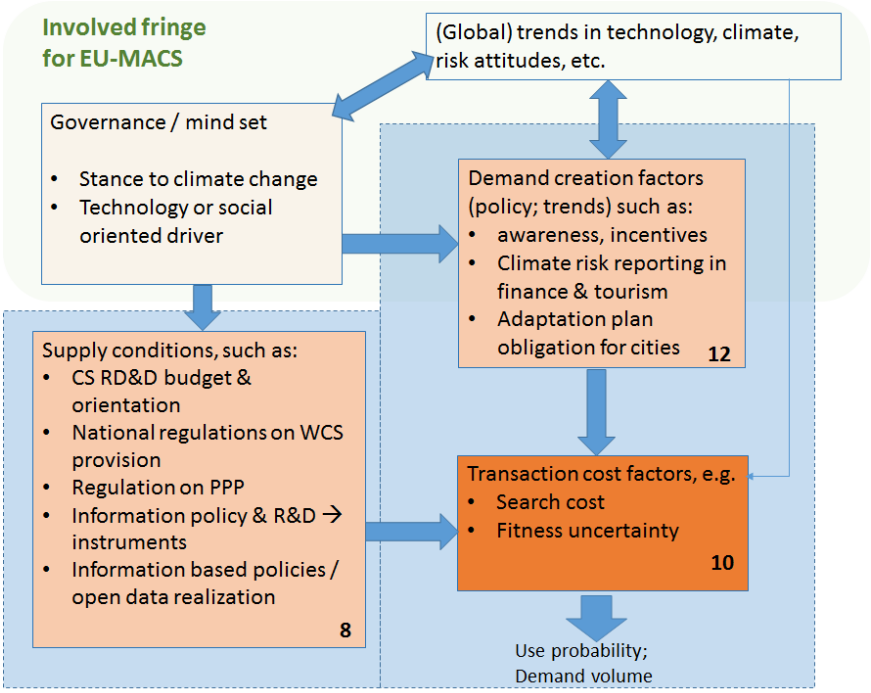

FIGURE 6 MAIN DOMAINS OF OBSTACLES FOR UPTAKE OF CLIMATE SERVICES

Encounter obstacles (and enablers) can be allocated to three domains, being (1) those rooted in demand (user) side features, (2) those rooted in supply (provider) side features, and (3) those arising when supply (provider) and demand (user) try to match. Obstacles at the supply and demand side are more fundamental and affect also the way the more operational obstacles of the matching domain occur.

Obstacles at the supply and demand side can at least partly be attributed to wider contexts, such as global trends in technology, risk attitudes, governance styles, and experienced climate impacts. This wider context is acknowledged but not analysed in EU-MACS.

4. IDENTIFIED OBSTACLES

4.1. Identification of obstacles

Based on the preliminary list generated in the internal workshop in December 2017 a draft final list was drawn up and sent for review and commenting to the EU-MACS partners. This was presented as follows.

Three domains of obstacles are identified, as specified below. Subsequently for each domain the obstacles are listed. Partners could comment whether obstacles were relevant and observed during the project (or in relevant earlier work), and whether obstacles were missing (added in purple text).

1. **Demand related obstacles and mechanisms** (i.e. preventing in general (many) users in the considered sector from articulating a need for CS)
2. **Supply related obstacles and mechanisms** (i.e. preventing in general (many) providers, in the considered CS product category, from effective product portfolios)
3. **Matching related obstacles and mechanisms** (i.e. delaying, distorting or frustrating matches of arisen CS needs and available CS offers due to operational shortcomings)

Obstacles	**Review comments**
Demand side	
lack of awareness of:	
• climate change (as serious risk for that sector)	
• (seasonal) climate variability (as assessable phenomenon)	
• climate information (as regular input for decision making)	
denial of climate change	Dwindling phenomenon
lack of incentives (e.g. if costs are (expected to be) fully compensated)	*
(public) acknowledgement of climate risks is seen as risky for (local) business development (e.g. tourism)	*
perception that responsibility rests fully on other actors	
perception that there are no response options (fatalism or gambling)	*
(preliminary) impact projections are of minor importance compared to many other risks	
no clue about how such information could be used in decision making (i.e. no risk management)	
inherently short term oriented business model (ruling out adaptation CS)	
acquisition and/or use of CS is expected to be too expensive, ….	
budget limitations force the user to acquire only a subset of needed CS (or not any CS)	
Lack (coordinated) internal communication	
Good availability of public (free) CS reduces (or even frustrates) development of (more tailored) private SCS	
Supply side	
CS product portfolio is totally or largely out of scope for the user group	

CS provider does not employ clear product profile or client type profile	
CS provider faces legislative limits regarding product or user segments it is allowed to service	*
insufficient resourcing of CS product development	
available CS information is not really packaged as **service** (but e.g. rather as R&D project output)	
no interest or capability to develop CS beyond mere data provision	
lack of understanding of user characteristics	
Timeliness of provision	
Intently avoided provisions (e.g. based on ethical considerations of use effects)	
Matching	
unclear where to look for CS services (if NMS cannot deliver)	
hard to specify CS needs*	
user organisation cannot develop unified vision on CS needs*	*
hard to make choices between alternatives (within and across providers)	
mismatch of provider's and user's 'language' and conceptions	
uncertainty about the eventual relevance of the CS for the user's decision process ('fit for purpose')	
uncertainty ranges of offered climate information incompatible with user's decision process	
temporal and/or spatial resolutions do not match with the user's other data	
insufficient guidance and/or embedded consultancy from the provider(s)	
user demands too sophisticated for no-charge or low-charge CS provision	
Incompatible operational culture and language	

*) obstacle not encountered by all partners;

Terminology

It was acknowledged that the term climate services is not always helpful, and – depending on the context – could sometimes be replaced by commonly accepted and sector specific terms. Also the distinction between providers, purveyors, and users can get blurred as well.

It is important to acknowledge that also more downward the value chain there are 'providers', which usually means these are users of the services of the providers located more upstream in the value chain. With further market expansion and innovations several classes of current 'end-users' (such as in the financial sector) may *also* become CS providers in conjunction with their financial services to their clients. Instead of purveyor, the term intermediary or broker could be clearer. Some intermediaries do little more than facilitate matching of supply and demand. Others may combine that with consultancy services inter alia to assist prospective users in the process of identifying CS needs and their specifications and/or assist providers in the profiling of their service products. The several forms of cooperation between one or more providers and users can also create new sub-categories, e.g. where one municipality or one city department could become the internal provider / distributor of locally tailored CS. These examples illustrate that there is fluidity in business models in the arising CS market.

Obstacles and enablers

The approach in this report focuses in the first place on obstacles to the uptake of climate services. It is good to recall that removing or resolving obstacles to use of CS often entails creation or opening of opportunities for the users of CS. Better and more detailed knowledge of how climate change or climate variability can affect one's business is also the point of departure for creating solutions. At least these solutions mean avoided cost, but they can also bring extra revenues thanks to a new (innovative) competitive edge.

Concrete examples of linkages between obstacles and enablers are the following. The *absence of incentives* to use (proper) CS can be transformed into the working of pro-activating and rewarding incentives. Similarly, business models of CS providers that include features that tend to lower upfront cost and increase early benefits for CS users, can be expected to improve uptake of CS.

Next to the direct connections between solving obstacles and creating enablers, there is also the relation between obstacles and policies & measures. Apart from earlier mentioned incentives, better and low-threshold informational practices generate both benefits and raise uptake. Low-threshold informational practices can mean different things for different target groups. A provider can assume higher skill levels for professionals than for private citizens. In those cases training for underskilled professionals may be better than simplifying the products. This doesn't reduce the need to try design clear products. Systemized feedback from users as part of the quality assurance is another way to improve access and appeal over time. If selectivity in uptake persists, it may be after all necessary to design simpler versions.

New entrants and market dominance

In order to better judge representativeness of survey results and stakeholder interaction information the project internal experts also pondered the occurrence of market (segment) dominance. Overall the prevailing opinion is that generally speaking there is no disturbing degree of market dominance, if any. At much lower aggregation levels, e.g. one country – sector combination, there sometimes is. More upstream, where economies of scale and scope in having many and high diversity of datasets have effects, some providers prevail.

New entrants are on the one hand small companies offering specific solutions or focussing on particular sector needs. In addition various types of joint initiatives arise at international, national and regional levels, both with a (semi) public status and with a private status. Oasis Hub (see also D1.3) is an example of this trend.

4.2. Associations between obstacles and position in the value chain

Some of the obstacles in the three domains can be associated with segments in the value chain and thereby also with particular types of CS providers. For a start it should be realized that 'users' refers both to so called 'end users' (whose use of CS predominantly leads to actions that do not involve generation of CS) and 'other users' (whose use of CS usually involves generation of mid- or downstream oriented CS). Figure 7 provides an impression of where in the value chain selected obstacles typically affect, and what parts of the value chain different types of CS providers typically serve. The bar next to the CS providers' abbreviations depicts the typical coverage ('stretch') of the provider type in the value chain. The depth of the colouring indicates the average strength (performance, fitness for purpose) in the various stages of the value chain, i.e. colouring can be loosely associated with obstacles mentioned.

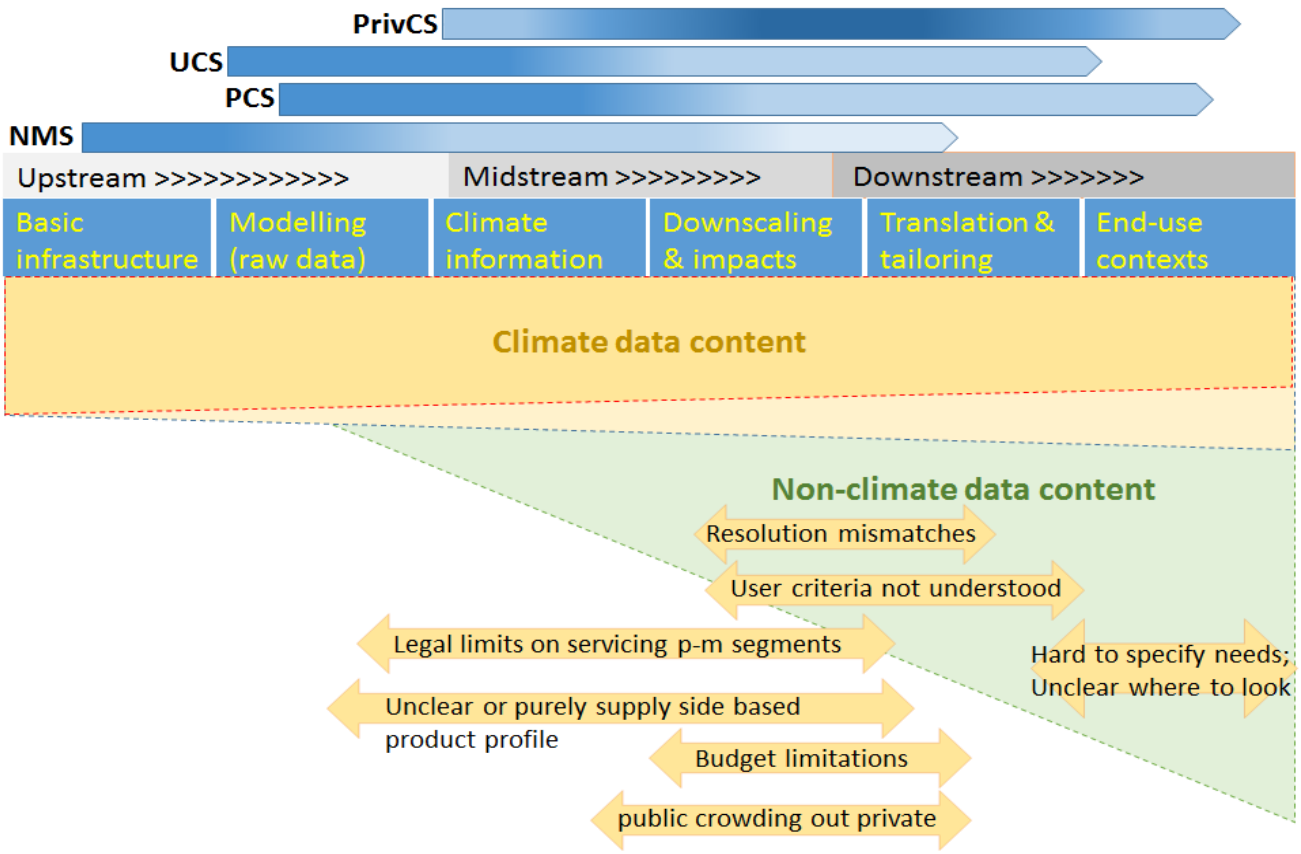

FIGURE 7 VALUE CHAIN - OBSTACLES - CS PROVIDERS

Legend: NMS – National Meteorological Service (WMO member); **PCS** – Public Climate Services institute or agency; **UCS** – University based climate services; **PrivCS** – Climate Services provided by private company (as dedicated CS consultancy or as part of larger consultancy portfolio or as side product (e.g. of insurance or logistics) (NB! roles of NMS, PCS and UCS can be mixed for some product-market segments)

In the EU-MACS focus sectors of financial services and urban planning the interest in adaptation oriented CS clearly takes precedence over seasonal CS, except for indemnity insurance and re-insurance. On the other hand in tourism the prime interest gravitates around seasonal CS. As many seasonal CS can be better associated with tangible user benefits, such CS lend themselves to be provided as a charged service and hence commercial provision could often be the first option (provided open data principles are sufficiently applied to enable product development). Under those conditions however, one would expect that market parties have strong motivations to learn the effective models of service provision and use. This means that in case of commercial provision public support and promotion of such services is at best only defendable for a limited period, i.e. to explore new types of business and delivery models, and should entail also societal benefits, such as improved vitality of tourism oriented peripheral regions. *All in all this means that Figure 7 is representing in the first place adaptation oriented CS, even though the value chain structure and some of the obstacles are also relevant for seasonal CS.*

From Figure 7 can also be inferred that the addition of non-climate data (green area) and the merging of climate and non-climate date (the light yellow shaded area) associates with growing complexity and growing palette of required skills. In the upstream and early midstream segments non-climate data usually concern closely related physical phenomena such as hydrology and vegetation. In later midstream and downstream segments it concerns ever more societal processes, requiring knowledge and skills outside the

typical realm of disciplines in (public) CS provider organisations. For many CS providers with an upstream emphasis it may therefore be particularly relevant to consider how wide their 'stretch' should be.

