Prospects for Climate Service Market Dynamics - projections, enhancement measures, and innovation options - a bi-project synthesis report

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Glossary of Terms

Term	Explanation
adaptation	Actions and plans that aim to reduce the physical and knock-on effects of climate change; adaptation can be automatically invoked as well as be planned; if planned it can be anticipatory (in response to scenarios) or reactive (in response to experienced (mostly) adverse events)
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
carbon footprinting	The total amount of caused CO_2 emissions in the entire production chain (or even all GHG emissions) attributable to a particular product or product group (i.e. CO_2/kg cheese); yet also of a particular company or household can be made a carbon footprint, meaning the total annual CO_2 emissions attributable to the activities and purchases of that actor.
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.
deliverable	Particular output from a EU project, as a report, web-site, event, etc.
downscaling	A procedure to take information known at large scales to make predictions at local scales, either by means of statistical post processing (static DS) or by means of by means of localized models (dynamic DS)
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 (as theoretical reference base) 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; in the EU-MACS and MARCO projects also broader concepts of 'market' are acknowledged, which is important regarding the measurement of market volume.
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
mitigation	Actions aimed at the reduction of greenhouse gas emissions or at the increase of carbon sinks with the purpose of slowing down and eventually stopping global warming
observatory	A (market) observatory is meant to monitor the evolving conditions on the market (such as volume of services, number of providers, users, and other actors, shares per product segment, costs or prices, newly emerging products, etc.). In addition to transparent market data, it can also regularly provide short-/long-term analyses, including typologies of actors and products, obstacles, surveys, product ratings, user satisfaction, etc.

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; the value chain is often projected as having upstream, midstream and downstream sections, of which the borders are however not very clear cut; 'upstream' refers in this case to basic climate data, 'midstream' to downscaled data & information - often combined with non-climate data and/or embedded in impact assessment tools, and 'downstream' to more specific climate services tailored to the needs of clients or client groups or co-designed with them, also embedding of climate services in broader oriented consultancy services occurs.

List of Abbreviations

C40	Network of the World's largest cities to promote, share, and lobby climate action
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)
CTA	Constructive Technology Assessment
ERA-NET	
GDP	Gross Domestic Product
GFCS	Global Framework for Climate Services
H2020	research & innovation funding programme of the EU
ICLEI	Global network of local authorities to share and learn knowledge and experience on climate and environmental action
ISO	International Organisation for Standardisation; international standard-setting body composed of representatives from various national standards organizations; ISO numbers refer to particular protocols.
JPI Climate	Joint Programming Initiative "Connecting Climate Knowledge for Europe"
LIFE+	EU funding instrument for the environment and climate action
MDB	Multilateral Development Bank
NGO	Non-Governmental Organisation
NMS; NMHS	National Meteorological Service, National Hydro-meteorological Service (standard abbreviations in WMO context)
R&D	Research and Development
SDG	Social Development Goal (UN concept)
SME	Small and medium sized enterprise(s)
W&CS	Weather and Climate Services
WP	Work Package (WPn – Work Package no. n (1 – 7))

NON-TECHNICAL SUMMARY

In response to the EU H2020 call "SC5-03-2016 - Climate services market research", the two complementary projects EU-MACS "European Market for Climate Services" and MARCO "MArket Research for a Climate Services Observatory" were carried out from November 2016 to December 2018. The consortia of the projects had partly overlapping membership and the coordinators cooperated closely throughout the entire duration of the projects.

While both projects developed best practices and recommendations for climate services providers/purveyors and policy makers with a view to growing the market and enhancing users' access to quality services, they also respectively provided specific insights on the European (and international) climate service market characteristics and foresight into market growth (for MARCO) and on climate services market barriers and enabling conditions (for EU-MACS). This common report aims to compare, combine and solidify the main outcomes of the projects and thereby offers an overarching synthesizing view on the market for climate services in the EU.

The synthesis articulates around three main thrusts:

- combining the EU-MACS analysis on obstacles and enablers with the analysis of market development prospects carried out in MARCO (Chapter 3)
- adapting the establishment of a modular market observatory, proposed in MARCO, following the potential policy scenarios described in EU-MACS (Chapter 4)
- highlighting synergetic recommendations and formulating complementary conclusions (Chapter 5)

Both MARCO and EU-MACS made assessments on the current activity volume and the prospects for development of the market for climate services: One MARCO estimation approach is based on very extensively trawled and post-processed information about transactions. A second approach in MARCO, being more like foresight analysis, uses proxy indicators related to foreseen development of underlying drivers in already somewhat established climate service user segments, such as energy, urban planning, and international development banks. The EU-MACS estimation approach, which has also a foresighting flavour, is based on application of damage functions of the DICE model (Dynamic Integrated model of Climate and the Economy) in conjunction with variably effective climate services policy packages, represented by collections of rated measures.

As regards these different assessments it is important to highlight the existing leeway in the understanding of the concepts '*climate service*' and 'climate services *market*'. In this respect, some key features need to be kept in mind, such as the degree of inclusion of unpriced public provision of climate services, R&D activities, subcomponents of larger climate services, or timescales (e.g. sub-seasonal forecasts).

The different approaches indicate that **a significant and persistent growth** may be expected. The growth rates in the transaction-based approach, which refer only to the next few years, hover around 9%-10%. The EU-MACS and the MARCO foresight analyses suggest annual growth rates of 3% - 5% of the market value. It is important to realize that the activity volume (rather than value) may grow more, e.g. due to a decrease in average unit-cost of climate services. The various assessments also confirm the understanding that both provision and use of climate services show **large shares for the public sector**. However, in recent years **the share of the private sector** in climate services provision reached **around 30% - 35%, and is expected to grow**. The most important user segments are: water management, energy, agriculture, spatial planning, education, business services, and forestry.

The market growth will not only depend on (public) budgeting and economic growth, but also on the intensity and coverage of **policy programmes to promote the use of climate services** and their integration or connectivity with public and private planning cycles as well as with risk management systems and practices. In that context, the establishment of a - **potentially multi-functional - market observatory** is a significant building block in the policy portfolio.

Such a market observatory will need to build on existing initiatives (e.g. Copernicus C3S, Climateurope, open market places, GFCS, etc.), which provide a common space where some climate service providers, purveyors and users may already interact to some capacity, at national/regional and/or sectoral scales. However, the full identification and the widely shared understanding of the gaps between CS supply and demand, as well as the quantitative evaluation of the potential for market growth are still uneven and incomplete and would require a dedicated dynamic platform as presented in Chapter 4.

While MARCO identified fourteen (14) market support components to potentially design a multi-functional observatory, it is not expected to cover all functions in a proposed structure launched in a nearby future. However, depending on the types of stakeholders expected to be most proactive in promoting and integrating climate-resilient solutions, specific prioritized functions can be envisaged in addition to some core common components. Building on the climate service policy scenarios discussed in EU-MACS – distinguishing a state-centred, business-centred, network-centred approach - it would be relevant to initiate and/or pursue coordinated Climate Services action with regard to the following functions, while allowing modular design of the platform and targeted stakeholders:

- **State-centred**: Standardisation of climate services, Resilience monitoring and forecasting, Policy recommendations
- **Business-centred**: Stimulating the market / matchmaking, Consulting Services, New business models and provision of market intelligence
- **Network-centred**: Awareness Raising, Education/Training, Identifying Framework Conditions, and Helpdesk.

Finally, recommendations drawn from EU-MACS and MARCO are compared and grouped in order to highlight three (3) overarching synergetic recommendations:

- Recommendation 1: Increase visibility of providers to support strategic alliances
- Recommendation 2: Showcase success stories and added value
- Recommendation 3: Pragmatically align with sectoral, cross-sectoral or non-sectoral demand

While these three recommendations should guide any further activities in supporting the market for climate services, a more detailed set of proposed actions or identified needs is compiled in a comprehensive matrix, covering MARCO-relevant market support functions and EU-MACS's areas of improvement.

- MARCO-relevant market support functions: Identification of market opportunities, Providers' database, New business models and provision of market intelligence, Resilience monitoring and forecast, and awareness-raising.
- EU-MACS's areas of improvement: Matching CS supply and demand, Innovation, Data, infrastructure and services, and Quality assessment

The summary matrix can be used as reference when developing an advanced roadmap to support the uptake of climate services as well as any other legacy activity, derived from EU-MACS and MARCO.

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1. INTRODUCTION

1.1. The context of the two projects

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

EU-MACS and its 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 (e.g. the ERA-NET for Climate Services (SC5-02-2015) and the project funded under the Coordination and Support Action (SC5-05b-2015) called Climateurope. Also many projects in the JPI Climate ERA4CS programme contribute to development of climate services, either for hitherto non-served themes and sectors or for appreciable improvement of existing climate services.

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

In this framing, EU-MACS (European Market for Climate Service) analysed market structures and drivers, obstacles and opportunities from scientific, technical, legal, ethical, governance and socioeconomic vantage points. The analysis is grounded in economic and social science embedded innovation theories on how service markets with public and private features can develop, and how innovations may succeed. MARCO aims at unveiling market opportunities to support future market growth. The market is thereby defined as a space of commercial and non-commercial exchange of information and products. Different methodologies and approaches will be integrated to analyse the supply and demand side of the market, and forecasting future users' needs.

1.2. Purpose and scope of this bi-project report

The projects have closely cooperated with respect to outreach and communication, and coordinated their research efforts so as to achieve complementary rather than duplicate output. Both projects have produced an own series of reports and other deliverables, including own synthesis reports and Policy Briefs. The purpose of this report is therefore to highlight how the separate findings reinforce each other and how their synthesis provides additional insights. To this end, three key topics were identified that together cover the essence of the projects. These topics are:

- To combine the EU-MACS analysis on obstacles and enablers with the analysis of market development prospects carried out in MARCO (**Topic 1**)
- To underpin propositions for a market observatory from the MARCO project with the aid of lessons on market and organisational design and resourcing from EU-MACS (**Topic 2**)
- To formulate additional recommendations following from the synthesis across the projects, and underline important conclusions and recommendations from the separate project that get extra endorsement from the other project (**Topic 3**)

After the discussion of each of these topics in consecutive chapters, possible next steps are outlined for the EU and other actors.

The report structure is as follows: first, in chapter 2, a brief summary of the design logic of each project is presented in order give the reader an appreciation what kind of information is produced and how the projects fit together; chapter 3 discusses the uncertainties of climate services market developments; chapter 4 summarizes the alternative organisational designs for the market observatory in response to three potential policy scenarios. Subsequently, chapter 5 reviews what conclusions and recommendations can be drawn and which earlier recognized conclusions and recommendations enjoy further endorsement across the projects. A short outlook on possible next steps to put the promotion of climate services uptake at work is given in chapter 6.

In this joint synthesis report we deviate from the literature reference convention, if it concerns the projects' deliverables. Projects' deliverables are referred to as EU-MACS Dn.n and MARCO Dn.n respectively, and are hyperlinked.

2. RATIONALE OF BOTH STUDIES

An outline of the MARCO study

MARCO gathers market research firms, climate scientists, CS practitioners and innovation actors, in dialogue with stakeholders, to provide an enriched European CS market assessment with case studies, forecast future user needs, unveil opportunities, and promote market growth. An overall causal structure is shown in Figure 1. Feedback loops between applied methodologies have been organised to validate findings. Integrated market research has drawn on climate vulnerability analysis, potential market estimation, transactional market quantification, qualitative surveys, sectoral / regional case studies. Gap analysis and innovation modelling have also contributed to reveal the untapped market and outline market growth until 2030.

Following the market analysis and the stakeholder engagement, MARCO finally sets some final recommendations for a market observatory / platform to facilitate the uptake of climate services in EU.

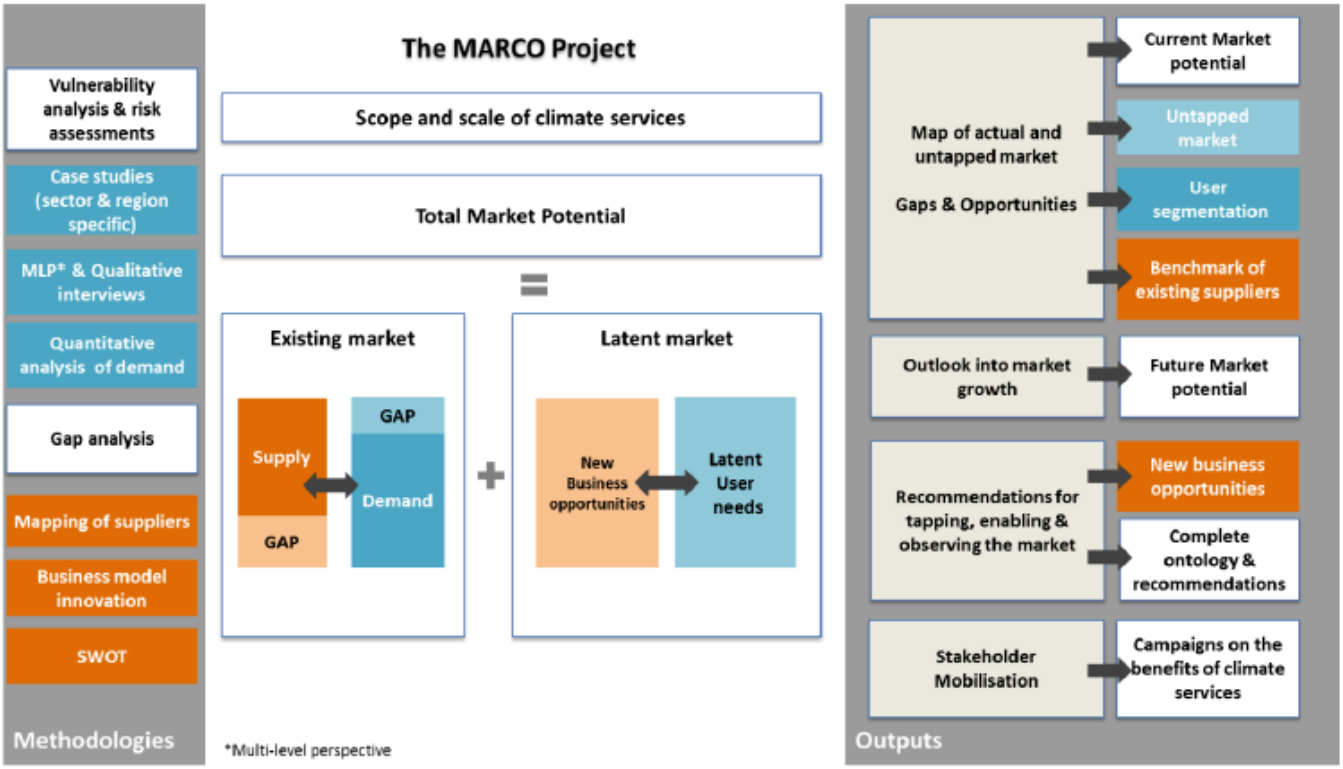

FIGURE 1 CAUSAL STRUCTURE OF THE MARCO PROJECT

An outline of the EU-MACS study

Even though various theories on market failure and on evolution of innovations are well known and applied, the empirical application of these theories on the functioning of CS markets faces its own methodological challenges. A part of what we analyse relates to non-realized and non-observed actions. Furthermore, in order to better understand obstacles and underutilization of CS application potentials, it does not suffice to collect simply use volumes and numbers and categories of users, instead we need to understand how users searched for CS supply options and on what grounds certain source(s) were selected. On the other hand, it is also necessary to review the implicit and explicit perceptions of CS providers with respect to user needs and how they translate that into contents and product presentation of their climate services portfolio.

The CS market assessment is carried out at two levels. Firstly, there is the static level of analysing realized and potential value of existing climate service supply chains. The difference between potential and realized value can be narrowed down by removing obstacles and enabling possibilities in a given supply chain. Secondly, there is the dynamic level of analysing the innovation processes driven by evolution in demand of existing and new users and by product development in the supply chain, ranging from improved climate data to increased user friendliness of CS delivery, and inter alia responding to the feedback from users and evolutions in demand.

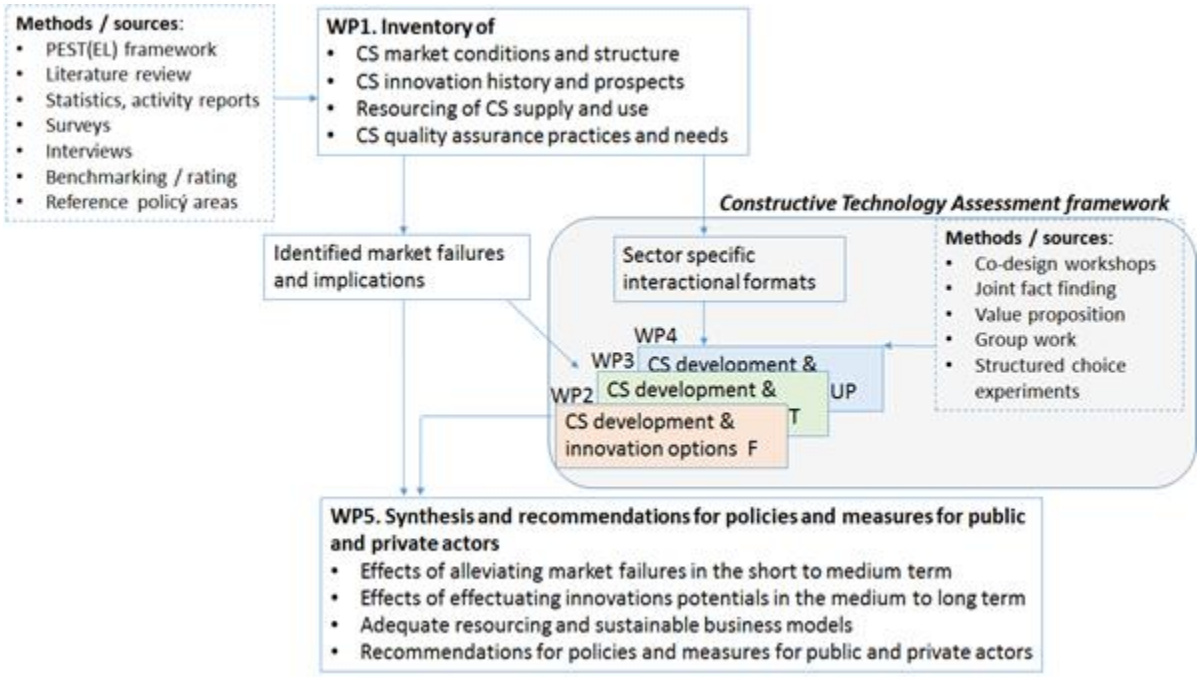

FIGURE 2 CAUSAL STRUCTURE OF THE EU-MACS PROJECT

The static level of analysis, aiming at identifying and investigating market failures and points of departure for innovations, is carried out in WP1 and entails various information collection approaches and comparative analysis. The question how to tackle these market failures is taken up in WP5 in conjunction with the findings regarding the exploitation of the innovation potential, resulting from the dynamic level analysis in WP2-WP4. The dynamic level analysis is framed in a Constructive Technology Assessment (CTA) approach. For two of the three focus sectors (Tourism and Urban planning) a Living Lab approach is used within the context of the CTA frame. For the third sector (Finance) a more ad-hoc individualized exploration approach is followed, tuned to the existing risk management and decision support frameworks in the financial sector and accounting for larger obstacles in sharing information even during workshops or surveys.

3. OVERALL PROSPECTS OF THE CLIMATE SERVICES MARKET IN EUROPE

3.1. Introduction and market delineation

The point of departure in this chapter is that the insights from EU-MACS regarding obstacles and mechanisms underlying less than optimal uptake can be used to edit and differentiate projections made in the MARCO project. In the context of the synthesis work inside the EU-MACS project, when assessing the applicability and effectiveness of policies and measures to alleviate obstacles, ballpark estimates are made of the contributions of these policies and measures to the improvement of uptake (EU-MACS D5.2). These changes in uptake are subsequently compared to other – exogenous – factors, such as GDP growth, affecting the size of the climate services market.