As indicated in section 3.1 the typology of public and private goods for CS associates to some extent with the segments of the value chain discussed above. This is illustrated in figure 8, where is indicated for each typology what *tend* to be the most likely value chain segments from which CS are typically provided. In due course this shows that when a (public) CS provider wishes to extend its portfolio with more downstream oriented CS it should realize that the most suitable market organisation and business model really differs from its default public service model. Vice versa similar arguments apply for pure end-use CS providers which want to extent backward in the value chain.

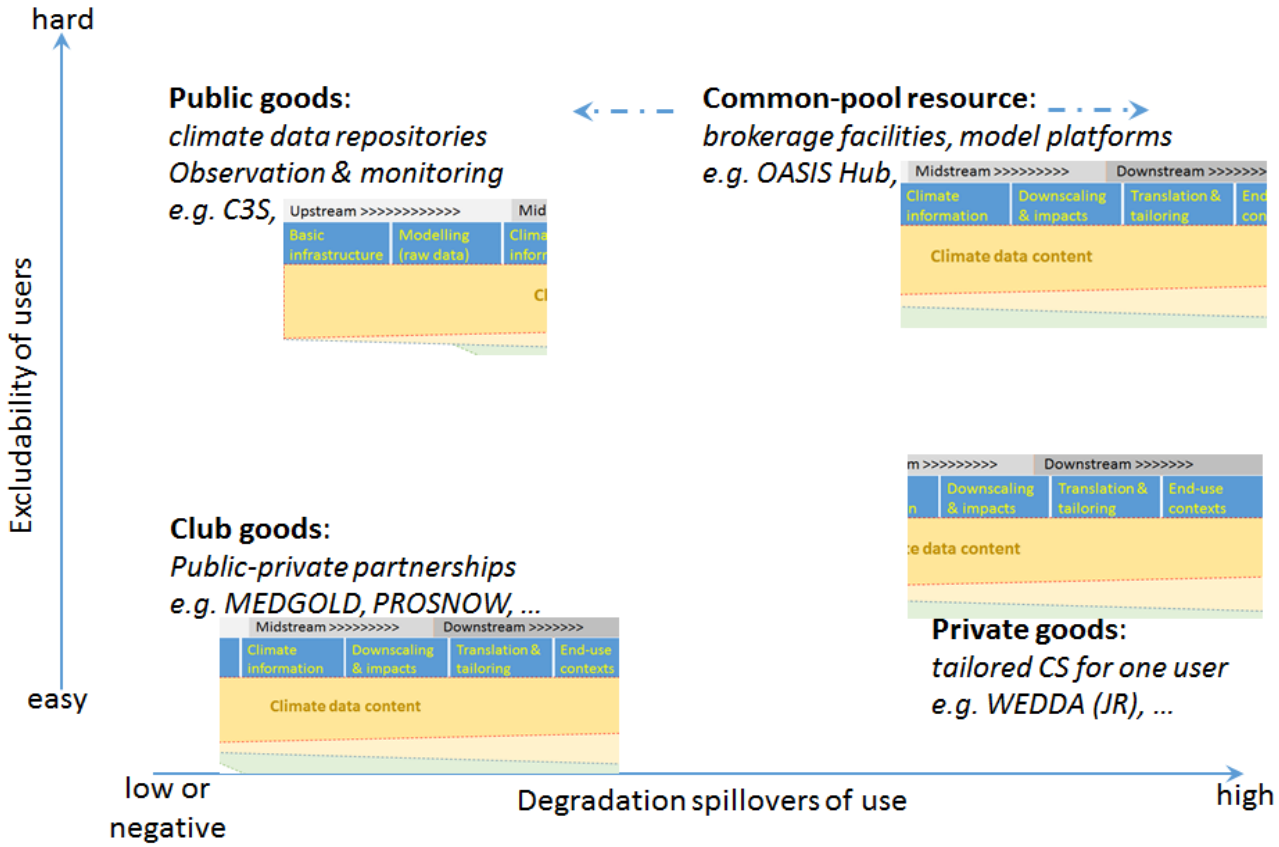

FIGURE 8 IDENTIFICATION OF VALUE CHAIN SEGMENTS WITH THE PUBLIC AND PRIVATE GOOD TYPOLOGY FOR CS

Conclusion

All in all a consensus arose of what seem to be the principal and other fairly relevant obstacles, and that the relevance of these obstacles varies over product-market segments (in terms of countries, user sectors, and types of climate service). In the evolving dynamic climate services market one should be aware of the fluidity of some of the concepts, whereas at the same time some fundamental obstacles can really limit the product and market development options. Furthermore, even though adaptation oriented CS and seasonal CS may to a significant extent encounter the same obstacles, the severity of the obstacles and the ways to overcome them may differ.

5. RATING AND ORDERING OBSTACLES

5.1 Occurrence and consequence as basis for significance

Based on their experiences in their own interactions with stakeholders in EU-MACS, and in other contexts, the project experts were invited to rate the identified obstacles:

- Firstly in terms of occurrence among users, providers, and cases (for matching) by means of frequency classes
- Secondly in terms of significance of the obstacle, if active, by means of a weighing factor

Occurrence frequency was defined as:

Part A – frequency

1 = Seldom < 10%	2 = Not so often ≥10% - < 40%	3 = Quite often ≥ 40% - < 85%	4 = most, if not all, users / providers / …

Weighing factors were defined as:

Part B – significance (weight) of factor

1 = marginal	2 = moderate	3 = notable	4 = (very) substantial

Project partner experts filled in tables organized as shown below. A cross (X) was put in one cell per line. Comments could refer to the sourcing of the information, the rating's applicability (conditionality), slight re-interpretations of the obstacle, etc.: The full tables are provided in Annex 1. Ratings were obtained from HZG (overall), Acclimatise (finance), Joanneum (tourism), and FMI (urban; overall).

FACTORS	1	2	3	4	comment
Demand:					
- Obstacle 1					
- etc					
Supply					
- Obstacle 1					
- etc					
Matching					
- etc					

Overall results of significance rating (score = occurrence level x weight) for all answers together and for two sub-sectors are shown in table 2. It is highly important to regard these scores *as only indicative* and notably in terms of relative significance. Yet, high scores across the board hint at truly important obstacle.

Table 2. Significance rating of obstacles by sector and domain of obstacles

Demand:	**ALL**	**tourism**	**Priv. banks**
(preliminary) impact projections are of minor importance compared to many other risks	12	12	9
inherently short term oriented business model (ruling out adaptation CS)	12	16	9
no clue about how such information could be used in decision making (i.e. no risk management)	10	9	12
lack of awareness of climate change or (seasonal) climate variability or climate information (as regular input for decision making)	9	9	9
lack of incentives (e.g. if costs are (expected to be) fully compensated)	6	6	10
perception that responsibility rests fully on other actors	6	9	6
denial of climate change	4	4	1
acquisition and/or use of CS is expected to be too expensive, leading to reduced or non-exercised demand	2	4	1
(public) acknowledgement of climate risks is seen as risky for (local) business development (e.g. tourism)	1	6	1
perception that there are no response options (fatalism or gambling)	1	9	1
Lack of internal coordination	*		8
Supply:			
available CS information is not really packaged as service (but e.g. rather as R&D project output)	12	9	12
CS product portfolio is totally or largely out of scope for the user group	9	6	8
insufficient resourcing of CS product development and delivery	9	9	6
CS provider faces legislative limits regarding product or user segments it is allowed to service	8	1	-
lack of understanding of user characteristics	8	6	8
CS provider does not employ clear product profile or client type profile	7,5	4	8
no interest or capability to develop CS beyond mere data provision	6	9	8

Matching:	ALL	tourism	Priv. banks
mismatch of provider's and user's 'language' and conceptions	12	9	16
uncertainty about the eventual relevance of the CS for the user's decision process ('fit for purpose')	12	16	9
temporal and/or spatial resolutions do not match with other user's data	12	6	12
insufficient guidance and/or embedded consultancy	10	9	12
user demands too sophisticated for no-charge or low-charge CS provision	8	8	1
hard to specify CS needs	7,5	9	9
unclear where to look for CS services (if NMS cannot deliver)	6	9	12
user organisation cannot develop unified vision on CS needs	6	1	3
uncertainty ranges incompatible with user's decision process	3	12	3
hard to make choices between alternatives (within and across providers)	1,5	1	1
Lack of climate service data processing skills (no GIS capacity)	**		16

*) Other partners did not explicitly mention this obstacle, but from the exercises in WP4 (urban planning) and from anecdotal evidence can be inferred that this is a more wide spread problem across user sectors.

**) Lack of CS data processing skills, notably for spatially explicit data (GIS), appears to be an issue in the financial sector for the time being. Once CS data start to be used more, recruitment of GIS experts and of expertise will probably alleviate the problem. Can also be an issue in other (not studied) sectors.

The orange cells indicate significant deviations from the overall impression of a particular obstacle.

Overall the table illustrates that there tend to be three levels of significance:

- obstacles that seem to score high to very high (>9) across the board – this means that both occurrence and consequence are significant
- obstacles that are moderately to fairly significant (6-9), may have quite disparate scores for occurrence and consequence, whereas they may be more significant in a particular sector
- obstacles with low scores, occurring rarely and/or of modest consequence; yet even in this case some product-market segments may have higher scores owing to specific contexts

This rating gives a first idea on what issues should be focused. Yet, many of these obstacles are interlinked, and just addressing a few that seem to score high may turn out to be ineffective due to the interrelations. Especially obstacles in the matching domain are typically affected by flaws in the supply and/or demand domains.

5.2 Ordering of obstacles in terms of interactions

In the last part of the first consultation of the experts inside the EU-MACS consortium it was asked to indicate relations between obstacles, including the direction of the influence (obstacle A affects obstacle B or vice versa or – sometimes – mutually). Responders could also add comments to the identified relations. Annex B contains an overview of cross-tables.

We first list the included obstacles per domain and add some explanation to each of them. Subsequently we present a flow chart of (probable) causal relations within one domain. For the last – operational – domain of matching, we indicate also probable background causes in the demand and supply domains.

Demand domain

Table 3. Demand domain obstacles further clarified

Demand:	clarifications
1. Lack of awareness regarding climate change or (seasonal) climate variability or climate information (as regular input for decision making)	Lack of awareness refers to the impression that it is not so relevant for the organization, while this not being based on proper knowledge; somehow in the priorities the topic never gets high enough – which may happen more in SMEs; the existence of climate change and variability is usually not denied, but gets only attention in acute situations; a fortiori awareness about climate services (both adaptation and seasonal) suffers from the same perceived irrelevance frame
2. denial of climate change	Denial is nowadays getting quite rare. People and organisations may have hesitations about the (acute) relevance for them (see some other points);
3. lack of incentives (e.g. if costs are (expected to be) fully compensated)	This refers to economic (dis)incentives (e.g. when risks can be transferred), legal (dis)incentives (e.g. when there is no obligation in planning), and social (dis)incentives (e.g. high vs. low reputation risks); the (absent) source can be internal (objectives & norms) and external (inadequate legislation); the latter is more likely for adaptation oriented CS, but also possible for seasonal CS
4. (public) acknowledgement of climate risks is seen as risky for (local) business development (e.g. tourism)	Unlike in point 2 one is well aware of climate change, but fears that high awareness among customers may lead to behavioral adaptation to the detriment of the sector (in that region). Ii is encountered in tourism, but also an issue in climate change exposed real estate markets (e.g. Miami). This is less relevant for seasonal CS.
5. perception that responsibility rests fully on other actors	As consequence of or prelude to point 1, or to support the stance of point 4, this view can arise, which makes such harder to incentivize unless legally made accountable
6. perception that there are no response options (fatalism or gambling)	This may be owing to either lack of knowledge or to conviction. Could be perceived as subset of point 1, but the thresholds for achieving change can be much higher
7. (preliminary) impact projections are of minor importance compared to many other risks	This could be regarded as a certain stage of awareness where acquisition of rational information led actors to conclude this way (rightly or wrongly). The actors should at least update this assessment regularly. This point may appear active in combination with no.9
8. no clue about how such information could be used in decision making (i.e. no risk management)	This may represent several levels of severity of missing capacity to handle information. In the worst case the risk management system is gravely deficient. In other cases it may be more a matter of entirely new information, outside the competence area of the organization. Eventually, it gets also a matter of balancing upfront cost, potential benefit and willingness to adapt.
9. inherently short term oriented business model (ruling out adaptation CS)	For several sectors commercial product lifetime cycles are short, whereas drivers of demand are mobile and volatile. This is typically the case in tourism and leisure services, while also the downstream parts of food production chains are to some exposed to this. All these examples are easier to sensitize

	to seasonal CS, but have difficulties to identify benefits of adaptation oriented CS.
10. acquisition and/or use of CS is expected to be too expensive, resulting in no or reduced demand	This can be a separately created perception, but is often related to (inter alia) points 1, 4, and 7. For a part of the actors in tourism this often implies no demand exercised. For smaller and/or budget limited municipalities it may mean reduced demand (in volume and/or quality)
11. Lack of internal coordination	Knowledge on risks and opportunities, such as exploitation of CS, is often insufficiently shared in (large) organisations. Similarly, initiatives for the use of CS may not be communicated to other parts of the organisation. Last not but least coordination of different CS needs may be lacking. At least for both the financial sector and urban planning this obstacle proved relevant.