On the other hand, in MARCO were carried out both near term and long term assessments of how the market for climate services may develop. The near term assessment provides quantitative projections of the annual transaction value of climate services, including disaggregation by type of climate service (roughly identifiable with the stage in the value chain), by (prospective) end-use purpose (roughly identifiable with economic sectors), and by country or region (MARCO D6.3). The long term outlook reviews likely developments of key drivers up to 2030, such as investment volumes and population, in important application domains of climate services, such as electricity production, international development finance of climate related investments, and urban planning and management (MARCO D6.5). Moreover, in MARCO is produced an evaluative summary (MARCO D6.3) of the different types of foresight information produced (case studies, transaction based forecast, sectoral outlooks based on benefit potential).

A common feature of all these forward looking exercises is that they are subject to large uncertainties. This is also explained in the concerned Deliverables. Furthermore, it is important to realize that the implicit or explicit delineation of operationalized concepts as 'climate service' (delivery) and 'climate services market' is not the same in the above mentioned assessments. As a consequence, experts both within and external to the projects may regard levels or sizes as too high or too low, and/or growth rates too optimist or pessimist. This report is not meant to judge whether some projections are better than other ones. Instead, it intends to give an idea of the order of magnitude of current and future climate services activity and of the relative importance of various segments, and more in particular to provide understanding of the sensitivity of the outlooks with respect to certain prerequisites.

Before proceeding to summarize and synthesize the key findings of both projects regarding market prospects, it is important to discuss the existing leeway in understanding of the concepts 'climate service' (delivery) and 'climate services market'. Next to differences in these concepts within the different forward looking exercises, it is practically certain that different readers will also exhibit a variety in understanding of these concepts. It is crucial to understand the differences and the logic of these differences in order to better appreciate the results and the perception of the results of different experts.

The varying understanding of 'market'

Generally a market can be understood as: "*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.*" (EU-MACS D2.1) So, essential for a market is that there are ***transactions***, and hence by extension a ***price***. However, In the case of climate services, these may be delivered as part of a public duty without the notion of a transaction nor of a price. For example, this happens when a public expert agency is supporting – as

a public duty – other public bodies in the fulfilment of a strategy, planning or operations. Public bodies often deliver services to citizens free of charge, but at least a part of these deliveries has transaction features (e.g. in terms of web visits or data downloads), and thereby such activity could be taken into account in some kind of extended concept of a market, including (transaction like) public sector deliveries.

Delivery of climate services can be based on complex sequenced and/or collaborative processes. As a consequence, several transactions may be observable even though there is eventually only one 'final' delivery to an end-use purpose. Furthermore, in such a value chain some contributions may have been subsidized, while some others may have been provided 'in kind' on the basis of some kind reciprocity principle or agreement. As a consequence attributed values may suffer both from double counting as well as undercounting. This problem gets often more prominent, if the concerned activity includes or even focuses on climate services development, rather than regular provision. Furthermore, if the activity is largely R&D, one may even wonder whether it belongs to the 'climate services market' (see also below the discussion of the understanding the concept 'climate services'). Funding for development of climate services often comes from public R&D programme based grants; a resourcing model which constitutes an auction of sorts, rather than the climate services market that most (end)users are interested in. Also the distribution of the research grants over consortium partners, may lead to double counting caused by forwarding of payments.

All in all on the one hand one could denote all activity aiming at developing or delivering climate services as 'market', in the meaning of a catch word. For an adequate understanding of market value and appropriateness of policies and measures it is however better to be more precise by what is meant with market. Figure 3 below summarizes how different actors and experts may understand what activities are covered by a climate services *market*. There is public and private provision of climate services, either in the form of service *development* or as operational service *delivery*. Private service development usually means a company's own investment in innovation, whereas at the public side it can mean *publicly funded* R&D, predominantly carried out by public organisations (MetOffices, universities, etc.), but private or PPP activity may be included. Uncharged service delivery is naturally mainly an issue for public providers, but private providers may have some free-of-charge services (dotted line), as part of a comprehensive business model.

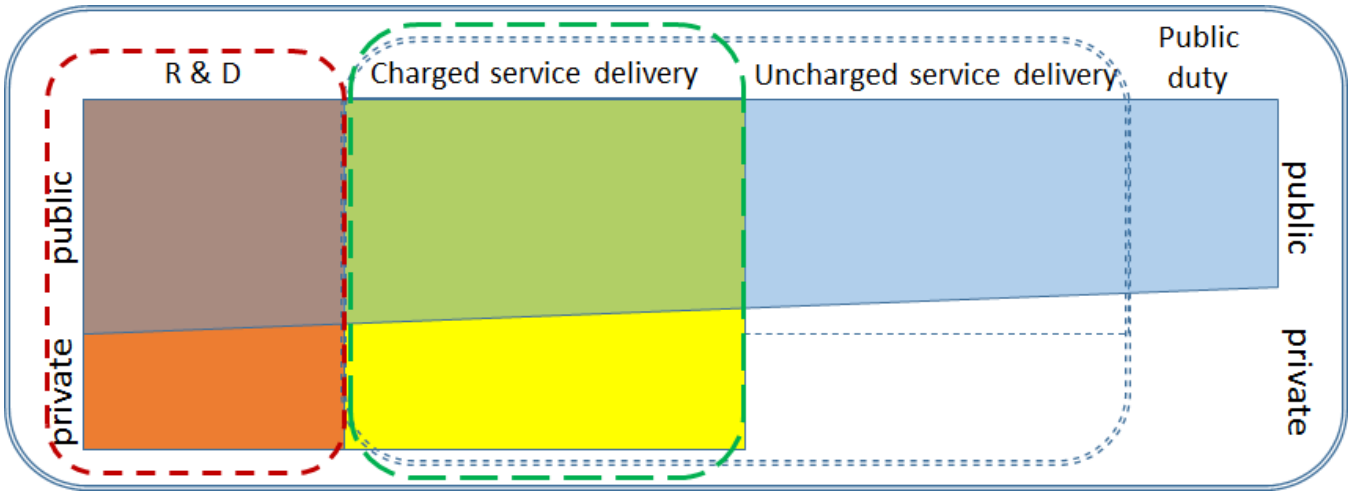

FIGURE 3 DIFFERENT DELINEATIONS OF WHAT IS CAPTURED BY 'MARKET' FOR CLIMATE SERVICES

When market is used as a catch word all the activities shown in Figure 3 are included. If product development is seen as distinct from service delivery, the climate services market proper gets reduced to delivered climate services, of which public duty could be taken out as being unattainable for market provision. Finally, in the narrowest sense the climate services market would only concern charged services.

The varying understanding of 'climate service'

Both projects have basically adopted the definition of the European Roadmap: "*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]" (European Commission 2015).

In EU-MACS seasonal climate services as well as provision of historical statistics and related indicators are regarded as a climate service. On the one hand, in the MARCO long-term market assessment climate services are tied to the needs for adaptation to climate change, whereas in the near term market projection a very broad notion of climate services is used (essentially based on a collection of search terms). In EU-MACS, on the other hand, it is underlined that, even though integration in wider knowledge and warning service packages and translation into non-climate variables is often important, the role of the climate information in the provided service should be essential. In practice, this means that for example monetized hazard risk projections or indicators can be a climate service, whereas a carbon footprinting service would be not. The latter may use climate services as an input, if the production chain has weather sensitive segments. Similar notions may also apply to other integrated services, such as for example integrated building management. This may explain to some extent why the transaction based projections tend to produce clearly larger numbers than can be inferred from the other approaches.

As already mentioned above, if an observed activity is wholly or predominantly a R&D effort to develop (building blocks of) climate services, this could be regarded as being part of a separate R&D market, especially if it is carried out without high guarantee commitments to a provision phase. Indeed, some climate service delivery models integrate development, or at least tailoring, with provision of climate services. In these integrated cases the activity in the development part could be regarded as belonging to the climate services market.

Some experts would consider the basic observation system, often largely owned by public meteorological and hydrological agencies, as not being part of the climate services. However, others, such as many meteorologists, hydrologists, and climatologists would regard the separation as misleading, if only because some monitoring services can feed directly into climate services.

Since the term 'climate service' (incl. its translations in other languages) is not a generally established term, the observation of the provision of climate services is also obstructed by definition mismatches. This may concern both qualitative collection of information, such as in interviews, as well as systematic (large scale) data collection, e.g. from statistics, registers, and annual reports. In interviews, such misunderstandings tend to reveal timely, but not always. In the transaction based data collection, a certain amount of proxy terms is, however, quite useful. The appropriateness can vary case by case, and which by and large seems to lead to – what by many experts is understood as – a quite expanded notion of the climate services market.

Conclusion on key terms

All in all, we can conclude that the understanding of what constitutes a 'climate service' and what a 'market' for climate services is very hard to unify. **Instead of imposing one view, it seems wiser to make explicit what one's choices are, and what the grounds for these choices are.** Over time, and in relation to policies that have to define boundaries, a further harmonisation will probably arise. For comparison could be referred to the term 'energy services', which experienced a similar plight, but nevertheless became a more or less accepted term, which however still highly benefits from being clarified when used in a certain context (see also EU-MACS D1.2; EU-MACS D5.2).

Key points to keep in mind regarding differences in perception of climate services and markets:

- The extent to which a climate services market encompasses also unpriced public provision of climate services;
- The extent to which a climate services market encompasses also R&D for (components of) climate services, even if disjunct from the eventual provisioning of such a new climate service;
- The extent to which a climate service can be integrated into wider service and knowledge packages, and the degree to which it is crucial to the nature of that overall service;
- The extent to which climate services are concerning particular time scales, i.e. mainly for the purpose of supporting climate change adaptation or also seasonal climate (variability) projections, indicators etc. based on historic time series, and so-called sub-seasonal forecasts (1 – 3 months).

3.2. What can we learn from the projections?

As explained in section 3.1 both in MARCO and EU-MACS have been made different assessments on the volume and development prospects of the market for climate services. For several reasons the assessment approaches differ from each other, which puts some limits on comparability. An advantage of using different sources and methods is that when nevertheless similar sized estimates result the credibility of the *approximate* estimates of size and pace of change is growing. Given the high uncertainties and lack of data that is the best one can expect at this stage of market evolution.

Realized market activity can be considered as a stage wise process with *resolved* uncertainty along the way leading to an outcome. Hence projections about future level of market activity concern the same stages, but with *unresolved* uncertainties. Depending on the information and methods used the extent of uncertainty may remain unclear, e.g. due to joint treatment of several stages and simplifying assumptions. This can be visualized as an uncertainty cascade as shown in Figure 4 (MARCO D6.3). It starts from the top where there is uncertainty about the pace of climate change and its impacts (severity, scope for prevention and recovery) – also in conjunction with other changes affecting vulnerability and opportunities. Subsequently, policies regarding mitigation and adaptation (incl. specific climate services policies), regarding societal hazard resilience and broader, regarding the sustainable development goals greatly affect exposure and vulnerability, whereas the intensity and effectiveness of these policies is uncertain. Thirdly, there is a host of reasons (related to resource models, culture, quality assurance, etc.) why climate services offered and climate services needed don't match or cannot find each other, even if risks are relatively clear and policies supportive. Last but not least how transactions eventually arise and recur has its own uncertainties, whereas also the identification of what should be counted in leaves – as yet – significant margin for interpretation.

In the summarizing presentation of the market prospects below the several projections concern either contributions of one layer or cover several or all layers while applying simplifying assumptions for some of them.

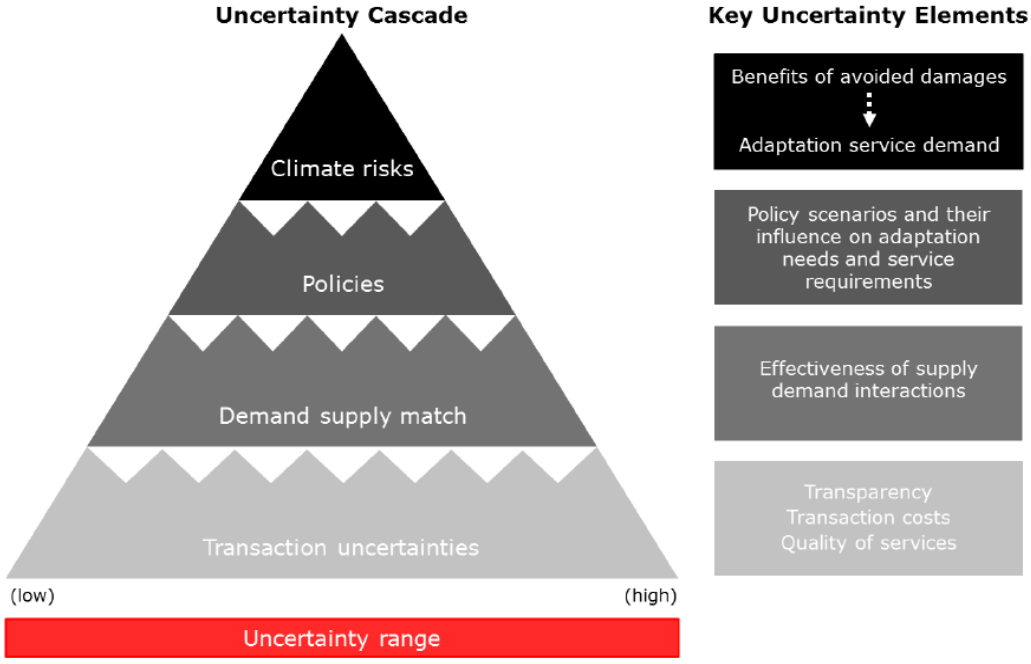

FIGURE 4 CASCADE OF UNCERTAINTIES FOR CLIMATE MARKET OUTCOME (SOURCE: MARCO D6.3)

Below first an overall perspective is given of the estimates of the current market volume and its development until 2030. Once again it is important to realize these figure are at best *indicative*, like ballpark estimates. Also an indication of the main structure in terms of main types of users, and public vs. private service provision is given. Furthermore, an indication is offered about the uncertainties around the market prospects related to (1) the extent recommended policies and measures are implemented and effective, and (2) the alternative scenarios of how the benefit potential and drivers of demand may develop.

Current and future prominent application domains and sectors

TABLE 1. SUMMARY OF ESTIMATED MARKET TRENDS FOR CLIMATE SERVICES IN EUROPE

	Recent past[1]	Next few years[1]	2030[1]
Transaction based assessment[2] (MARCO D6.4)	7.3	11.3	
Prime drivers overall[3] (EU-MACS D5.2)	0.9 – 4.6		1.7 – 8.4 (T=1.35) 2.1 – 10.4 (T=1.5)
Prime drivers of selected sectors[4] (MARCO D6.5)	MDB: 6.5 (adap.) MDB: 25.6 (mitig.)		MDB: +60% ~ +160% Cities: +150%

1) Figures denote billion Euros, unless indicating %; 2) very broad scoped definition of climate services; 3) primarily adaptation oriented climate services – upper and lower bound of appropriated benefit potential in absence of obstacles; T= refers to temperature rise (see main text) 4) refers to development of main driving factors for demand for climate service (investments); MDB refers to multilateral development banks; 'Cities' refers to number of cities with urban (resilience) audit – implying climate services use

The estimates for the recent past (Table 1) refer to 2016 or a period 2014-2016. The volumes refer to Europe or even just EU28 (EU-MACS), whereas the coverage of climate services is broader in the first

mentioned MARCO estimate (transaction based; including climate services as part of broader services) as compared to the one in EU-MACS (mainly referring to adaptation). The MARCO estimate is based on information about transactions (see MARCO D6.4, D2.1-D2.3), while the EU-MACS estimate is based on application of damage functions of the DICE model in combination with information from earlier studies on the effectiveness of weather service and their value assessments (EU-MACS D5.2; Nurmi et al 2013). With reference to figure 4 one could say that the transaction based approach assumes a fixed situation for layers 1 – 3, whereas the damage potential based approach assumes a fixed situation for layers 3 and 4, plus simplified effective / ineffective notions for layer 2. For the estimate from EU-MACS (D5.2) the estimated damage potential drives the outcome directly, whereas for the estimate from MARCO (D6.5) the relevant budgets of multilateral development banks are driven by a combination of GDP growth and climate policy and SDG policy ambition levels or conversely by urban population growth and degree of catch up of not yet served cities.

While accounting for the differences in the coverage of the estimates and underscoring the uncertainties there seems to arise an initial understanding of the current (2016) market size in Europe being in the order of magnitude of 3 billion – 8 billion Euro.

The different approaches all indicate that a significant and persistent growth may be expected. However, the transaction based estimates of growth in market value for the near future seem to differ from the estimates in EU-MACS and the indirect indications from prime drivers (MARCO D6.5) in terms of pace of growth. The growth rates in the transaction based approach hover around 9% – 10 %, whereas the other two assessments point suggest growth rates of 3% - 5% for market value. Additional information from interviews, workshops, and surveys (EU-MACS D1.2, D2.1, D3.1, D4.1, D5.1, D5.2) generally doesn't seem to suggest that very high growth rates are the rule. Some explanations for a possible deviation between development of market value and market activity (i.e. transactions; contracts; establishment of new organisations) are (1) the transformation of public (and free) provision of climate services to private or at least charged provision of climate services, and (2) reductions in the unit-price of climate services. Reason no.1 is for example relevant when a climate service changes from a pilot into an operational service. The second option may occur due to competition, technical development and entering of more cost critical users into the market (e.g. for urban climate services the showcase project for cities with high willingness to pay are realized, but for smaller, poorer, and less threatened cities willingness to pay can be expected to be significantly smaller.

The different assessments in MARCO and EU-MACS produce quite similar impressions of what are the most prominent sectors using climate services, or for what eventual purpose climate services are provided (sometimes first to an intermediate actor). Table 2 summarizes the main findings. The various assessments also confirm the understanding that both provision *and* use of climate services shows large shares for the public sector.

TABLE 2 MOST PROMENT SECTORS IN CURRENT OVERAL DELIVERY PORTFOLIO

	Most prominent sectors
Transaction based assessment	1.Power & heat; 2.public administration (national/local); 3.construction; 4.ICT; 5.agriculture, forestry and fisheries
Web surveys:	
MARCO	**D4.6**: Renewable Energy, Agriculture, Built Environment, R&D, Utilities, Education, Business Services, Forestry;

	Across all the sectors approx. 1/3 of the deliveries is by private actors and 2/3 by public or not-for-profit; About half of the services concerns long term projections (decadal and beyond); around 35% concerns intra-annual, and the rest otherwise. **D3.1:** About 30% of climate service providers is from the private sector, and approx. 7% not-for-profit, others from public sector; principal user sectors (according to suppliers): water management, energy, agriculture, spatial planning, education, forestry
EU-MACS	**D1.1**: Agriculture; Water management; Transport & logistics; Energy; (other) critical infrastructure; Disaster reduction management; About 15% of climate service providers is from the private sector, and approx. 7% not-for-profit, others from public sector, whereas about 1/3 of the users is from the private sector

To give the above summary of volume, trends and providers' and users' profile additional perspective it helps to consider the general structure of the value chain of climate services, as is shown in figures 5 and 6.