By using Table 2 in conjunction with Figure 6 (and for that matter Figures 7 and 8) one can better grasp how obstacle alleviation could be dealt with in **clusters.** For example, when just trying to provide up-to-date information in order reassess implications of obstacle 7 (other non-climate risks prevail), one should check whether that stance is reinforced by a short term oriented business model (obstacle 8), and whether – even if obstacle 7 would be alleviated – the organisation has the capacity to exploit the information contained in CS (obstacle 8). In turn, it may be that rather than trying to turn around each organisation in the sector individually, it would be much more effective to change regulations such that obstacle 3 (incentives) is turned into a driver. For Figure 7 (Supply) and Figure 8 (Matching) applies the same type of joint use with Table 2. In other words, Table 2 helps to prioritise, while Figures 6 – 8 help to turn separate measures into a coherent strategy. Packaging of measures is however complex, while we have not yet thoroughly considered effects of innovation processes and external resourcing models. Actual design and comparison of policy packages is done in D5.2, while in this deliverable we focus on alleviation of individual obstacles by one or more measures, yet while already acknowledging the interactions. \

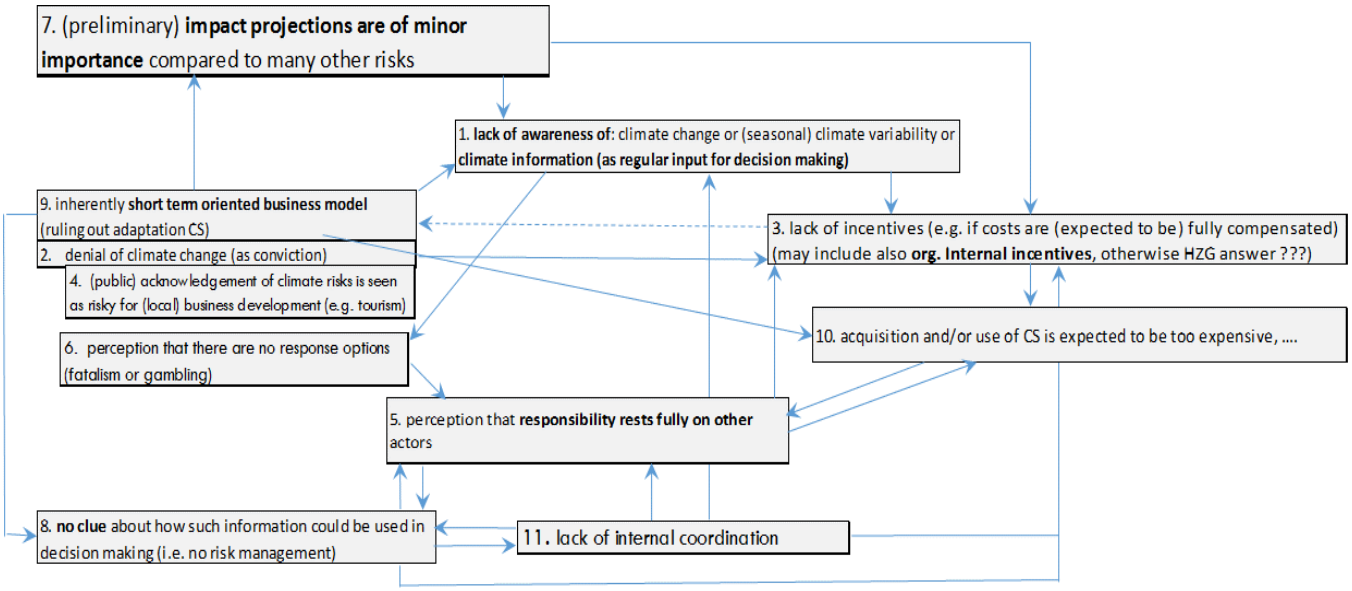

FIGURE 9 CAUSAL LINKS BETWEEN OBSTACLES IN THE DEMAND DOMAIN

Main types and origins of obstacles:

- **1.No incentives (incl. disincentives) (no.3, 4, 7, 9, 10):** (demand seems not necessary or is much smaller than in optimal case)

- **External**: expected net benefits of CS use are unclear or negative; no (legal) obligations; lack of financial support; principal agent / split incentives; peer pressure absent or counter-effective;
- **Internal:** beneficial use of CS is not rewarded (HR salary & motivation); principal agent / split incentives between departments; current business model puts CS outside scope;

- **2.Lack of awareness (no.1, 2, 5, 6, 10, ..):** (no clue that there could be beneficial use for CS)
  - About risks of climate change
  - About risks of climate variability
  - About adaptation options
  - About existence and potential benefit of CS
- **3.Organisational deficiencies (no. (3), 8, 11, ..):** (potential demand is not or partly effectuated)
  - Inadequate risk management system, hard to connect to CC
  - Serious shortfalls in internal information sharing
- **4.Lack of resources (no…):** in many cases lack of resources is not a root cause, but a consequence following from perceived low relevance or urgency, or from low awareness; nevertheless, for some (segments) of sectors it may be a root cause in its own right, often related to the size of the user's organization, such as the many SME's in tourism, and many smaller municipalities in rural and peripheral areas. In case of smaller municipalities it will be mostly a matter of reduced the use of CS, whereas e.g. for SME's in tourism it may rather mean no use at all.

Supply Domain

Table 4. Supply domain obstacles further clarified

Supply:	Clarifications
1. CS product portfolio is totally or largely out of scope for the user group	For many users and sectors the available information is insufficiently relevant in terms of contents, and/or the information is hard to connect (technically or conceptually) to other (non-climate) information; prospective users may search for other CS providers or (sometimes) start to develop (in cooperation) new CS or give up searching for CS; consultancy will often be an essential part of the portfolio desired by users; depending on business model CS provider can try to respond to this CS development need
2. CS provider doesn't employ clear product or client type profile	Unclear profiles obstruct search and evaluation for prospective users, raising hesitations on fitness for purpose. The root cause is often in not clearly established business models of CS providers.
3. CS provider faces legislative limits regarding product or user segments it is allowed to service	The legislation in EU Member States (MS) varies on the extent to which public service providers (such as NMS) can engage in product-market segments with private competition and/or in public-private partnerships. So not every business model is allowed in every MS. Ease of international delivery of CS adds further complexity to this factor. This was only occasionally mentioned in interactions in EU-MACS.
4. insufficient resourcing of CS product development and continued provision	There is latent demand for not yet existing products, waiting to be developed. On the other hand the overall feedback in interactions suggests that resourcing for CS development is not the most serious bottleneck. Instead, assuring resourcing for *continued* provision of (new) CS, once developed and piloted, seems quite difficult.
5. available CS information is not really packaged as **service** (but e.g. rather as R&D project output)	For a genuine CS *market* CS provision should be based on continued (established) provision of services, even though a part of the deliveries will have a project character. So far, a lot of provision has been in the context of pilots and one-off (co-development) projects. Quite some CS providers still have the R&D project approach as the default mind set. Even though creativity and unique solutions will continue to play a role in many CS deliveries, it still requires a transformation to a customer oriented CS delivery vision.

6. no interest or capability to develop CS beyond mere data provision	As such this can be a valid and wise choice depending on the organisation's profile and resourcing options, but it just as well means that various product-market segments are not any more to be aspired.
7. lack of understanding of user characteristics	Often as a consequence of not having clearly established a business model, the awareness of (and interest in) user characteristics is weaker; this situation may be aggravated and perpetuated depending the organisational culture

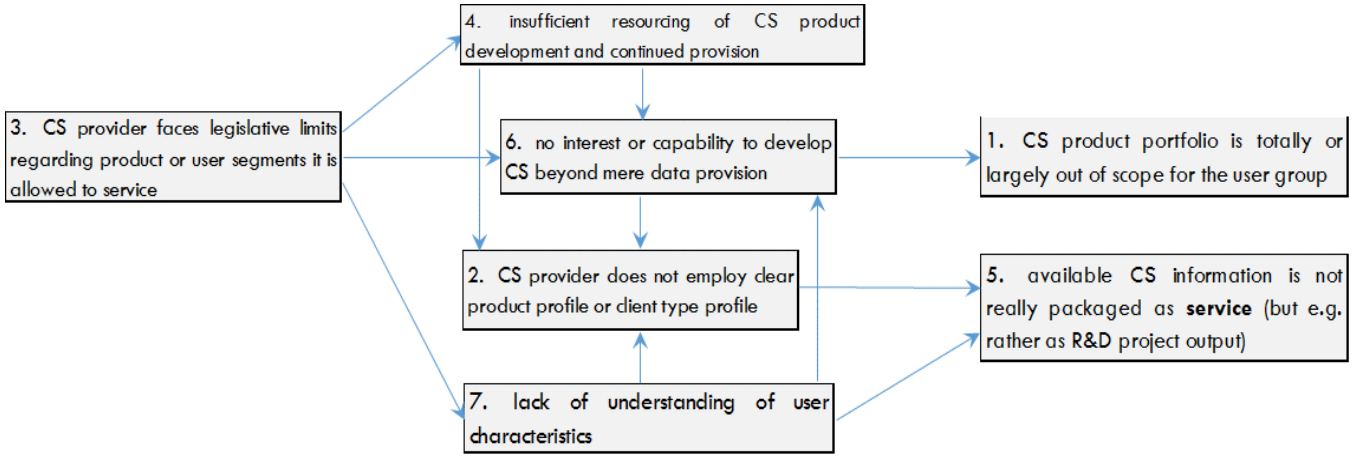

FIGURE 10 CAUSAL RELATIONS BETWEEN OBSTACLES IN THE SUPPLY DOMAIN

Main types and origins of obstacles:

- **1.No incentives to service in some product-market segments (incl. disincentives) (no.3, 4, (6)):**
  - **Legal:** NMS is not allowed to service (certain) private actors[4] (charged or free), if this can be arguably done by private actors; vice versa, private service providers may find it difficult to find funding for more complex product development;
  - **Resourcing:** insufficient resourcing of CS development or of (public) CS provision obliging the CS provider to make limiting choices;
  - **Cultural:** the prevailing mindset attaches less value to service provision compared R&D work, possibly also reflected in HR motivators
- **2.Lack of user knowledge & orientation (no. 6, 7, (2, 5)):** (no capability or interest to understand user needs)
  - **Lack of skills:** Available skills cannot cope with user understanding user needs
  - **Lack of experience and appeal:** CS provider has poor network to the user group, and lacks clear profile to this group
- **3.Organisational deficiencies (no. 2, (5)):**
  - **Product profiling absent or ineffective:** lack of consciously developed business models makes CS offer ineffective in terms of contents and/or appeal (profile))
  - **Inadequate business model(s):** this is the root cause of many obstacles, including those that surface in the matching phase (lack of user oriented product profiles, uncertain fitness for purpose, no user oriented QA, etc.)

[4] This includes companies owned by public bodies (e.g. municipal energy or waste handling company).

- **4.Lack of resources (no.4, (3)):** even though the survey (D1.1) suggests that limited financial resources is reported as being a fairly important issue for CS providers, interviews for other sections of WP1 indicated that funding does *not* seem to be a dominant factor, when referring to CS development and piloting; it may be for some private CS providers, whereas funding for continued (regular) CS provision may be more often at risk of failing (which in turn might be related to weak business model development, but this hypothesis was not assessed).

Matching Domain

Table 5. Matching domain obstacles further clarified

Matching:	clarifications
1. uncertainty about the eventual relevance of the CS for the user's decision process ('fit for purpose')	Often as a consequence of inadequate, i.e. no user oriented product profiling, nor QA, a prospective user has significant doubts about eventual usefulness of the information in its *own* decision context; admittedly also from the (prospective) user some degree of acquainting with the subject area may be expected; next to clearer profiles and better QA, also other interaction formats (e.g. co-design) can help
2. uncertainty ranges incompatible with user's decision process	This is a rather technical obstacle, which is sometimes relevant (and in those cases can even be decisive); can be overcome either by scientific progress in modeling and/or by applying a different risk management approach
3. unclear where to look for CS services (if NMS cannot deliver)	This obstacle has a decreasing significance over time, when ever more (user) sectors gain at least some experience with CS; at the moment this seems still a (somewhat) relevant point for prospective users from the financial sector and tourism; open communities of practice and brokerage can help
4. hard to specify CS needs*	In sectors where awareness has grown only recently, as well as in user organisations where internal coordination is weak (while this is not recognized by the CS provider) this can occur. More intensive interaction formats are (part of) the answer.
5. mismatch of provider's and user's 'language' and conceptions	This follows from insufficient user orientation and interest from the side of the CS provider, but can be aggravated by a poorly prepared user. The prime responsibility for matching is however at the provider's side, at least at early stages of the matching and product definition or tailoring process
6. insufficient guidance and/or embedded consultancy	For a part of the mid-stream CS market this may be less relevant, while for downstream users the embedding in wider consultancy activities is usually essential, hence the significance of business models. Perhaps in the long run, when use of CS gets much more mainstreamed, parts of consultancy may be served through artificial intelligence (AI).
7. user demand is too sophisticated for no-charge or low-charge CS provision	This obstacle is related to culture mismatch, inadequate CS product profiling, inadequate awareness of (parts of) the user organization. Can be accommodated to some extent through better interaction formats, but may also be a matter of waiting for innovations, and learning at the user side.
8. temporal and/or spatial resolutions do not match with other user's data	This is similar to and related with no.2 (trade-off between resolution and uncertainty; see D1.2). Usually users want higher spatial resolutions than offered, while also near future effects (5 – 15 years ahead) are often desired.
9. user organisation cannot develop unified vision on CS needs*	This is the strategic level version of no.4. In contrast to no.4 in this case the root cause is in this case certainly in the demand domain, where needs identification should start and include an organization wide view. It may be further aggravated by insufficient sharing of information.
10. hard to make choices between alternatives (within/across providers)	This can be caused both by lack of preparation by the user *and* by intransparency of CS product portfolios.
11. lack of CS data processing skills	Especially lack of GIS data processing skills (like in finance), but also general limitations in data processing (tourism) can be a significant obstacle, which can be overcome by training or outsourcing.