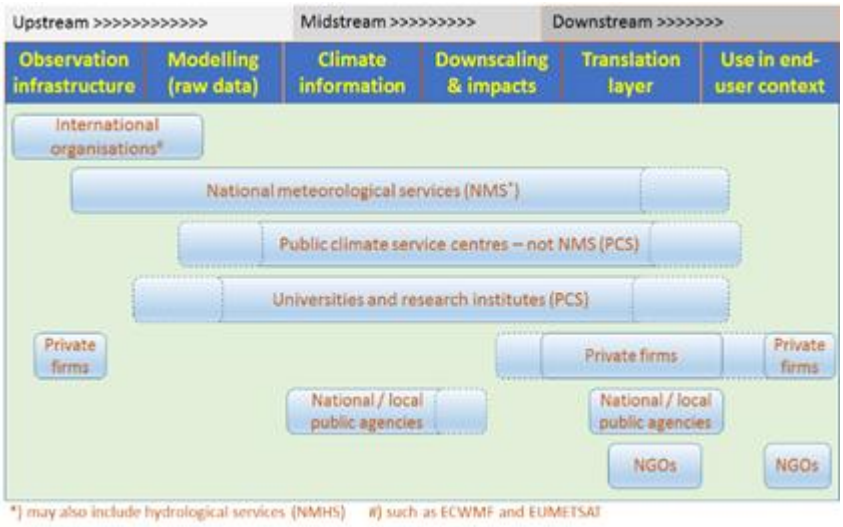

FIGURE 6 TYPES OF PROVIDERS AND THEIR POSITION IN THE VALUE CHAIN

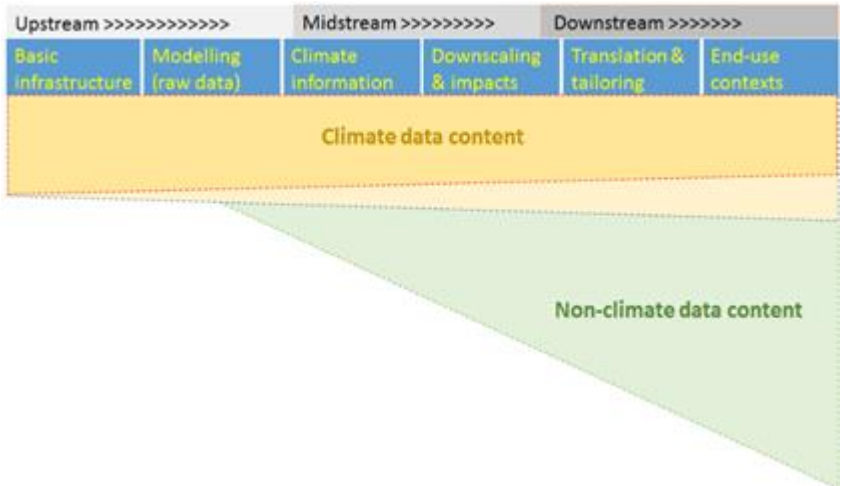

FIGURE 5 SHIFTING INFORMATION CONTENT AND VALUE ADDED IN THE VALUE CHAIN

Figure 6 (based on EU-MACS D1.1) shows a distinction in 6 segments, starting from basic data generation through observation and modelling (and climate data post-processing) via an intermediate phase of downscaling and impact analysis (requiring ever more non-climate data towards tailoring of information for different user groups, as well as embedding climate information in broader consultancy and training. In the upstream, midstream and downstream parts of the market (and value chain) different mixes of skills and resources are needed, which also explains why public organisations tend to dominate the climate services supply capacity in upstream and to some extent midstream segments, as shown in Figure 5. Generally, parallel with a growing share of non-climate information content also the value added of the climate service grows. Whereas the transaction based estimates seem to suggest a more significant private sector provision of climate services, the surveys, interviews and workshops seem to suggest an – as yet – more modest share. In Figure

5 this is represented by a relatively modest occupation by the private sector. An explanation for the differences in estimated significance of the private sector, is probably related to the fact that hitherto climate services for end-users provided by private actors often concern integrated knowledge elements of much broader oriented consultancy or expertise services. Indeed various consultancy firms indicated that growth in climate services provision happens more through expanding service packages to existing clients than acquiring new clients specifically through climate services.

Effects of climate services promoting policies:

The indications of the growth potential presented above are driven by either short term extrapolation (of transaction intensity) or by expected GDP loss (in % of baseline) as a function of global temperature rise. The former is projection is uncertain due to the indirect observation method and attribution challenges. The latter projection is uncertain due to uncertainty in GDP development, global temperature development and climate sensitivity with respect to greenhouse gas concentration levels. Table 1 (above) shows the variability in outcomes for 2030. Similarly the expected development of the demand drivers for multilateral development banks (MDB) and cities have some uncertainty in their own rights as well as in relation to actually exercised demand for climate services. Moreover the latter two indicators are also policy dependent. The influence of policies on the uptake of climate services is an own significant factor next to the aforementioned ones.

The market growth will not only depend on (public) budgeting and economic growth, but just as much, if not more, on the intensity and coverage of policy programmes for promotion of climate services use. Some of these policies address the provision or use of climate services more directly, such as promotion of brokerage and market places to better select climate services, others create better preconditions or motivators, such as obligations for asset managers and cities to systematically report on climate change risks to which their assets and activities are subjected. Also the establishment of a – potentially multi-functional – market observatory is a significant building block in the policy portfolio. This option is further discussed in the next chapter.

In EU-MACS D5.2 was explored what policy instruments and public and private measures could contribute in particular to promotion of the uptake of climate services, while acknowledging that policy regimes and governance philosophies do vary across the EU Member States. The latter aspect was accommodated by formulating different policy scenarios. Interestingly enough it seems that the different scenarios affect the choice of instruments only to a moderate extent, whereas the intensity with which instruments are used may differ more. For further details is referred to chapters 2 and 5 of EU-MACS D5.2.

There are other uncertainties, e.g. related to technical development in data generation and distribution as well as related to development of prevailing resourcing models of climate services. By devising a coherent set of policies and measures aimed at promoting climate services by reducing or eliminating obstacles the uptake of climate services can be precipitated. Overall the results indicate that a more vigorous and coherent policy for promoting the uptake of climate services, may have even more impact than the other growth factors. Especially, in the next few years the unfolding of the market will depend on the installation of effective policy packages. The larger availability of all kinds of data on the ambient environment in conjunction with paradigm shifts in sustainability thinking in e.g. the financial sector and in urban and infrastructure planning will anyhow guarantee some degree of 'endogenous' growth of the market for climate services, regardless of climate services promotion policies. **Yet, highly effective policies could boost the growth for several years e.g. by a factor 2 to 4.**

Important uptake enhancing policies and measures for all policy regimes are:

1. (Self-) regulation on mandatory climate risk reporting, transparency, & accountability – at least for several sectors, such as financial sector, urban planning, critical infrastructure, and food supply;
2. Enable, incite and support collaboration between different types of actors, notably also across the public – private divide, to engender learning and better needs based design and operation of climate services;
3. When engaging in climate service development, especially public actors and public-private collaborations should adequately and timely assess realistic and viable resourcing/business models for the stage of regular climate service provision;
4. Standardization , such as of terms, product categories, and product ratings, and quality assurance which is also relevant to current and prospective users, should be pursued by the entire climate services sector;
5. Monitoring and ex-post evaluation of climate services use and its effects, of which the results are public, with the aim to inform policy makers as well as providers and users, while inter alia also enabling to demonstrate the benefit generation capacity of different types of climate services for different types of users;
6. Basic climate research aside, innovation in climate services should encompass user relevant aspects of service delivery, such as related to visualization, risk indicators integrated with the user's decision variables, collaborative mutual climate service development and delivery models, etc.

4. PROPOSITIONS FOR A MARKET OBSERVATORY FOR CLIMATE SERVICES

In this section, the prospects for a market observatory/platform for climate services, initially presented in the MARCO report D2.7, are further discussed based on the policy scenarios that are described in the EU-MACS report D5.2. In that context, the identified market support components (see Figure 7) that could serve as a foundation for the observatory, are further characterized, adjusted and/or prioritized according to the suggested policy and governance contexts. Related implementation frameworks would also differ in order to foster the uptake of climate services in the EU, giving the leading role of specific stakeholders.

It is also important to remind that some existing initiatives (e.g Copernicus C3S, Climateurope, etc) do address some of the identified market support components at national/regional or sectoral scales and it is therefore critical to not create unwanted redundancy but rather create synergies between the various resources, instruments and programmes involved. An overarching coordinating scheme would increase consistency across the market of climate services and understanding of the market for all categories of providers, purveyors, users and decision-makers.

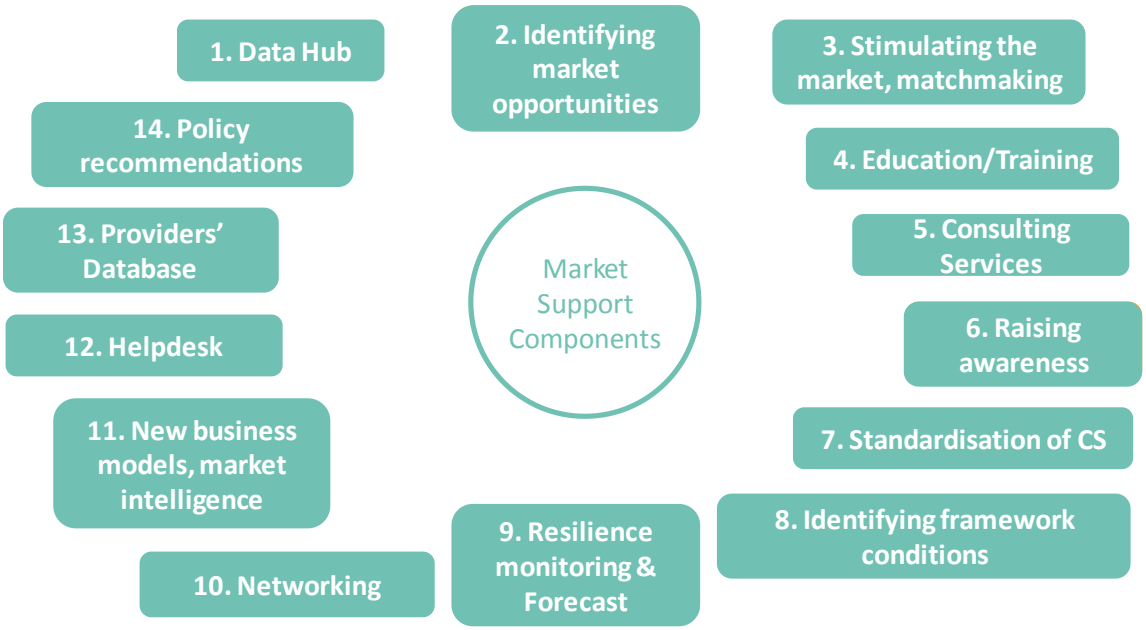

FIGURE 7 - MARKET SUPPORT COMPONENTS

4.1. Scenario rationale 1: state-centred

In this scenario, the state or public authorities are in a key position for integrating climate services in the policy and decision-making. They are the main driving forces behind the market for climate services. Related mandatory measures would then require clear and transparent regulatory frameworks that would help mainstream climate services in different fields of implementation. With regard to the list of 14 market support functions identified in MARCO, 3 of them would be considered as essential components to allow public authorities to catalyse climate innovation and provide the necessary incentives and obligations to use climate services, being: (1) the standardisation of climate services, (2) resilience monitoring and forecast, and (3) policy recommendations.

Enhanced market support components

- Standardisation of CS

The EU authorities would contribute to the development and enforcement of international standards that would provide a set of consistent, comparable and improved climate-related methodologies to public and private organisations that are engaged in climate action. Such standardisation is key to enable scientific robustness and transparency and to thereby disseminate trusted climate intelligence. The potential implementation of an EU "Climate Accountability and Risk Directive" (cf. EU-MACS D5.2, Ch. 2.3) could directly require the certification according to some sectoral standards, which the proposed market observatory/platform would be in charge of defining and promoting.

- Resilience monitoring and forecast

The public authorities would be the primary agents of building climate resilience. In order to attract more interests from other sectors, it is important to track and measure the socio-economic and environmental benefits of CS. Resilience monitoring (as well as evaluation at a later stage) would be a key role for the proposed market observatory/platform as to showcase the effective integration of climate services within decision-making and development planning and the good quality of service when actually delivering the climate services. In addition, any forecasting component would enable to better plan in the long run and to reflect visionary and systemic thinking to address climate change, rather independently from any private interests.

- Policy recommendations

The market observatory would be pivotal in advocating the extensive use of climate services in different sectors as well as in proposing policy developments in order to ensure a stronger match between the market developments and the actual needs. Policy recommendations and evaluations would be performed in order to better support the decision-makers and ensure progressively stricter regulations towards climate-resilient economies.

Expected operational impacts on the observatory/platform

- Public funding

In this state-centred scenario, the market observatory would mostly be running on public funding. Following the EU's investment in the Copernicus programme, it could be expected that the European Commission would be interested in further analysing the market for climate services and thereby establishing a dedicated market observatory. As many market support components would directly feed into some public decision-/policy-making, the financial sustainability of such platform would depend on the possibility to really showcase the valuation of the economic benefits of climate services, by internalizing the externality of enhanced climate resilience.

- Open source, open data policies

A public-funded market observatory is to be broadly recognised and used as a reference, if it is to be representative of the available climate services, the latter mostly being developed from open data. In that context, it would be important to ensure the implementation of open source policies on climate data and models, in order to allow an equitable access to climate information and transparent data treatment.

- Compatibility with public adaptation programmes and green public procurement

In addition to contributing to new policy developments, the state-centred market observatory would be tailored for helping to respond to public processes and tenders such as adaptation programmes funded by public institutions like the European Investment Bank (EIB) and national governments, as well as green public procurement. In that context, climate-proof solutions would be fostered and well-integrated in the public sector, demonstrating best management practices to the private sector.

4.2. Scenario rationale 2: business-centred

In this scenario, the private sector is leading the innovative developments in the CS field and could therefore be regarded as most tech-savvy on the effective implementation of climate services, ensuring dynamic market evolutions to be referenced in a business-driven market observatory. The created momentum would provide the incentive for the public sector to also engage in the integration of user-friendly/packaged CS solutions. In that context, 3 market support components would be strongly valued in order to allow the private sector to scale-up climate innovation, as well as to identify and invest into on-demand climate services: stimulating the market/matchmaking, new business models and market intelligence, and consulting services.

Enhanced market support components

- Stimulating the market, matchmaking

The market observatory would offer a creative space where climate services providers, purveyors and users can directly interact in order to ensure that developing services respond to actual needs and that best practices can be shared and replicated to other sectors/regions. The platform would be instrumental in ensuring appropriate matchmaking between providers, purveyors and users, fostering synergetic collaborations as well as welcoming and guiding new market stakeholders.

- New business models and market intelligence

Given the variety of potential applications for climate services, the platform would need to ensure that the latest developments - in particular from a large panel of private stakeholders - feed into comprehensive market intelligence, including regular analyses to reveal evolutions and trends and to promote innovative business models that could attract new investors. Specific attention would be given to monitor scale effects in small sub-markets with few stakeholders and bigger sub-markets with more business competitors.

- Consulting services

Brokerage and other consulting services would be developed to offer advisory and tailored support to private businesses that are willing to implement climate-proof options. The market observatory would include a pool of consultants that would be able to tailor climate solutions, based on the comprehensive existing intelligence as well as technical know-how from key experts. It can be expected that in a business-centred scenario, private businesses would also be invited to implement packaged climate risk assessment modules, in order to evaluate their climate vulnerability and identify options to address those risks.

Expected operational impacts on the observatory/platform

- Private funding

In a business-centred scenario, it would be expected that the market observatory/platform would be mainly funded on private money, including membership fees from the interested businesses and investors, as well

as direct payments for the brokering and consulting services. With the expected uptake of climate services, more complex solutions are to be developed in response to sectoral and/or regional specificities. Climate expertise would therefore be more widely recognized and valued. In that context, the market observatory on climate services could not only reach financial self-sufficiency with adequate financial mechanisms charging beneficiaries and also generate some seed funding to allocate for innovative programmes.

- Innovation-driven approach, fostering incubation, acceleration and upscaling of new solutions

The business-centred approach would lead to a dynamic market evolution, where climate risk management is well-integrated into business development measures. Innovation-driven entrepreneurship would be then fostered in order to catalyse the radical social and economic changes needed to address climate change. The market observatory would be a key structure to help Small- and Medium-sized Enterprises (SMEs) and start-ups identify market niches, test innovative solutions and propose upscaled implementations. The platform would not only provide technical assistance in terms of the quality of service delivery but also a business development framework to fully exploit the market opportunities.

- Global competitiveness, export stimulation

The market observatory would primarily cover the EU market, building on the comprehensive existing information generated in MARCO, other H2020 research projects, the Copernicus Programme etc. In order to strengthen the EU leadership towards climate action and promote the uptake of EU-designed climate solutions, including by export outside the EU, it would also be interesting to extend the market characterization to a global level and to provide recommendations to increase the competitiveness of EU-designed solutions.

4.3. Scenario rationale 3: network-centred

In this scenario, the civil society as well as local private and public cooperation constitute the key driving force behind climate action. Any type of actor is to understand that it can act upon climate change, whereas it is also presumed that these kind of self-organizing initiatives and collaboration usually find the most effective solutions. The market observatory for climate services would notably contribute to a robust understanding of the possible applications for climate services, so as to engage with diverse stakeholders and co-develop solutions. As climate action can seem complex and difficult to act upon, participative approaches would indeed provide the needed “inspire and incentivise” push to engage concrete action. Citizens and local actors, such as SME’s, would then feel empowered to mobilize and (re)organize themselves and adopt new climate-proof behaviours, putting pressure on others to follow the initiated change in society. In that context, 4 market support components would be strongly valued in this scenario: raising awareness, education and training, identifying framework conditions and helpdesk.

Enhanced market support components

- Raising Awareness and Education/training features

The market observatory would showcase communication products to inform on the large scope of implementation of climate services and highlight successful case studies that can provide incentives not only to businesses to better assess their needs in terms of climate risk management, but more generally to citizens to be more climate-literate and adopt climate-proof solutions. Similarly, the education and training components of the platform would play a critical role in order to build competences and ensure the share of best practices.

- Identifying framework conditions

The market observatory would notably focus on the enabling conditions in terms of infrastructural, technical, human and institutional capacities in order to develop, provide and promote high-quality climate services. The civil society would then foster a greater coordination across (public and private) stakeholders and make the case for more ambitious climate action as a societal goal.

- Helpdesk

Any interested stakeholder in climate risk management could benefit from the helpdesk of the climate services platform, so as to identify appropriate existing services as well as to link with knowledgeable experts. This inclusive approach would raise the visibility of the observatory and would improve the accessibility to climate solutions to non-expert stakeholders.

Expected operational impacts on the observatory/platform

- Blended funding

Blended schemes could financially support the operation of a market observatory on climate services, as the positive impacts should benefit the public and private sectors and contribute to a climate-resilient society. Given the global challenge that is climate change, it would be important to mobilize diverse sources of funding to ensure action at the local, national and regional levels. In that context, NGOs could provide appropriate expertise in mobilizing and coordinating different streams of resources.

- Flexibility on regional / sectoral features

As to ensure citizen engagement, it would be important to showcase regional and sectoral features in the market observatory. Valuing local climate action and therefore fostering the link between local risks and locally-preferred solutions could first attract the potential end-user and provide the incentive for further engagement, which could lead to disruptive solutions at larger scale/scope.

4.4. Conclusion

While MARCO (D2.7) recommends the set-up of an instrument that would combine functions of a market observatory and of a community platform, the hybrid proposal cannot realistically offer all functions from the beginning and shall thus have to focus first on providing consolidated data on the current market globally and more precise, reliable information on some of the priority sectors identified during the project. In addition, the proposed instrument will need to ensure consistency with some existing initiatives, in order to foster synergetic rather than redundant services.