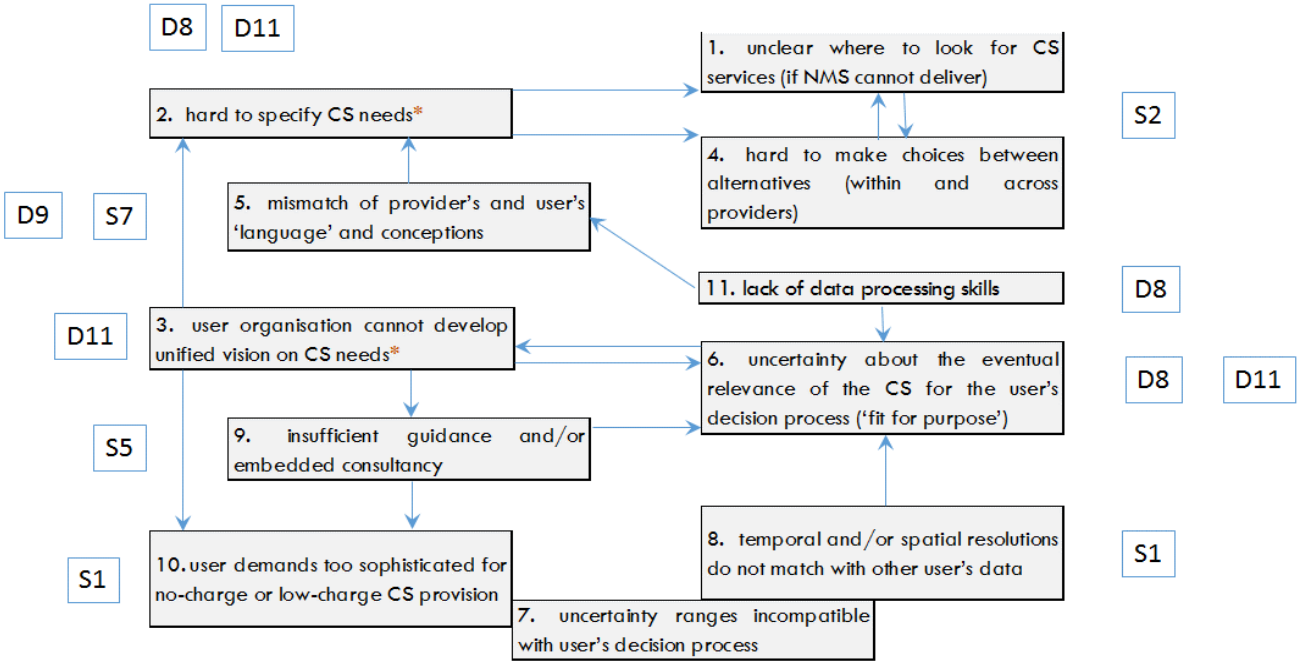

FIGURE 11 CAUSAL LINKS BETWEEN OBSTACLES IN THE MATCHING DOMAIN (D AND S NUMEBRS REFER TO DEMAND AND SUPPLY DOMAIN OBSTACLES AFFECTING OBSTACLES IN THE MATCGING DOMAIN

6. OPTIONS FOR POLICIES AND MEASURES

In a second round of internal consultations partner experts were asked about policies and measures for alleviating the identified obstacles. Furthermore, in conjunction with the invitation to identify policies and measures to alleviate or remove obstacles the question was raised to what extent seasonal CS and adaptation oriented CS should be promoted jointly or separately, to the extent promotion is deemed necessary for either type of CS.

6.1 joint or separate promotion of different types of CS

The project internal experts were first asked about differentiating between seasonal and adaptation oriented CS. They were instructed and requested as follows.

The extent to which climate adaptation oriented CS and seasonal CS (aimed at coping with climate variability) should be promoted jointly or separately has not received much explicit attention in the literature, be it peer reviewed or 'grey'. Various CS providers (and CS developers) indicated in EU-MACS interviews that for them there are economies of scope and other synergies in providing both. This is especially valid for CS providers which have (also) upstream capacities.

In contrast, for CS users more downstream in the value chain, not the least for those in our focus sectors, adaptation oriented CS and seasonal CS are totally different things related with different managerial segments in their organisations. Possibly some urban infrastructure managers recognize that e.g. the use of seasonal CS may provide a learning pathway for the use of adaptation oriented CS.

Next to so-called end-users probably an important target group in this respect are expert organisations that combine upstream/midstream CS with other information and knowledge to provide downstream CS or use it in services which are not termed nor regarded a CS. A superficial website-can suggests that these domains are often not integrated or only seemingly integrated.

Q1: should the promotion of both types of CS be conducted in an integrated way? – please motivate your answer; differentiation (Yes for This / No for That) and conditions (Ye, but only if ….) are allowed.

Answers:

1. "**I'd say mostly no**. Seasonal forecasting is more like an extension of weather services. There is less need for integration with other types of data (the information is likely easily understandable and useful to the user as such) and commercial markets are likely to develop without much effort should the quality of seasonal forecasts reach the threshold where they are broadly useful.
   As mentioned above, the link between seasonal CS and climate adaptation (or mitigation) is quite different from other types of CS. Although seasonal CS provides means to manage climate risks, it would largely happen on operational timescale. Seasonal CS are more likely a means to improve operational efficiency than to drive and guide efforts of strategic climate adaptation. Then again, seasonal CS is definitely a tool in disaster risk reduction.
   The development of seasonal CS is still facing the fundamental challenges regarding limitations in forecasting. It is perhaps even dangerous to mix the different types of uncertainties in the promotion of CS."
2. "**In my opinion yes**, if the users are the same for both, as well as their needs and motivations. If the service provides an integrated solution, it is more likely to be of use for the users and become the one-stop shop for related information and services.
   If there are discrepancies between the types of users, their needs and motivations, the answer could be no. However, with good design, it is possible to make an integrated service where the user is very

clearly led to the information and type of service most interesting for them, even if there is also other information available that they may not find so useful."

3. **"Contra**: Those who are skeptical about climate change and do not see a need for adaptation oriented CS may nevertheless see a value in seasonal products. Therefore, it could be wise to promote the services separately as it may prevent them from blocking the use of CS/WS in general.
   Pro: On the other hand, this could also be an argument to promote them in an integrated way in order to raise the awareness for adaptation oriented CS through the use of WS.

   Furthermore, the use of WS or seasonal CS could also represent some sort of adaptation: as weather and climate variability are expected to increase in future due to climate change, increased usage of these more short-term oriented products may become an important adaptation measure. Hence, in some sense, WS, seasonal CS and adaptation-oriented CS are hard to separate."
4. "**Yes they should be integrated**, but best if there is the ability to have guidance for different end users, navigational guidance to either.

Synthesis:

In fact the answers have more in common than would seem at first sight. Considering that promotion is in the first place about convincing prospective users, while the two product groups serve quite different user needs, it seems wise not to simply promote them in one package. In fact, promotion should also be differentiated by user groups, even though such variation can be based on clever use of a selection of common building blocks. At the same time in the promotion of particular CS the links with other types of CS should never be totally severed. Prospective users may have a diversity of clusters of CS needs, whereas a particular promotion will mainly address one cluster.

Additional reasons in favour of (only) a modest degree of integration are:

- seasonal CS and adaptation oriented CS are in all likelihood provided under quite different market conditions, and consequently common promotion may cause confusion or suspicion as consequence of quite different delivery conditions;
- for CS providers there will be active and latent economies of scope and scale, which may also be related to use (sales) levels, and hence a radical severing of the promotion of the products may cause extra costs and hamper CS innovation

6.2 Identified options for policies and measures

The project internal experts were informed about the most significant obstacles (as defined and displayed in Ch.5). Subsequently they were instructed and requested to fill in as follows.

The high rated obstacles (and other less prominent) have been identified in Deliverables from WP1-WP4 (with a variation in exact wording). The challenge is now to come up with suggestions regarding policies and measures that alleviate or even eliminate certain obstacles. Later on in Task 5.3 we will also consider interaction effects as well as effectiveness of packages of policies and measures.

In the literature policies and measures are often used interchangeably. In this case we mean by 'measure' an action, ruling/guideline, or investment implemented by an organization or sector. A 'policy' on the other hand – in the present specific context – is essentially a piece of legislation which can entail one or several types of instruments, such as: (1) obligations (e.g. to make evidence based adaptation plans), (2) minimum standards (e.g. use of quality assured information & tools), (3) accountability or liability conditions, (4) reporting (and transparency) obligations, (5) information market access and pricing (e.g. 'open data policies'), (6) resourcing (subsidies, charges, R&D funding), (7) public procurement, and (8) awareness, information and education campaigns (e.g. for sectors for which CS may seem less obvious, such as tourism).

It is important to realize that modern policy design often means that several instruments are built together into a compound policy package. For example, obligations to make adaptation plans and/or comprehensive risk management plans (no.1) could be combined with minimum standards on the information used (no.2), whereas no.1 and no.2 may also function as prerequisite for eligibility for support funding (no.6) or public procurement (no.7). It should be realized that in D5.2 we will use a wider concept of 'policy', including various preparation processes and societal deliberation and lobbying.

Q2: *You are invited to suggest policy instruments and/or concrete measures for selected obstacles in the table below. The first cell on the right contains some guidelines regarding the items to be included.*

The full list of proposed policy measures in presented in Annex 2. We present a summary below both differentiated by type of instrument (table 6) and by urgency based on the obstacle rating in Ch.5.

In Ch.5 was explained that obstacles can be distinguished by 4 types of underlying mechanisms, being: (1) lack of incentives or presence of disincentives; (2) lack of awareness; (3) organisational deficiencies, and (4) lack of resources. This division in four types of mechanisms can be applied to all three domains of obstacles (demand, supply, matching).

Lack of incentives can be regarded as the most crucial type of mechanism, as interventions in this realm will at the same time affect: business model shortfalls, resourcing, and prioritization in user organisations. If incentives are boosted or new ones added, policy makers should check that resourcing is commensurate to the implied tasks.

In terms of policy instruments incentives can be financial (e.g. subsidies) or regulatory (obligations and norms). Considering the presented analysis of obstacles obligations seem to be the prime option for improving incentivization for CS uptake. Subsidies on CS are unlikely to improve uptake of CS efficiently, as costs of CS are also significantly related to use and perceived uncertainty over the fitness for purpose. Yet, some kind of support, e.g. through **public service contracts**, to better safeguard continued provision of public CS, seems justified.

Incentivization of the use of CS can take the form of **obligations to prepare and update adaptation plans** of good standing, based on qualified data. Another (complementary) option, especially relevant for all types of asset management, is the **obligation for regular disclosure of risk related to climate change effects** and related adaptation efforts, as also implied by the TFCD and EU propositions regarding sustainable finance.

To further support the improvement process ignited by incentivization oriented obligations, explorations with new (cooperative) forms of CS provision and CS (co)development need to be supported and results actively shared and evaluated in the relevant provider and user communities. To safeguard continued existence of newly developed public CS, public service contracting merits to be explored. Public service contracting means that a public agency agrees with the supervisory public body (e.g. a ministry) to fulfil a certain public task, specified by means of volume and quality indicators, for which an earmarked compensation is agreed. Recent years' performance, public policy ambitions, and efficiency gains steer the required performance level and the level of the earmarked compensation. If, realistically seen, alternative suppliers would be available, public service contracts can also be auctioned.

Given the large role of the financial actors in the economy and in the investment decisions across all sectors, the climate risk disclosure process needs to be closely monitored by the public sector in order to ensure the right effectiveness on improving climate change preparedness and on the use of qualified CS. Adequate progress in the financial sector will greatly help progress in uptake by other sectors, owing to the risk transparency that financial actors will require from their clients.

After boosting incentives and complementing these with proper resourcing options, the next important category of measures concern a cluster of organisational issues. The most important concerns proper business model development of public CS providers. Good implementation of the chosen business model should also tackle more specific organisational issues – depending on the business model chosen. For a given business model it also becomes clearer what more user oriented quality assurance should entail and what type of communicative skills need to be emphasized. The transformation of such providers can be supported with information and training, as well as exploration (piloting) of new business models, including cooperative concepts in which providers and users work together (co-development and continuous learning). Some of the innovative business models may require regulatory changes in order to allow the public CS provider to engage in such kind of cooperation. Another important supporting element is ensuring that open data policies are actually and coherently implemented. This is particularly important for private climate service providers and for CS brokerage services. A coherent open data policy should be oriented to enabling maximum societal benefit from these data, which is not the same as maximum private business volume. Open data policy not necessarily means that all pubic data should free of charge, but open data should be affordable and those open data which are also relevant for private citizens are preferably free of charge. Last but not least the combination of open data policies with strict separation of publicly and privately served CS product segments may simply lead to absence of service or lack of innovation (Perrels 2018). This is further discussed in D5.2 in the context of a broader discussion of resourcing of CS.

As already indicated in relation to the previously discussed clusters of instruments (i.e. planning and risk disclosure obligations, organisational changes) **information policies** are in many cases effective boosters of the main policy instruments. For supporting the uptake of climate services information policies are certainly an important supportive instrument, inter alia for awareness raising (in some sectors), for better and easier sharing of information, for better market transparency, and for training and education. On the other hand a large scattering of different information policies can get counter-productive. Allowing for differentiation within one programme is usually preferable over many separate programmes.

Last but not least policy instruments can also be of a hybrid type combining obligations with performance measurement and related rewards and sanctions ('feebates'). The obligation to climate risk disclosure for asset managers at the same time creates a valuable risk information system if reporting is well organized, which can further support the use of more or more advanced climate services. Hybrid instrument design is not the same as policy package design (i.e. how a collection of instruments works together), which we handle in D5.2.

Table 6. Main types of measures and policies

Instrument categories	Public and sector policies	Measures at organisation level
Financial incentives ○ subsidies ○ sanctions ○ public procurement	Climate communication fund; Public service contracts on CS; Promoting / supporting brokerage services (e.g. start-up subsidy)	Sponsoring networking between business – experts – policy makers; Promoting / supporting brokerage services (e.g. start-up VF)
Obligations ○ Accountability ○ Disclosure ○ Minimum standards	Regulated climate proofing (incl. resilience level); Societal risk assessments; Public service contracts on CS;	Sectoral guidelines and standards (such as endeavoured in the TFCD process)
Information ○ Training ○ Campaigns ○ Open access ○ Communities of practice ○ Quality standards	Regulated climate proofing (incl. resilience level); CCIAVD as part of business education; Ambitious open data policy; W&CS marketing packages; CS Best Practice programmes	Sponsoring networking between business – experts – policy makers; W&CS marketing packages; CS Best Practice programmes
Hybrid ○ Feebates (performance dependent) e.g. related to progress in uptake ○ Sanctions combined with standards / open access / disclosure rate	Public service contracts on CS; Exploration of new business & resourcing models ('fremium'; P&U clubs; etc.); Promoting / supporting brokerage services;	Promoting / supporting brokerage services;

6.3 Next steps – connecting to D5.2

The above outline of possibly relevant policy instruments (with more details in Annex 2) creates a basic reservoir of options for the next step in the synthesis in which we investigate plausible packages of policy instruments under differently oriented policy regimes (Deliverable D5.2).

For judgement of the fitness of policy instruments in particular policy regimes and innovation contexts we will use the information and tools presented in preceding deliverables and this deliverable. In addition we will use product-market and product cycle tools from BCG, as well as a simple model for uptake probability preliminary explored in D2.1. Eventually we will combine alternative innovation prospects with selections form the basis collection of policy instruments presented here and review these pre-selections in terms of political and societal acceptability in a given policy regime. This should result in a set of *climate service policy scenarios*. This process is summarized in figure 10 below.

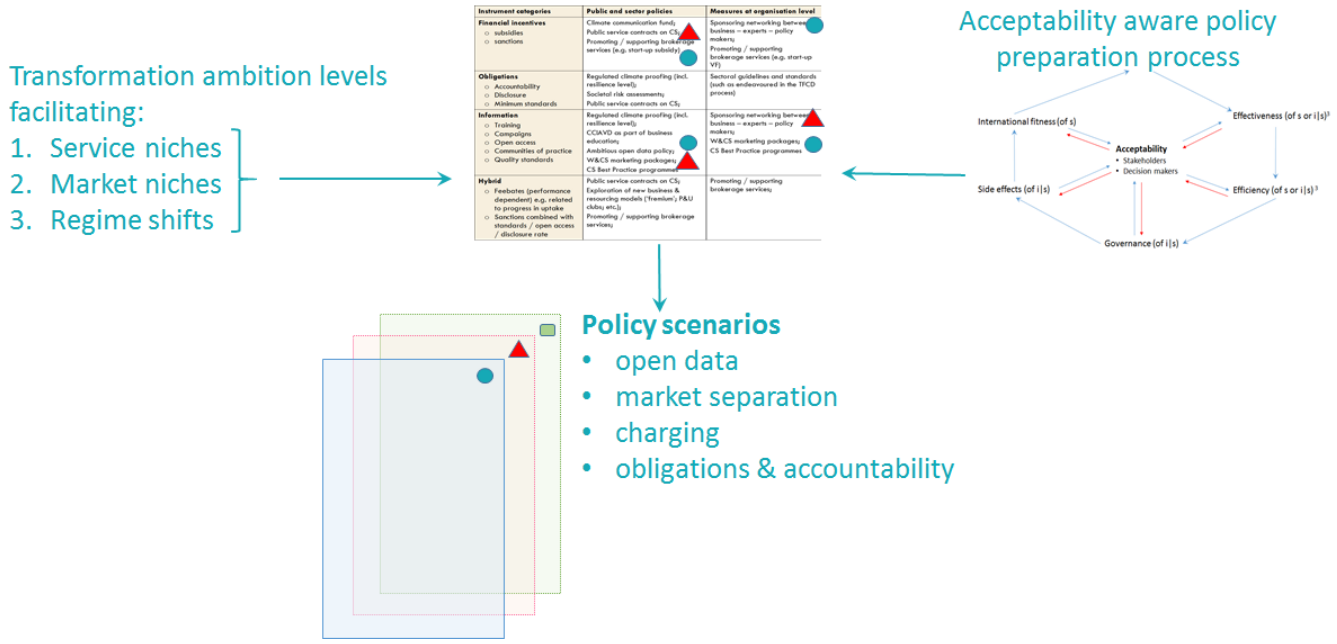

FIGURE 12. TOWARDS CLIMATE SERVICE POLICY SCENARIOS (INPUT FROM D5.1 AND D1.4 INTO D5.2)

7. CONCLUSIONS

Based on the work in the previous work packages and the targeted reviews of the project internal experts for this Deliverable a structured set of obstacles and underlying mechanisms and interactions could be presented, while referring to known economic theories and concepts.

The indicated significance of different obstacles should be understood as qualitative, even when ratings have been used in order to produce some kind of ranking. Apart from the fact that the rating process as such is imprecise, the dynamics and innovations in the CS market can lead to changes in the ranking. For some obstacles, such as lack of awareness about climate change effects, we could even notice some decrease in significance during the duration of the study.

Background drivers for the use of Climate Services

We distinguish four main motivational themes for the use of CS, being:

- Resilience
- Adaptation
- Mitigation
- Integrated sustainable development

These themes are not (entirely) mutually exclusive, but – at least in earlier stages of CS use – one theme may take typically precedence in the specification of CS needs, and thereby steer (or limit) on what is regarded as relevant, regardless of whether other types of CS may be relevant as well for the user. At least in early stages of interaction CS providers better accommodate to the focus implied by the prevailing motivational theme. Thanks to learning and feedback processes a wider scope of applications will open up over time.

Terminology

There is a fairly large *non-unified* set of terms used in CS development and delivery. Lack of harmonization in terminology contributes to the confusion among prospective users and thereby slows down uptake through various mechanisms. This obfuscating terminology includes the very term 'climate services' itself, of which the interpretation varies between 'nothing else than climate data' and 'anything that contributes to better coping with climate change, climate variability, and climate policy'. Last but not least 'climate services' can be understood as services of the climate system, similar to the concept of 'ecosystem services'.

Furthermore, the different main categories of climate services (seasonal, adaptation oriented, classic statistical) imply major differences in the nature of the products.

The term 'climate services' can be useful in climate policy oriented publications, but in the context of motivating prospective user groups other terms closer to the relevant vocabulary of targeted user groups seem to be called for. The situation is comparable to the large variety in the understanding of the term 'energy service' (Fell 2017).

Also the distinction in providers and users of CS is not optimal, since many midstream and downstream providers of CS are *both* users (of CS produced more upstream) and providers (of their own CS). In other words the position in the value chain is as important for typecasting the CS product as the notion user or provider and the main type of CS (seasonal, adaptation related, ..).

Value chain and the degree of separation of types of climate services

The distinction in upstream, midstream and downstream CS is helpful for identification of certain obstacles with particular sections of the value chain, and choices whether a CS provider better covers a large stretch or rather provides other (more downstream located) CS providers. Internal economies of scope and scale (in a stretched CS provider) are than weighed against larger flexibility and better skill allocation of subsequent separate actors.

Ordering and ranking obstacles to uptake

Obstacles, when resolved, can often turn into or create space for new opportunities. Therefore the removal of obstacles should not be framed in a defensive framework (only).

The most important obstacles are rooted in shortcomings in the organisation and strategic choices of CS users and providers, sometimes enhanced by external factors, such as legislation, which disincentivizes users or providers. In addition there are obstacles at operational levels, when actors try to match CS offers and CS needs, e.g. when it is hard to search and select fitting CS.

The most **important obstacles** for the uptake of CS in the **demand domain** seem to be for the time being:

- (preliminary) impact projections are of minor importance compared to many other risks
- inherently short term oriented business model (ruling out adaptation CS)
- no clue about how such information could be used in decision making (i.e. no risk management)
- lack of awareness of climate change or (seasonal) climate variability or climate information (as regular input for decision making)

The most **important obstacles** for the uptake of CS in the **supply domain** seem to be for the time being:

- available CS information is not really packaged as service (but e.g. rather as R&D project output)
- CS product portfolio is totally or largely out of scope for the user group
- insufficient resourcing of CS product development and delivery

The most **important obstacles** for the uptake of CS in the **matching domain** seem to be for the time being:

- mismatch of provider's and user's 'language' and conceptions
- uncertainty about the eventual relevance of the CS for the user's decision process ('fit for purpose')
- temporal and/or spatial resolutions do not match with other user's data
- insufficient guidance and/or embedded consultancy

Key policy measures

Not all policies and measures need to be pursued as public actions. Sometimes private (sector level) actions can be even more fitting and sometimes also mutually complementary public and private measures can be implemented.

Most important is to **create sufficient incentives** in hitherto not activated sectors. Moreover, due to the large follow-up effects the take-up of CS by the financial sector (as part of climate change risk disclosure) is to be of high importance in any CS promotion policy package. A second major issue is a systematic and well-founded **application (and regular review) of business models by CS providers,** notably public CS providers, while also including options for cooperation forms between users and providers.

Various informational policies can raise the effectiveness of the main instruments. Especially **market transparency** and consequent **open data policies** are important for better exploitation of service potentials.

In terms of concrete policies the following stand out as important options::

- establish **public service contracts** specifically for CS delivery in otherwise poorly serviced product-market segments, entailing performance elements in terms of volume and quality in relation to earmarked funding, while of sufficient yet finite duration – consider auctioning in later phases, at least for some CS product groups
- apply **climate change risk disclosure legislation** to relevant sectors, with requirements on data quality and tractability
- oblige regional and local authorities, infrastructure companies, and other sectors identified as critical (in relation to societal functioning) to prepare and maintain **climate proofing strategies and declarations**
- provide financial and knowledge support for **exploration of new business & resourcing models** aimed at smooth and lasting CS delivery, under the condition that lessons can be shared with third parties
- **enforce consistent and broad scoped open data policy**, while guaranteeing sufficient funding for good quality data generation;
- consider **adapted pricing of open data** such that the better the openness of follow-up products is the lower the charge of the open data
- promote and support **CS best practice programmes** to boost learning among both user and provider groups
- selectively promote and support CS brokerage (for sectors and/or products with apparent notable underutilization)

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ANNEX 1 – QUESTIONS OF THE 1ST CONSULTATION ROUND

Questions for T5.2 (as the basis for D5.1)

In EU-MACS we distinguish three main domains of effects on CS uptake:

4. **Demand related obstacles and mechanisms** (i.e. preventing in general (many) users in the considered sector from articulating a need for CS)
5. **Supply related obstacles and mechanisms** (i.e. preventing in general (many) providers, in the considered CS product category, from effective product portfolios)
6. **Matching related obstacles and mechanisms** (i.e. delaying, distorting or frustrating matches of arisen CS needs and available CS offers due to operational shortcomings)

Relevant factors in each of these domains are:

Demand:

- lack of awareness of:
  - climate change (as serious risk for that sector)
  - (seasonal) climate variability (as assessable phenomenon)
  - climate information (as regular input for decision making)
- denial of climate change
- lack of incentives (e.g. if costs are (expected to be) fully compensated)
- (public) acknowledgement of climate risks is seen as risky for (local) business development (e.g. tourism)
- perception that responsibility rests fully on other actors
- perception that there are no response options (fatalism or gambling)
- (preliminary) impact projections are of minor importance compared to many other risks
- no clue about how such information could be used in decision making (i.e. no risk management)
- inherently short term oriented business model (ruling out adaptation CS)
- acquisition and/or use of CS is expected to be too expensive, ….
- budget limitations force the user to acquire only a subset of needed CS (or not any CS)

Supply:

- CS product portfolio is totally or largely out of scope for the user group
- CS provider does not employ clear product profile or client type profile
- CS provider faces legislative limits regarding product or user segments it is allowed to service
- insufficient resourcing of CS product development
- available CS information is not really packaged as **service** (but e.g. rather as R&D project output)
- no interest or capability to develop CS beyond mere data provision
- lack of understanding of user characteristics

Matching:

- unclear where to look for CS services (if NMS cannot deliver)
- hard to specify CS needs*
- user organisation cannot develop unified vision on CS needs*
- hard to make choices between alternatives (within and across providers)
- mismatch of provider's and user's 'language' and conceptions
- uncertainty about the eventual relevance of the CS for the user's decision process ('fit for purpose')

- uncertainty ranges of offered climate information incompatible with user's decision process
- temporal and/or spatial resolutions do not match with the user's other data
- insufficient guidance and/or embedded consultancy from the provider(s)
- user demands too sophisticated for no-charge or low-charge CS provision

*) this is on the borderline of matching and demand (as the underlying reason may be a failing demand factor) and/or caused by inadequate client profiling by CS provider (e.g. sometimes first SNA necessary); this aspect is nevertheless placed in the category 'matching', as this problem is often only revealed when getting to the matching stage.

Q1:

A. The distinction between actors in the climate services 'market' by role is often not so easy to apply; up to now typical terms in the literature are:
    a. **Providers** (organisations that supply CS, implicitly it usually also means that they create CS; providers are associated with actors in the upstream and midstream part of the CS value chain)
    b. **Purveyors** (organisations that make CS available, but do not create these themselves (though purveyors may for example add value regarding search, comparison, selection, display)
    c. **Re-users** (organisations that obtain CS (data) from upstream providers and use that for generation of own CS (e.g. by combining these with other data; this term is quite often used by national met-offices, in fact with implicit reference to the PSI and INSPIRE directives; re-users are associated with actors in the midstream and downstream part of the CS value chain)
    d. **End-users** (organisations that use CS for decision making in their own operations without the purpose to generate CS for further downstream use *)
    e. **Brokers (**organisations that assist and consult prospective users to find fitting CS providers, and on the other hand help CS providers to present and market their CS products**)**

    *) However, in some sectors, such as tourism and indemnity insurance, sort of *courtesy climate services* can arise in support of the main service

    Based on your experience in the EU-MACS and MARCO projects and beyond, to what extent should these distinctions (a-e) be:

    - *Reassessed* – (more terms, less terms, other terms, other definitions, etc. ?)
    - *Differentiated* by CS market segment ?

    Reply HZG-GERICS:

    It depends on what the distinction is needed for. From a more theoretical viewpoint it might be helpful to have some degree of differentiation, e.g. an expert in the field of CS might know the difference between a provider and purveyor. And even for experts it might get tough: I, for instance, would not agree to the "definition" (if there is any at all?) of a purveyor given above. For me, a purveyor is what is referred to as re-users.

    When looking at the terminology above, there seems to be no clear-cut differentiation between some categories:

    - Provider = organisation that supply CS
    - Re-user = organisations that obtain CS (data) from upstream providers and use that for generation of own CS

      This would mean that providers are only the first actor in the whole value chain, so how can they be placed somewhere mid-stream?

In addition, there seems to be an overlap between Brokers and Purveyors (as "defined" above).

From a more practical viewpoint these distinctions (might) cause confusion. For instance, research performing organisations (e.g. universities or GERICS) in many cases consider themselves as providers of climate services, even though these types of providers would, according to the terminology provided above, be a re-user. I was wondering, how, for instance, Acclimatise would consider themselves as – I would assume as a provider of CS.