However, depending on the future policy and governance contexts for climate action, some market support components / functions may be more relevant and increase the usefulness for such coordinated platform. Figure 8 differentiates the prioritized market support components for each of the 3 scenarios that were presented in EU-MACS: state-centred, business-centred and “network-centred”.

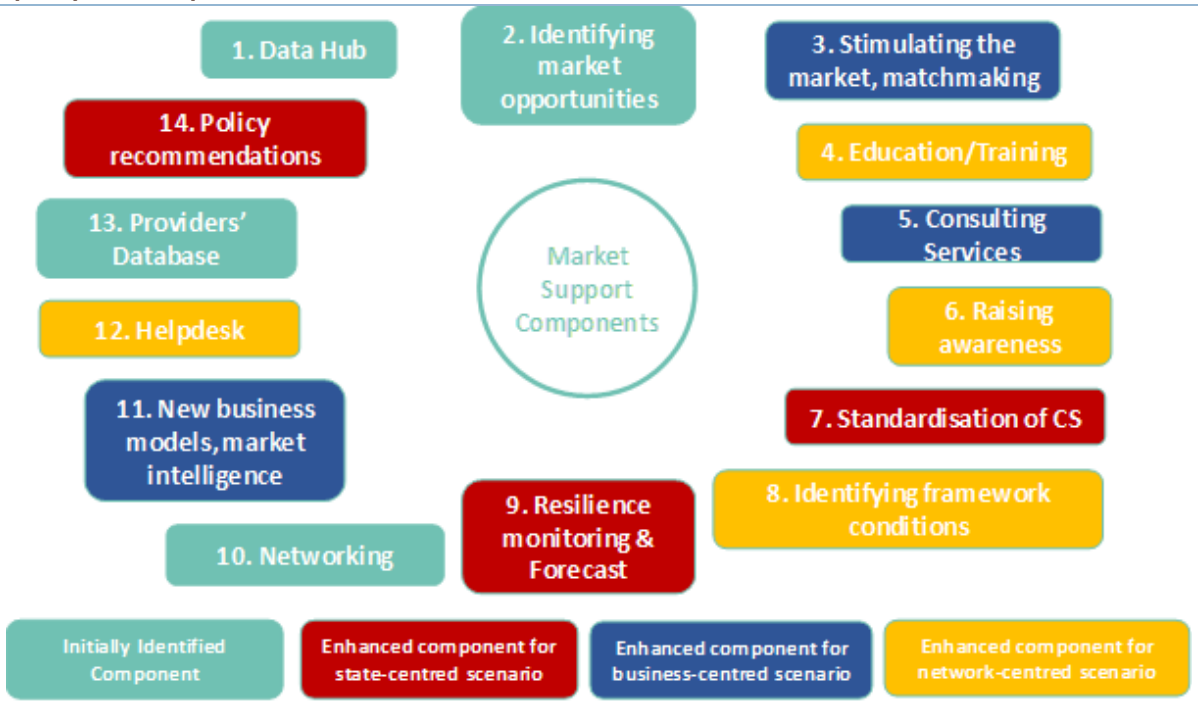

FIGURE 8 – IDENTIFICATION OF ENHANCED MARKET SUPPORT COMPONENTS FOR THE DIFFERENT POLICY SCENARIOS

A new systemic approach to the establishment of the market observatory/platform can be then developed where core components "Data Hub", "Identifying market opportunities", "Providers' Database" and "Networking" would be complemented by specific groups of support functions depending on the type of stakeholders that is most proactive in addressing climate risks (i.e. public, private, civil society), as illustrated in Figure 9.

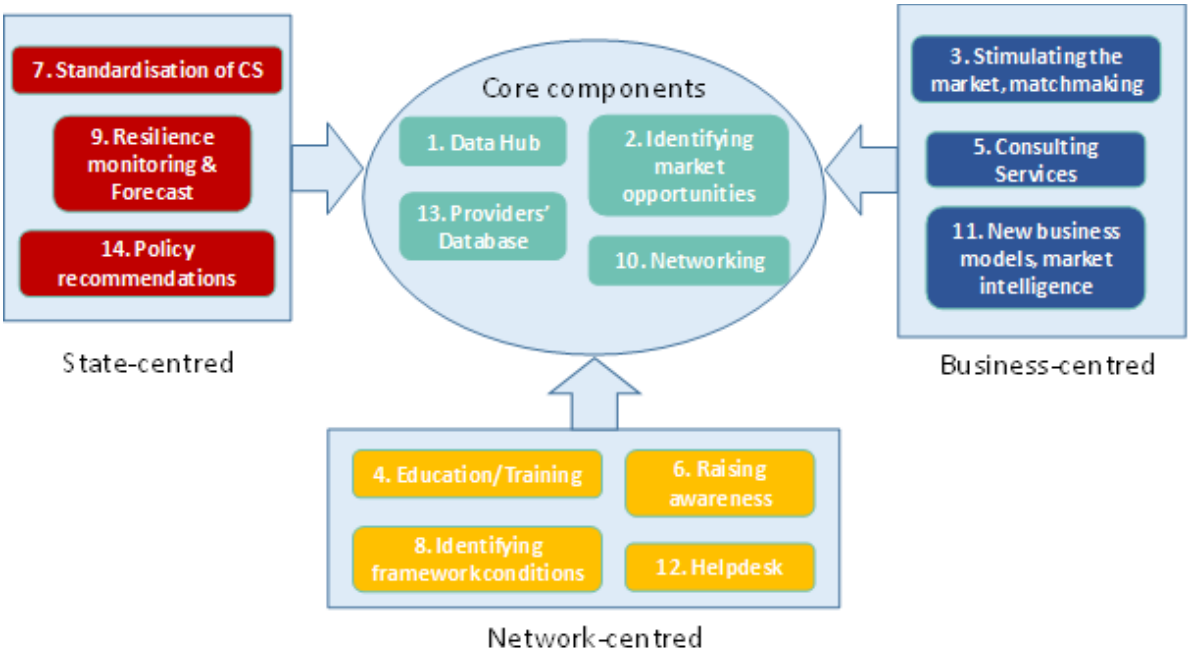

FIGURE 9 – ADAPTED APPROACH TO THE MARKET PLATFORM

5. KEY CONCLUSIONS AND RECOMMENDATIONS

5.1 Recap of the conclusions of chapters 2, 3 and 4

In connection with the provision of climate services many, if not most, stakeholders will count all climate services provision, regardless of whether it is charged, as part of the 'climate services *market*'. A smaller but still significant share of the stakeholders will also count all development effort for climate services as part of that market. Others may understand that as a closely related, but still distinct market (if a market at all). Several forms of collaboration can also blur the distinction between development and provision of climate services.

Most stakeholders seem to agree with the definition of climate services as meant in the so-called Roadmap (EC 2015) 'the transformation of climate related data – often together with other relevant information - into customized information products, … '. Yet, some count in also (basic) observation services, whereas others would leave out all or most of the observation activity. It should be noted that there is rising number of monitoring services, which in fact entail also climate change monitoring services.

As the 'market for climate services' is not a precisely defined entity, while a part of these activities are not realized through – what economists would regard – a market, the evaluation of the annual value of provided climate services faces substantial uncertainties, and would benefit from better observation methods to determine the value. Nonetheless, based on the various evaluations in both projects the current annual value of climate service provision in Europe hovers between about 3 billion and 7 billion Euro. There is prospect for significant growth, which could easily amount to 3% - 5% per year up to 2030. In case an adequate set of policies and measures is taken, the annual growth rate could be initially appreciably higher for several years.

In recent years the share of the private sector in climate services provision was around 30% - 35%. This share is expected to grow, in a growing market. The most important user segments are: water management, energy, agriculture, spatial planning, education, forestry, education, business services, and forestry.

There is a significant array of policies and measures that can promote the use of climate services. The most significant options are:

- regulation on mandatory climate risk reporting, transparency, and accountability;
- enable, incite and support collaboration between different types of actors, notably also across the public – private divide;
- especially public actors and public-private collaborations should adequately and timely assess realistic and viable resourcing/business models for the stage of regular climate service provision;
- monitoring and ex-post evaluation of climate services use and its effects, of which the results are public, with the aim to inform policy makers as well as providers and users, while inter alia also enabling to demonstrate the benefit generation capacity of different types of climate services for different types of users;
- standardization, such as of terms, product categories, and product ratings, and quality assurance which is also relevant to current and prospective users, should be pursued by the entire climate services sector.

Some coordination platforms for climate services currently exist to some capacity, at national/regional and/or sectoral scales and thereby provide a common space, where some climate service providers, purveyors and users interact. However, the full identification and the widely shared understanding of the gaps between supply and demand, as well as the quantitative evaluation of the potential for growth are still uneven and incomplete. A comprehensive scrutiny of existing mechanisms should allow the foreseen market 'observatory/platform' to avoid duplication with current effective tools, to address the biggest gaps and to enhance integration of the market and its development.

From the fourteen (14) market support components identified in MARCO, different prioritized functions (as shown in Table 3) can be expected - in addition to some core common functions - depending on the type of stakeholders that are foreseen to strongly engage in climate action in the nearby future (i.e. public sector, private sector, or civil society). The different scenarios would surely impact on the funding mechanisms (and thereby, possible financial sustainability) and operational features of the platform. Any hybrid/balanced proposal of an overarching market observatory would benefit from gauging these 3 perspectives.

TABLE 3 - PRIORITIZED MARKET SUPPORT COMPONENTS

State-centred	Business-centred	Network-centred
Standardisation of climate services	Stimulating the market, matchmaking	Awareness Raising + Education/Training
Resilience monitoring and forecasting	Consulting Services	Identifying framework conditions
Policy recommendations	New business models and provision of market intelligence	Helpdesk

5.2 Integration of EU-MACS and MARCO key earlier recommendations

In addition to the conclusions that result directly from Chapters 2 to 4, five key conclusions from both projects should be highlighted. These have been derived by collecting and categorizing conclusions as summarized in table 4 in Annex 1.