For a (end-) user of services it is usually only important to know, where to get the services they need. It is most likely completely irrelevant to them, if they obtain it from a provider, purveyor or re-user. From their perspective no distinction is needed.

So, to conclude, the whole distinction tends to be confusing without providing substantial benefits. If this is really needed, it might be helpful to use more common terms such as intermediaries instead of purveyors and re-users, or only users instead of differentiating between re-users and end-users.

For the same reason I would not establish different terminologies for different market segments as this would increase complexity without any benefits justifying this.

ACCLIMATISE

- *Reassessment need:*
  Perhaps could add in something about hybrid user/provider, such as WB or large re-insurers who have tools others use (e.g. Climate Knowledge Portal or CatNet tool (from Swiss RE)) – or is this what you mean by the term *courtesy climate services*?

  We also feel purveyors do create climate services (contrary to the definition above) when they add value. Acclimatise considers itself a purveyor and we create services (just not climate data). We want to be careful to ensure a broad definition of climate services, i.e. we do not want to have a boundary around climate services so that providers of climate data are the only ones seen as CS providers. In other words, including advisory services in the climate services definition means we too are CS providers. Then maybe the term purveyors could drop away, or purveyors could be reassessed since taking climate data + value added = providing climate services.

- *Differentiated* by CS market segment?
  What do you mean by cs market segment - upstream/mid/downstream? We would caution against adding even more complexity to these terms, which could be the result of differentiating these by market segment.

JR

The definition of purveyors seems not to be that clear. Sometimes re-users are seen as purveyors (In the definition above, what does it mean "adding value"? – just preparing climate data, without combining these with other information? Adding value also means re-using data…), and the distinction between purveyors and brokers is not that clear either.

And, Re-users are also Providers. 'Intermediary' is another term that is often used in this context (for re-users, purveyors, and/or brokers).

FMI (KPS) (referring to urban planning only):

KPS/FMI: In my opinion, a strict division into providers and purveyors (and to somewhat brokers) is unnecessary as many organisations can have various roles and the roles can be mixed. For instance in Finland, FMI could be at least a provider and a purveyor, and perhaps even a re-user to some extent. Naturally, this is not the case in many other EU countries but in Finland, the NMS is one player in the "market" and therefore has multiple roles.

B. Do you have evidence based indications that the number of new entrants (can refer to all of the above types, except end-users) is larger downstream than upstream? Make you choice (by highlighting your choice in yellow):

   - NO, there are no clear differences between upstream and downstream
   - NO, I don't have evidence (FMI/JR), however (HZG), there is clear evidence in MARCO (Del. 3.1) that the absolute number of CS providers engaged in downstream activities such as consultancy / advisory services or risk assessments is larger compared to those engaged in upstream activities. How many of them are market entrants has not been assessed. Maybe the current assessment could serve as baseline. Repeating the assessment in a couple of years would than allow to identify new players
   - YES, namely – at anecdotal level (ACC) one can see there is a growth in firms like Acclimatise, providers or purveyors (see discussion above), who are geared toward downstream provision of CS, offering these CS to the finance sector. Due to important changes in the governance landscape in the finance sector, like Article 173 and TCFD, we are seeing more and more climate consultants offer tools and services which repackage upstream data into downstream information, tools and analysis for the finance sector. These schemes and regulations currently necessitate a large amount of translation and 'shepherding' of financial institutions who may not be equipped yet to understanding climate related data and information and how to incorporate it to their existing risk management systems and decision-making processes. I.e. there is strong need for mid and downstream providers and we are seeing a corresponding growth in firms answering that call. We think there is potential for growth in brokers, though it is probably too early for brokers yet in the finance sector, as use of a broker implies an organisation has a decent level of understanding on which data and information it needs – which is not yet widely the case in the FS sector…….

C. Do you have indications for notable market dominance by some CS providers, re-users or brokers for some product market segments and/or for some countries? Make you choice (by highlighting your choice in yellow):

   - NO, I don't have evidence

   FMI (referring to urban planning only): No, with some hints for the opposite: in Helsinki, the end user (the city organisation) uses various providers/purveyors from research institutes to consultancy firms, depending on the issue in question. The product/service is usually obtained through a normal tender process

   JR: No, evidence; moreover the market is quite small, so I would not speak of notable market dominance, even if there is one service that is used by a few businesses, but just provided by one CS provider.

   HZG: No evidence, I just scanned the relevant MARCO deliverables, if the transactional analysis shows some evidence, but the analysis had been made for market segments or countries only. The market share of single CS providers is not presented. If this is necessary I can ask the colleagues from kMatrix if they can check their data in this respect.

   According to statements from a SME in Germany, they cover almost 80% of the urban adaptation sector (i.e. they developed 80% of the local adaptation strategies). This however is not validated.

   When looking at the following figure from MARCO Del. 3.1 we see, that the number of CS providers for the different sectors addressed should allow at least for some competition. Only for very few sectors (such as Defence or Mining) the number of CS providers in Europe targeting those specific sectors is rather low.

NB: It has to be kept in mind, that most of the private CS providers identified by kMatrix are not included in these numbers, as it was overall not possible to identify, in which CS related activities they are engaged.

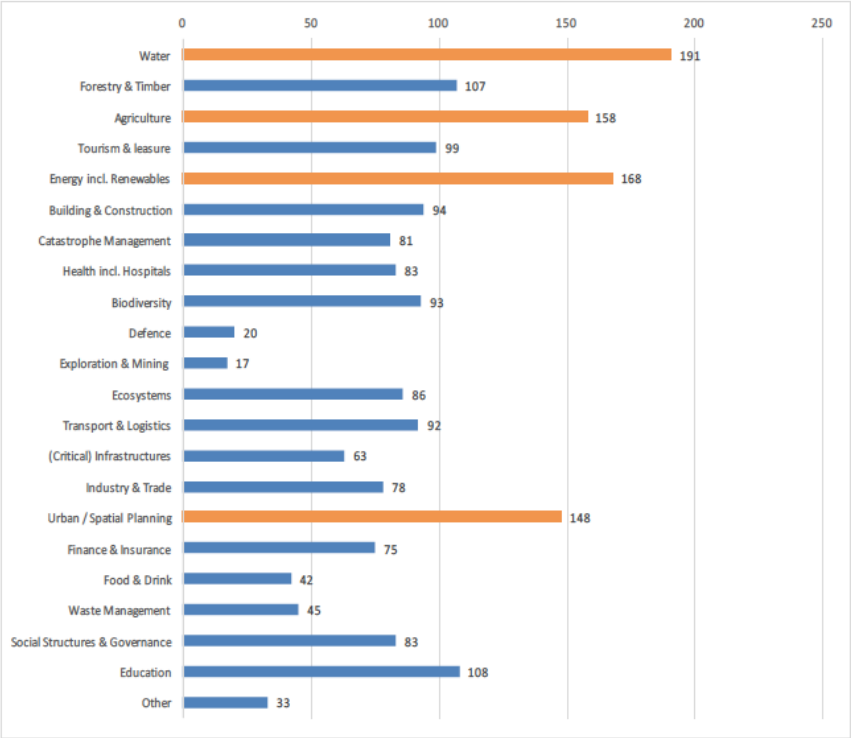


Figure 8: Absolute numbers of organisations providing CS to a specific sector

Source: Marco Del. 3.1

- YES, namely …….

ACC:

Maybe *dominance* is too strong, because across the finance sector there are so many diverse needs and a market as such is still forming. The stakeholders we consulted did, however, consistently mention these providers/purveyors they use or are thinking of using:

Upstream:

- NOAA and its National Centres for Environmental Information
- World Bank's Climate Knowledge portal
- UNEP Grid Sites
- Think Hazard
- WRI aqueduct

More downstream:

- Potsdam Institute for Climate Impact Research for information around scenarios and IAMs
- Tools:
    i. UNEP FI's drought stress testing tool;

ii. Swiss RE CatNet tool,
iii. AWARE risk screening platform (Acclimatise)

- Consultancy/advisory services:
  i. Acclimatise and US-based firm Four Twenty Seven are two leading firms providing consulting services around climate impacts, adaptation, and resilience to the financial services sector (evidenced by our recent selection as the joint technical secretariat to the EBRD and Global Center of Excellence on Climate Adaptation project which looked at metrics for physical climate risk and opportunities); we both often provide services to the development banks.
  ii. Mercer (a well-established financial consultant). Their TRIP methodology, set out in this report: *Investing in a Time of Climate Change* is one of the first tools/methods published to analyse comprehensive suite of climate risks. It suggests using IAMs for physical climate risk. Of the few asset managers who have tried to start using CS, this tool and report was consistently mentioned.

Other sources of location/asset level data (which are foundational to climate risk assessments in finance sector, given the large number of assets being analysed in their portfolios)

- Bloomberg terminal's 'Bloomberg Maps' – a new but popular initiative mostly focussing on providing information to FIs who need information on the energy sector. Tool which combines location and historical hazard data to produce interactive maps. This is a new effort, but given the presence of Bloomberg Terminals in almost every single FI, this has large potential for dominance.
- Asset Level Data Initiative. This initiative is widely mentioned, but upon speaking with them, it appears as it might not be moving forward yet or is not well-staffed yet.
- Platts databases (energy sector).

D. According to D1.1 financial resource limitations have been quite important for both CS providers and (re)users. On the other hand interviews in T1.2 and T1.3 tend to give a moderated picture, i.e. as if money is not so much a limiting factor, whereas also in WP2-WP4 can be observed that only for tourism costs of CS may be directly an issue. Do you have further explanations for this (seeming) conflict of signals?

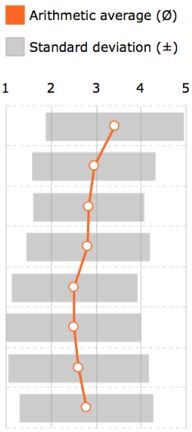
HZG: I would agree to the "moderate" picture. When we look at the 'users only' we see, that, among the economic barriers, limited financial resources is the most impactful barrier followed by human capital (see the following figure).

Please let us know, which economic barriers you have faced when using the selected service? Please rate their importance from 1 (low) to 5 (high). *

.png .pdf .xls .csv

Number of participants: 31

	1 (1)		2 (2)		3 (3)		4 (4)		5 (5)		Not applicable (0)		
	Σ	%	Σ	%	Σ	%	Σ	%	Σ	%	Σ	Ø	±
Limited financial resources	4x	12,90	3x	9,68	5x	16,13	3x	9,68	9x	29,03	7x	3,42	1,53
Human capital (incl. number and pr...	5x	16,13	2x	6,45	7x	22,58	5x	16,13	3x	9,68	9x	2,95	1,36
Organisational setting, incl. establi...	4x	12,90	5x	16,13	7x	22,58	5x	16,13	2x	6,45	8x	2,83	1,23
Added-value of climate services oft...	5x	16,13	4x	12,90	6x	19,35	4x	12,90	3x	9,68	9x	2,82	1,37
Timeliness of development and pro...	6x	19,35	6x	19,35	4x	12,90	2x	6,45	3x	9,68	10x	2,52	1,40
Dysfunctional definition or distribut...	7x	22,58	4x	12,90	5x	16,13	-	-	4x	12,90	11x	2,50	1,50
Missing definition or distribution of ...	8x	25,81	2x	6,45	5x	16,13	2x	6,45	4x	12,90	10x	2,62	1,56
High search costs to find a suitable ...	7x	22,58	3x	9,68	4x	12,90	6x	19,35	3x	9,68	8x	2,78	1,48



However, the limited availability of financial resources does probably not influence the acquisition of CS itself that much, as more than half of the respondents spent modest or significant purchase costs (see the following figure).

Did the acquisition of climate services entail:

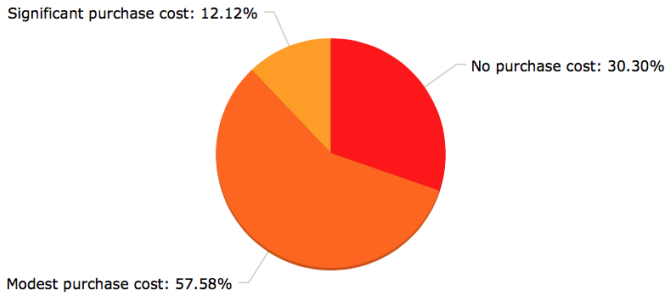
.png

Number of participants: 33

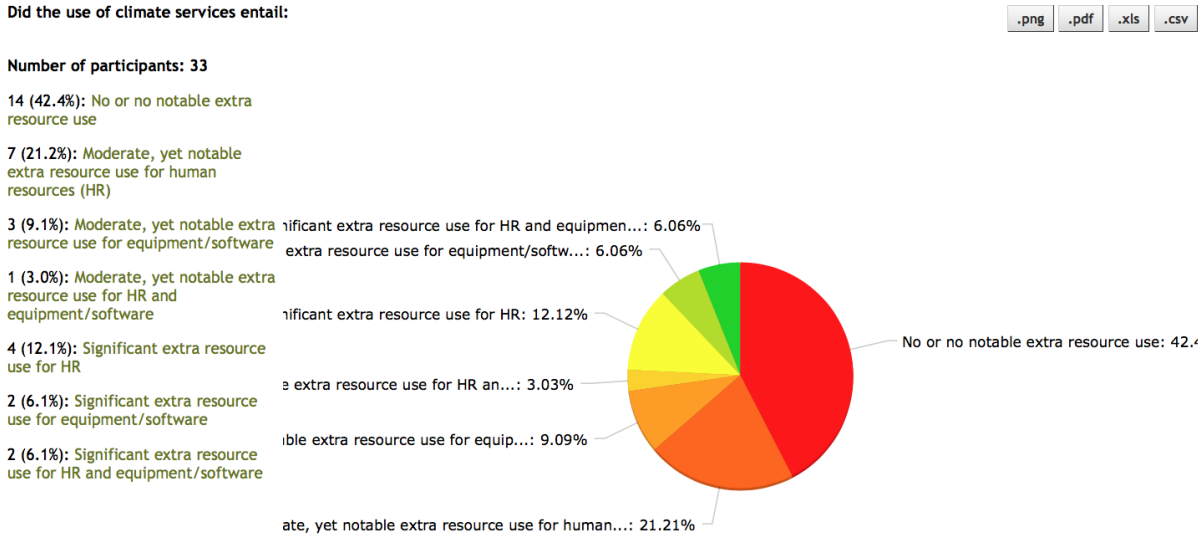
10 (30.3%): No purchase cost

19 (57.6%): Modest purchase cost

4 (12.1%): Significant purchase cost



When including costs for human resources or technological equipment in the category 'limited financial resources' the picture might change a bit. According to another question in the survey (see the following figure), the financial resources in relation to human recourses and equipment seem to play an important role. For almost 50% of the users, the use of CS entails moderate or even significant extra resources in these two dimensions. This is also reflected in the survey as the second most important technological barrier seems to be 'inappropriate format of available services'; it was also mentioned in some MARCO case studies (i.e. provided data or tools do not fit in the existing systems operated by users).



This could cause costs in different categories: either in terms of actual resources to hire new or capacitate existing staff, or in terms of opportunity costs, i.e. existing staff works on CC adaption issues (or similar) instead of something else.

From the survey we are not able to draw a similar differentiated picture for the CS providers as these questions were only addressed to the users. However, I could imagine, that limited financial resources are an issue for more or less the same / similar reasons. If you would, for instance, try to increase the temporal and / or spatial resolution you would need for a CS product, the computational capacity increases by the factor of ten (or so?). Then we would come back to the opportunity costs of that increase in resolution as the computational capacities are limited or you have to invest more in the computational infrastructure (which then might limit your decisions in other fields; e.g. hire an impact modelling expert to develop another CS product).

E. Are there plans to compare or jointly evaluate the supply side survey results of MARCO and EU-MACS? .. and comparison with earlier similar surveys?

HZG: So far we have not thought about it, as the structure and aims seem to be to different. However, if there would be specific questions we could try to find some evidence (or at least hints) in both surveys.

Q2:

Are there any factors listed in page 7 (in the three categories demand, supply, matching), which you never encountered in the sector reviewed by you, and which you regard as irrelevant? If so, list them here:

HZG: This is a tricky question as there are only very few, which, to the best of my knowledge, we have not yet faced at GERICS in one of our activities. None of those remaining factors seem to be irrelevant so there is nothing to be mentioned / added here.

ACC:

Demand

- denial of climate change
- lack of incentives (e.g. if costs are (expected to be) fully compensated)
- (public) acknowledgement of climate risks is seen as risky for (local) business development (e.g. tourism)

- perception that there are no response options (fatalism or gambling)

Supply

- insufficient resourcing of CS product development

JR:

Supply:

- CS provider faces legislative limits regarding product or user segments it is allowed to service

Matching:

- User organisation cannot develop unified vision on CS needs*
- Hard to make choices between alternatives (within and across providers)

FMI (referring to urban planning only):

DEMAND

• climate change denial: I would say clear denial is not an issue, but we have to keep in mind that I've only worked and interviewed people in the city who are by default interested in climate change. The organisation is huge so I cannot conclude that it is not an issue. Even the mayor of Helsinki in his public speeches has addressed climate change impacts and adaptation so in principle the city is taking it seriously.

- (public) acknowledgement of climate risks is seen as risky for (local) business development (e.g. tourism)
- perception that responsibility rests fully on other actors
- perception that there are no response options (fatalism or gambling)
- acquisition and/or use of CS is expected to be too expensive

SUPPLY:

- CS product portfolio is totally or largely out of scope for the user group

MATCHING

- unclear where to look for CS services (if NMS cannot deliver)
- hard to make choices between alternatives (within and across providers)

Q3:

What other factors, than those listed on page 7 have you encountered in the sector reviewed by you? Please list additional (not yet listed) factors here and indicate to what category (demand/supply/matching) they belong:

HZG:

- Supply: Timeliness of provision
  - Sometimes users have very specific information needs which makes it almost impossible to develop / deliver the information needed in the relevant timeframe (even though this is, according to the survey not that much an issue from for users – rated 2,5 on a five point Likert scale; with one third of the users having not faced this issue yet)
  - For public providers this might sometime also conflict with ethical or moral questions on whether or not to provide certain information to certain users (e.g. provide information on ice cover in the Artic to allow planning of extracting of fossil fuels)

- Matching:
    - Different languages, in particular when addressing private businesses as potential users it is not only about climate risks (that might or might not occur in 20 to 50 or even more years) but rather about **business opportunities** in the near future (5 to 10 years max.)
    - Technological incompatibilities between systems, e.g. data formats and / or software solutions; this seems to be a specification of the fit-for-purpose topic already identified

ACC:

Demand

- no clue about how such information could be used in decision making (i.e. no risk management) → we think this could be expanded to include a similar but alternative demand-related obstacle: users are not sure how the climate data and information could be brought into their risk management system on a practical level. Some risk analysts in banks that we have been speaking with, have only very recently been exposed to the outputs of climate impact studies, for example. They are struggling to convert the outputs into factors that can go into their models. So while they do indeed have a risk management system and they have stress testing models, most don't have a clue on how to use climate data and information to perturb their models.
- FIs don't know where other non-climate data (but essential) information is, such as the location or features of the physical assets they invest into. For example, they give corporate HQ a loan, but they don't track internally the location of asset purchased, making it impossible to know which hazard information they need. Another example is for asset /wealth managers/ equity investors, who just passively invest in a diverse fund that tracks a desired return rate – they don't have physical location data either). So the obstacle is lack of sufficient internal data management systems for information which is necessary to complete a climate risk assessment on an aggregated / portfolio level, which is a big inhibitor of demand for CS.
- Internal communication problems or lack of awareness of the *right* teams in FIs- e.g. the risk analysts do not currently discuss with the sustainability teams (similar to lack of awareness, but here, there *will* be awareness in the organisation about climate risk, but lack of internal coordination which would allow the organisation to act on this awareness. Risk analysts are pressed for time and face huge regulatory requirements, so getting their attention and focus is not always successful). Risk analyst teams often have larger budgets than sustainability teams do, and this combined with their ability to actually carry out the assessment mean they are vital to CS uptake in the finance sector.

Supply

- There are suppliers of data and information which may not know their data and information will later be combined with climate-related data to then become CS (e.g. a map with location of assets overlaid with hazard information which would inform a climate risk assessment). These suppliers are not CS providers but are suppliers of information who have undeveloped potential to feed into CS products and their lack of awareness and coordination with users about end use appears to be an obstacle to developing their products further.

Matching

- FIs don't have the right skill sets in-house – e.g. lack of GIS skilled staff. Demand has been articulated, supply is provided, but the banks can't do anything with large datasets without beign able to manipulate it in a GIS environment.

- Climate-related studies and data is not geared toward financial risk assessment. For the energy sector, for example, there are studies which look at the impact of climate on output, but they don't go to the next step of showing change in price of the commodity, which is what's needed to be able to be plugged into the credit risk models. In agriculture for example, studies about climate impact are designed for impact on food security, not for plugging into a credit risk model.

OTHER points to raise:

- Also, we see 'hard to specify CS needs' and 'user organisation cannot develop unified vision on CS needs' as demand side issues, rather than matching issues? It seems that no demand has arisen. Can you clarify if our understanding of the obstacle types is correct: Definition of obstacles types:

Demand	**Supply**	**Matching**
Factors that prevent users from articulating a need for CS	Factors that prevent the development of effective product portfolios	Factors that delay or prevent, or distort matches of cs needs and cs supply Some are similar to demand side factors, but if the problem is revealed only when getting to matching stage (e.g. demand has already arisen and supply has already arisen), then it is a matching factor

JR:

Demand:

- Lack of financial pressure (degree of suffering)
- Unawareness of CS benefits [maybe covered by 'uncertainty about the eventual relevance of the CS for the user's decision process ('fit for purpose')']

Match:

- Too coarse spatial resolution – [maybe covered by 'temporal and/or spatial resolutions do not match with other user's data', but it is not exactly the same; it could match with user's data but not with user's needs]

FMI:

DEMAND:

- Enough information is publicly available
- Clear information needs (such as flood risk analysis for a new suburb) are procured when needed and through a normal tender process.
- No need for additional information at the moment

Q4:

The factors listed on page 7 will not be equally relevant for each CS market segment. Some factors are more *frequently* relevant than others. On the other hand some factors seem more *decisive (more impactful*) than other ones.

Below are two tables where you can indicate frequency and significance (weight) of factors for the (sub)sectors and product types assessed. Please fill in first to what sector, product, and country the table applies.

- (end)use sector:
- Sub-sector (in case you want to distinguish, e.g. because of clear contrasts):
- Category of CS product:
- Country (or countries):

In the most outer right column you can indicate by means of a capital letter (A …Z) that comments to the rating can be found below under the applicable letter.

Part A – frequency

1 = Seldom < 10%	2 = Not so often ≥10% - < 40%	3 = Quite often ≥ 40% - < 85%	4 = most, if not all, users / providers / …

Part A – frequency	1 = Seldom < 10%	2 = Not so often ≥10% - < 40%	3 = Quite often ≥ 40% - < 85%	4 = most, if not all, users / providers / …	HZG
FACTORS	1	2	3	4	comment
Demand:					
lack of awareness of: climate change or (seasonal) climate variability or climate information (as regular input for decision making)			X		
denial of climate change					
lack of incentives (e.g. if costs are (expected to be) fully compensated)			X		VA often unclear
(public) acknowledgement of climate risks is seen as risky for (local) business development (e.g. tourism)					
perception that responsibility rests fully on other actors					
perception that there are no response options (fatalism or gambling)					
(preliminary) impact projections are of minor importance compared to many other risks					A
no clue about how such information could be used in decision making (i.e. no risk management)					B
inherently short term oriented business model (ruling out adaptation CS)					
acquisition and/or use of CS is expected to be too expensive, ….					
Supply:					
CS product portfolio is totally or largely out of scope for the user group					
CS provider does not employ clear product profile or client type profile					
CS provider faces legislative limits regarding product or user segments it is allowed to service					
insufficient resourcing of CS product development			X		
available CS information is not really packaged as **service** (but e.g. rather as R&D project output)					
no interest or capability to develop CS beyond mere data provision					
lack of understanding of user characteristics			X		Limited / incomplete understandin

ML Development Banks					ACC
FACTORS	1	2	3	4	comment
Demand:					
lack of awareness climate change or (seasonal) climate	X				
denial of climate	X				never
lack of incentives (e.g. if costs are	X				never
(public) acknowledgement of climate risks is seen as	X				never
perception that responsibilit	X				never
perception that there are no response	X				never
(preliminary) impact projections are of minor	X				
no clue about how such information	X				
inherently short term oriented	X				
acquisition and/or use of CS is	X				
Supply:					
CS product portfolio is totally or					
CS provider does not employ clear					
CS provider faces legislative limits					
insufficient resourcing of CS					
available CS information is not really					
no interest or capability					
lack of understandi					

Commercial (large) Banks					ACC
FACTORS	1	2	3	4	comment
Demand:					
lack of awareness climate change or (seasonal) climate			X		
denial of climate	X				never
lack of incentives (e.g. if costs are	X				never
(public) acknowledgement of climate risks is seen	X				never
perception that responsibilit			X		client should assess own risks
perception that there are no response	X				never
(preliminary) impact projections are of			X		
no clue about how such information				X	A
inherently short term oriented			X		B
acquisition and/or use of CS is	X				C
Supply:					
CS product portfolio is totally or				X	F
CS provider does not employ					HARD TO ASSESS
CS provider faces legislative	X				SOME METOFFICES
insufficient resourcing of CS	X				NEVER
available CS information is not really				X	G
no interest or capability					HARD TO ASSESS
lack of understand				X	

(WINTER) TOURISM					JR
FACTORS	1	2	3	4	comment
Demand:					
lack of awarene climate change or (seasona			X		
denial of climate	X				A
lack of incentive s (e.g. if costs are			X		
(public) acknowl edgeme nt of climate			X		
percepti on that responsi			X		
percepti on that there are no			X		
(prelimin ary) impact projectio				X	
no clue about how such informati			X		
inherentl y short term				X	
acquisitio n and/or use of			X		
Supply:					
CS product portfolio		X			
CS provider does not employ		X			
CS provider faces legislativ	X				
insufficie nt			X		
availabl e CS informati on is not			X		
no interest or			X		B
lack of understa		X			

URBAN PLANNING (Hki)					FMI
FACTORS	1	2	3	4	comment
Demand:					
lack of awarene climate change or (seasona	X				
denial of climate	X				
lack of incentive s (e.g. if costs are	X				
(public) acknowl edgeme nt of climate	X				
percepti on that responsi	X				
percepti on that there are no	X				
(prelimin ary) impact projectio		X			
no clue about how such informati	X				
inherentl y short term					
acquisitio n and/or use of	X				
Supply:					
CS product portfolio	X				
CS provider does not employ		X			
CS provider faces legislativ	X				
insufficie nt	X				
availabl e CS informati on is not			X		
no interest or			X		
lack of understa		X			

	1 = marginal	2 = moderate	3 = notable	4 = (very) substantial	HZG
FACTORS	**1**	**2**	**3**	**4**	**comment**
Demand:					
lack of awareness of: climate change or (seasonal) climate variability or climate information (as regular input for decision making)			x		
denial of climate change				x	
lack of incentives (e.g. if costs are (expected to be) fully compensated)		x			
(public) acknowledgement of climate risks is seen as risky for (local) business development (e.g. tourism)	x				
perception that responsibility rests fully on other actors	x				
perception that there are no response options (fatalism or gambling)	x				
(preliminary) impact projections are of minor importance compared to many other risks			x		
no clue about how such information could be used in decision making (i.e. no risk management)		x			
inherently short term oriented business model (ruling out adaptation CS)					A
acquisition and/or use of CS is expected to be too expensive		x			
Supply					
CS product portfolio is totally or largely out of scope for the user group			x		
CS provider does not employ clear product profile or client type profile			x		
CS provider faces legislative limits regarding product or user segments it is allowed to service				x	
insufficient resourcing of CS product development			x		
available CS information is not really packaged as **service** (but e.g. rather as R&D project output)			x		
no interest or capability to develop CS beyond mere data provision					B
lack of understanding of user characteristics		x			

ML Development Banks					ACC
FACTORS	**1**	**2**	**3**	**4**	**comment**
Demand:					
lack of awareness of: climate change or (seasonal) climate variability or climate information (as regular input for decision making)	X				never
denial of climate change	X				never
lack of incentives (e.g. if costs are (expected to be) fully compensated)	X				never
(public) acknowledgement of climate risks is seen as risky for (local) business development (e.g. tourism)	X				never
perception that responsibility rests fully on other actors	X				never
perception that there are no response options (fatalism or gambling)	X				never
(preliminary) impact projections are of minor importance compared to many other risks			X		
no clue about how such information could be used in decision making (i.e. no risk management)	X				
inherently short term oriented business model (ruling out adaptation CS)			X		
acquisition and/or use of CS is expected to be too expensive,		X			
other (added) factors	X	X			
Supply					
CS product portfolio is totally or largely out of scope for the user group					
CS provider does not employ clear product profile or client type profile					
CS provider faces legislative limits regarding product or user segments it is allowed to service					
insufficient resourcing of CS product development					
available CS information is not really packaged as **service** (but e.g. rather as R&D project output)					
no interest or capability to develop CS beyond mere data provision					
lack of understanding of user characteristics					
other (added) factors					

Commercial (large) Banks					ACC
FACTORS	**1**	**2**	**3**	**4**	**comment**
Demand:					
lack of awareness of: climate change or (seasonal) climate variability or climate information (as regular input for decision making)			X		A
denial of climate change	X				never
lack of incentives (e.g. if costs are (expected to be) fully compensated)	X				never
(public) acknowledgement of climate risks is seen as risky for (local) business development (e.g. tourism)	X				never
perception that responsibility rests fully on other actors		X			B
perception that there are no response options (fatalism or gambling)	X				never
(preliminary) impact projections are of minor importance compared to many other risks			X		C
no clue about how such information could be used in decision making (i.e. no risk management)			X		D
inherently short term oriented business model (ruling out adaptation CS)			X		See D and A
acquisition and/or use of CS is expected to be too expensive	X				
other (added) factors		X			enough drive within teams
Supply					
CS product portfolio is totally or largely out of scope for the user group					
CS provider does not employ clear product profile or client type profile					
CS provider faces legislative limits regarding product or user segments it is allowed to service					
insufficient resourcing of CS product development					
available CS information is not really packaged as **service** (but e.g. rather as R&D project output)					
no interest or capability to develop CS beyond mere data provision					
lack of understanding of user characteristics					
other (added) factors					

(WINTER) TOURISM					JR
FACTORS	**1**	**2**	**3**	**4**	**comment**
Demand:					
lack of awareness of: climate change or (seasonal) climate variability or climate information (as regular input for decision making)			X		
denial of climate change				X	
lack of incentives (e.g. if costs are (expected to be) fully compensated)		X			
(public) acknowledgement of climate risks is seen as risky for (local) business development (e.g. tourism)		X			
perception that responsibility rests fully on other actors			X		
perception that there are no response options (fatalism or gambling)			X		
(preliminary) impact projections are of minor importance compared to many other risks			X		
no clue about how such information could be used in decision making (i.e. no risk management)			X		
inherently short term oriented business model (ruling out adaptation CS)				X	
acquisition and/or use of CS is expected to be too expensive,		X			
Supply					
CS product portfolio is totally or largely out of scope for the user group			X		
CS provider does not employ clear product profile or client type profile		X			
CS provider faces legislative limits regarding product or user segments it is allowed to service	X				
insufficient resourcing of CS product development			X		
available CS information is not really packaged as **service** (but e.g. rather as R&D project output)			X		
no interest or capability to develop CS beyond mere data provision			X		
lack of understanding of user characteristics			X		

Urban Planning (Hki)					FMI
FACTORS	**1**	**2**	**3**	**4**	**comment**
Demand:					
lack of awareness of: climate change or (seasonal) climate variability or climate information (as regular input for decision making)		X			
denial of climate change	X				
lack of incentives (e.g. if costs are (expected to be) fully compensated)		X			
(public) acknowledgement of climate risks is seen as risky for (local) business development (e.g. tourism)	X				
perception that responsibility rests fully on other actors	X				
perception that there are no response options (fatalism or gambling)	X				
(preliminary) impact projections are of minor importance compared to many other risks			X		
no clue about how such information could be used in decision making (i.e. no risk management)	X				
inherently short term oriented business model (ruling out adaptation CS)		X			A
acquisition and/or use of CS is expected to be too expensive		X			
Supply					
CS product portfolio is totally or largely out of scope for the user group	X				
CS provider does not employ clear product profile or client type profile	X				
CS provider faces legislative limits regarding product or user segments it is allowed to service	X				
insufficient resourcing of CS product development	X				
available CS information is not really packaged as **service** (but e.g. rather as R&D project output)		X			B
no interest or capability to develop CS beyond mere data provision	X				
lack of understanding of user characteristics	X				

ANNEX 2. THE EXAMPLE TABLE AND ITS INSTRUCTIONS IN THE 2ND CONSULTATION ROUND

Demand domain	**Suggested policies and / or measures**
• Inherent short term orientation in business planning & operations of the considered sector (as potential CS users) …. Only seasonal CS??	- Compact description/name - Seasonal and/or adaptation oriented CS - Generic / CS provider oriented / user sector oriented - Level: EU / Member States / Regions / sectoral
• (preliminary) impact projections are of minor importance compared to many other risks	
• Lack of awareness about climate change impact relevance for the sector (relevance of obstacle declining) or about climate information services (still relevant)	
• no clue about how CS information could be used in decision making (i.e. often no proper risk management to which can be connected)	
Supply domain	
• available CS information is not really packaged as service (but e.g. rather as R&D project output) / offered CS products out of scope of user needs	**Policy instrument**: business model exploration and assessment as explicit element of CS development projects in EU and MS R&D programmes **Categories**: CS provider oriented – otherwise generic **Level:** EU and MS; This could also be part of a CS monitor or observatory
• lack of understanding of CS user characteristics / limited capacity or even limited interest in enhancing understanding of CS users	
• insufficient resourcing of CS product development	
Matching domain	
• uncertainty about the eventual relevance of the CS for the user's decision process ('fit for purpose')	
• temporal and/or spatial resolutions do not match with other user's data (could	

be regarded as specific subset of previous bullet point)	
• mismatch of provider's and user's 'language' and conceptions	
• insufficient guidance and/or insufficient embedded consultancy	

Demand domain	Suggested policies and / or measures
• **Inherent short term orientation in business planning & operations of the considered sector (as potential CS users) …. Only seasonal CS??**	**Policy instrument:** Regulated climate proofing (AP: could also be regional assessment) **Categories:** Adaptation oriented CS (but to some extent seasonal too). Generic. **Level:** EU - Short term orientation is a feature of current economic framework, where the discounting rate remains quite high. Enforcing better climate adaptation through regulation can change this, but the challenge of course is setting the "optimal" level of adaptation. **Measures**: Joint marketing of weather services and climate services **Categories**: CS provider oriented **Level:** MS & EU
• **(preliminary) impact projections are of minor importance compared to many other risks**	**Policy instrument:** Systematic societal climate risk assessments **Categories:** Adaptation oriented CS (but to some extent seasonal too). Generic. **Level:** MS / region / city - For many enterprises (especially SMEs) climate risks are understandably low in their risk hierarchy, as the specific risk for them is low, difficult to assess or managing it requires system level co-operation (or is considered as the responsibility of the society). Thus the climate risks should be assessed on a system or network level, based on which the meaningful risks and responsibilities could be derived for individual organizations. **Measures**: Intensified coupling of climate information with sector-specific information **Categories**: CS provider oriented **Level:** MS & EU **Measures**: Where meaningful, integration of tailored climate information into products and services already in use by the sector (see e.g. the PROSNOW approach) **Categories**: CS provider oriented **Level:** MS & EU **Policy instruments:** Incentives for CS providers and providers of non-climate related services already in use by a sector to cooperate and provide integrated services (funding schemes, attractive funding rates for private companies). **Categories**: CS provider oriented **Level:** MS & EU **Measures:** Stronger promotion of the integration of cc projections into general foresight studies / (regional) technology foresight studies **Categories**: CS provider oriented **Level:** MS & EU
• **Lack of awareness about climate change impact relevance for the sector (relevance of obstacle declining) or about climate information services (still relevant)**	**1.Policy instrument:** Sufficient funding of climate science communication **Categories:** Adaptation oriented CS. Generic. **Level:** EU / MS - While "awareness raising" is typically not enough if there are no clear (i.e. legislative) incentives to act, providing research institutions with the resources to communicate their results is important part in changing behavior of organizations. **2.Policy instrument:** Incorporating climate issues to business education at different levels **Categories:** Adaptation oriented CS. Specific: education sector. **Level:** EU / MS - Higher education institutions providing business administration, managerial etc. education should include basic understanding of the climate system and related societal, environmental, economic and technological challenges into their curriculum.

	Measure: build suite of sector specific case studies of successful matches of CS, to be compiled and shared on outlets such as Climate Adapt and through sector associations. These need to showcase how CS can be used to both assess climate risk and manage it. Relies on putting case studies into relevant language. Also relates to point above – aim would be to show that CS are needed to continually monitor risks from climate impacts, even if initial results were not positive. Categories: user oriented Level: EU **Measures:** Awareness raising; Demonstration of CS / good-practice examples; CS platforms informing about available CS **Categories:** generic **Level:** MS & EU **Policy instrument:** Funding for awareness raising at local level / Funding of demonstration projects **Categories:** CS provider oriented **Level:** MS & EU **Policy instrument:** Increase funding for high-resolution regional/local impact studies **Categories:** CS provider oriented **Level:** MS & EU
• **no clue about how CS information could be used in decision making (i.e. often no proper risk management to which can be connected)**	See "Regulated climate proofing" and "Incorporating climate issues to business education" above. **Measures:** Demonstration of CS/ best-practice examples (ideally presented by users); CS platforms **Categories:** user sector oriented **Level:** MS & EU **Policy instrument:** Enforce climate proofing of investments in the banking and insurance sector regulations as well as in the public sector (subsidies) **Categories:** **Level:** MS & EU
Supply domain	
• **available CS information is not really packaged as service (but e.g. rather as R&D project output) / offered CS products out of scope of user needs**	**Policy instrument:** Continuous funding of service-type activities **Categories:** Generic **Level:** EU and MS - Guaranteeing sufficient level of basic funding and requiring service-type communication from research institutions. **Policy instrument:** business model exploration and assessment as explicit element of CS development projects in EU and MS R&D programmes **Categories:** CS provider oriented – otherwise generic **Level:** EU and MS; This could also be part of a CS monitor or observatory user-centric service development through the Living Lab approach: active user involvement, (rapid) prototyping & testing, agile and inclusive co-creation with end-users & quadruple helix stakeholders (Guideline # 5 in guidelines for LL in CS) **Policy instrument:** Ambitious open data policies **Categories:** Generic **Level:** EU and MS - Requiring higher level of openness of all observation and research data and results in order to spur their re-use and refinement by other actors. **Measure:** develop or encourage fora for research and sector representatives to discuss current needs. Researchers get to learn what their research is being used for,

	and users can feedback new requests on features, or for how best to interpret research for the sector. Categories: provider Level: EU and MS
• **lack of understanding of CS user characteristics / limited capacity or even limited interest in enhancing understanding of CS users**	**Policy instrument**: Sponsoring networking between researchers, businesses and policymakers **Categories**: Generic **Level:** EU and MS - Creating personal and organizational contacts enables flows of information and builds trust among actors. user research & exploration of user needs through the Living Lab approach: focusing on the "exploration" and "need finding" phase of the innovation (Guideline # 1 & # 2 in guidelines for LL in CS) **Policy instruments**: co-design (including end-users and providers of non-climate services already in use) as explicit element of CS development projects in EU and MS R&D programmes **Categories**: CS provider oriented **Level:** EU & MS **Policy instrument**: Change funding schemes, e.g. funding end-users by means of vouchers and not directly CS suppliers for CS development (could increase the economic incentive to develop tailor-made CS) **Categories**: end-user oriented **Level**: EU & MS
• **insufficient resourcing of CS product development**	- Policy instrument: further funding programme or scheme such as Climate KIC for product development for providers in key sectors (e.g. Finance); develop regular stream of funding for research and innovation projects in CS Categories: supplier oriented Level: EU and MS **Policy instrument**: CS and sector specific funding programmes **Categories**: CS provider oriented **Level:** EU and MS
• **High costs of CS input data (e.g. meteorological measurement data) in some MS**	**Policy instruments**: Free access data policy (in particular for weather measurement data) **Categories**: CS provider oriented **Level:** EU & MS
Matching domain	
• uncertainty about the eventual relevance of the CS for the user's decision process ('fit for purpose')	See "Sponsoring networking between researchers, businesses and policymakers" above **Measures**: Free testing of CS / Freemium business models / Vouchers , demonstration of CS, co-design **Categories**: **Level**: EU & MS **Policy instrument:** CS vouchers for first-time customers **Categories**: end-user oriented **Level**: EU & MS
• temporal and/or spatial resolutions do not match with other user's data (could be regarded as specific	See "Sponsoring networking between researchers, businesses and policymakers" above

subset of previous bullet point)	
• mismatch of provider's and user's 'language' and conceptions	See "Sponsoring networking between researchers, businesses and policymakers" above **Policy instrument:** Abandon "climate services" (lessons can be drawn from 'energy services' **Categories:** Generic **Level:** EU - Climate services as a concept seem vague and not easily grasped, and are not part of the vocabulary used by many users. Climate risk management, climate information etc. are more understandable. enhancing cross-disciplinary collaboration & communication through co-creation (Guideline # 3 in guidelines for LL in CS) **Measures:** Intermediaries; Use of simple language in CS **Categories:** CS provider oriented **Level:** EU & MS
• insufficient guidance and/or insufficient embedded consultancy	**- Measure:** develop best practice guidance of how to develop navigation guidelines for portals Categories: Supplier Level: EU and MS- **Measures:** Intermediaries / Integration of CS into existing consultancy services **Categories:** CS provider oriented **Level:** EU & MS