Recommendation 1: Increase visibility of providers to support strategic alliances

EU-MACS recommendation	MARCO recommendation
Foster strategic alliances with users, consultancies, research, policy, etc.	Increase visibility of climate services providers on a "market place" Develop more creative and diversified business models for specific types of providers

The analyses in MARCO have shown that users of climate services often do not know who offers which products. Interaction with focus sectors in EU-MACS produced similar messages, at least for finance and tourism. The visibility of the providers – not only for the users – can be increased via the Market Observatory. However, this platform can not only be used to increase the visibility of providers from a users' point of view. Increasing the visibility of providers is also of great importance for other providers. EU-MACS concludes that strategic alliances for the joint development of products are an opportunity to win (1) increase quality by direct mutual consultation with all concerned within the specific value network breaking open provider potential idiosyncrasies, (2) offer products that work not only for providers, (3) become as polyglot as necessary as translating climate intelligence into use contexts, (4) link climate intelligence with other forms of expertise (e.g., economic, administrative, professional, architectural, agricultural, engineering, etc.) and (5) eventually gain benefits of scale and scope. This can be collaboration on eye-level, though commissioned work for a user wishing to integrate climate intelligence into other service or policy areas, pilot or definitive projects, large-scale or small partial activities. All in all, both modularisation and integration into bigger service products can be useful.

The initiation of such alliances can be supported by creating transparency about other market participants and their portfolios. Organizations usually have a good overview of the areas of the market in which they operate. Strategic alliances seem promising, however, especially in areas where competencies complement each other. Here, increasing visibility (who does what and for whom) can support market development.

The formation of strategic alliances can (also) take place in the form of public-private partnerships. These have been identified in both projects as promising innovative business models (EU-MACS D1.2).

Recommendation 2: Showcasing success stories and added value

EU-MACS recommendation	MARCO recommendation
Showcase best (novel) practice case studies/added value to potential users for their business success CS development, provision and use are often not considered worth the costs	Showcasing success stories

Case studies in both projects clearly showed that users of climate services often cannot appraise or lack the information to appraise the added value of applying climate services. This problem has two dimensions: (1) what is the 'best' climate service for my problem to be solved and (2) how can I best apply the 'best' climate service in the concrete decision-making situation? Although the answers to these questions are case-specific, it should nevertheless be possible to illustrate in exemplary cases, which climate service provides the greatest value added for which decision type and context, and how this specific service can be applied. In line with this EU-MACS would conclude that organizational and institutional manoeuvring space and feasibilities need to be understood and built into the service product, and service providing experts must be capacitated and trained for dealing with specific clients' use contexts. Pathing the way into a use context might, however, also include collaboration on the demand assessment and implementation of a service, not just direct usage, as most organizations will have to learn how to make the best out of climate intelligence. In that context, some illustrative and educative story telling would encourage them to take concrete actions.

In addition, it would orient them towards competent entities that can help them better define their needs in terms of climate resilience.

Recommendation 3: Pragmatically align with sectoral and cross-sectoral or non-sectoral demand

EU-MACS recommendation	MARCO recommendation
Move away from strict sector orientation, if reality of demand justifies it Develop innovative ways to look both on systems and practice level	Support market development in new priority sectors

In MARCO, the various supply and demand analyses were carried out for 27 sectors and 27 Member States of the European Union. By integrating the results in the gap analysis, it was possible to identify the sectors and regions with the greatest growth potential for the future (MARCO D2.5). Although there are different approaches to distinguish sectors from each other (MARCO D3.2) and assigning certain activities is not always easy, growth regions and sectors have clearly been identified. On practice level, issues in need of climate intelligence need a service that can integrate different sectoral or administrative/organizational demands. Think of how investments, e.g., in tourist regions in tourism, urban planning, transport, agriculture may interact or depend on each other once a more systemic view is applied. Regional policy-makers will anyway have all these (and more) dimensions in view.

5.3 Detailed recommendations from EU-MACS and MARCO

There are numerous other conclusions that can be derived from EU-MACS and MARCO. This integration follows the systematization of the Policy Recommendations (EU-MACS D5.2) and the Market Support Recommendations (MARCO D2.7) pursued in the projects.

First, we present the **EU-MACS conclusions**. EU-MACS has looked into broader sectoral practices and conditions for services, service infrastructure, resourcing, as well as into policies stimulating service innovation. The broad spectrum of issues influencing the climate service market building can be found back in the following recommendations. Those which are also supported by MARCO, are highlighted through Italics. In Annex 1, a more elaborate list of implications from EU-MACS can be found.

Regarding **matching supply and demand**, EU-MACS and MARCO (in Italics) have concluded:

- *Climate services development, provision and application is often not considered **worth the costs**. It is imperative to make it worth.*
- Market taxonomy based on users and providers may be too limiting. Focus on instead **value networks** is more realistic.
- *The boundaries of what climate services is/is not, can vary a lot for users and providers. **Intermediaries** are needed as guides.*
- *Keep the **expertise** (people!) in focus in developing climate services policies.*
- *Develop them **for users** and their demands, not only for abstract functions.*

- ***Role-specific finding and using aides**, coupled with (real human) **interactive support** is needed. Services should not just reveal themselves to those who already are experts.*
- Organizations and processes, into which climate services need to fit, can often be linked most effectively through **individuals who know how things work in their organisations**.
- *Climate services so far often is more a **means then an end**.* Stay focused on *the purpose of its use.*

Regarding the **innovation of service products and markets** for climate intelligence:

- **Co-creation processes** of climate services are key in order to overcome barriers (of use, mind-sets, organisational). **Early user involvement** avoids major revision at a later stage.
- Don't neglect reasons why **non-users** think they could do without climate intelligence or services in use context where you would expect they are perceived as useful.
- Climate services need to **observe and probe novel techno-scientific possibilities and trends** in order not to lose contact with other innovations. The latter may help fitting the services into current trends, systems, infrastructure, and mind-sets.
- *Help creating **incentives and duties** through regulation, self-regulation, public procurement, etc. as important impulses to consider climate intelligence and services.*
- *Showcase successful (novel) practice case studies and the value added to potential users for their business success. Show **how using climate intelligence works**, especially through dedicated services, and what is so **beneficial** about it.*
- Focus on sectors may not be sufficient. Find innovative ways to look both at **system and practice levels** needed, as well as across sectors. The same or similar use context(s) can extend into various different sectors at the same time.
- **Strategic intelligence** about innovation and co-production dynamics in collaboration with users needed, since climate service are a highly complex and unusual subject. This means **climate service R&D activities** need to be realistically studied (not evaluated according to external or normative criteria) and improved on the basis of what is really happening and how.

Regarding **data, infrastructure and service**:

- **Integrated (regional) climate cum impact models** are needed, **linking climate intelligence** to socio-technical, socio-economic, and many more perspectives. Climate alone is rarely the issue for users.
- Improve the **resolution** of climate information. Offer and make **affordable** what is needed, e.g., for specific adaptation purposes (in many cases local). Innovative payment schemes may help.
- *Consider **nuanced charging schemes**, accounting inter alia for equity and affordability, incentives for innovation and trial, and diversity in the organisation of use and acquisition of climate services*
- ***Common data formats and standards** for data records and exchange are needed, in order to reduce friction losses. This is a call for collaboration and harmonisation within the value network.*

Regarding **quality assessment**:

- Quality assurance should be supported by adequate **bi-directional communication** between providers and users; even though quality is initially created by proper internal 'production processes its maintenance and relevance depends on **how users define quality**

- Climate services could claim usefulness with greater **emphasis on "actionable" information** that is explicitly supporting decision-makers in better informed decision-making; and monitor its usefulness in context.
- ***Monitoring and assessment*** *of implemented adaptation is required given the complexity of climate services.* ***Involve users****, assess during collaboration with users, in order to avoid any provider bias.*
- *Climate service-based* ***tools supporting the evaluation*** *of adaptation measures' effectiveness are needed to facilitate communication between decision-makers and affected communities (e.g. in urban planning, tourism, etc.). Important also for the process of climate services development and service provision.*

Second, we present the **MARCO conclusions** (MARCO D2.7). Those which are also supported by EU-MACS, are highlighted through Italics.

Regarding the **identification of market opportunities,** MARCO has concluded:

- There are market opportunities in **Central and Eastern EU Member States** particularly in those regions for which high and multiple impacts are expected and in which, in addition, the market is still in a very pre-mature status.
- Next to the sectors already important today, there will be a few **new priority sectors** (such as health, forestry, tourism or energy infrastructures) according to the assessments of future impacts, risks and vulnerabilities as well as projected market growth rates.
- *Public and private providers have their specific strengths and weaknesses. Better* ***linking public and private providers*** *is important to develop more advanced climate services.*
- Many operational business decisions are taken on short time scales. The development of more advanced / sophisticated **climate services on seasonal to decadal time scales** might provide market opportunities.

Regarding the **database of providers** developed, MARCO concludes:

- *There is a current lack of visibility in terms of what types of climate services are available and how potential end-users can access them. In that context, it is essential to provide an updated and active repository to* ***increase visibility of providers*** *to allow interested end-users to easily access information on the climate services that are available on the market.*
- **Improving and mainstreaming the taxonomy** and/or classification of climate services is needed in order to ensure full flexibility and transparency of information.
- The providers database should be the basis for a more **user-friendly tool** that helps potential end-users to identify and select (combinations of) climate services that are relevant for their operational and prospective activities.

Regarding **business models and market intelligence,** MARCO concluded:

- *More* ***creative and diversified business models*** *need to be developed for specific types of providers such as Spin-Offs, Start-Ups or Public-Private Partnerships. A "How To" guidance document could provide sectoral challenges or insights into users' ways of thinking / working.*
- SMEs can act as change agents for the uptake of climate services particularly relevant to developing locally relevant, effective adaptation solutions. In that context, it would be useful to have **specific instruments / programmes that provide early-stage (investment) support** to SMEs, in order to ensure the development of climate-proof strategies.

- *In this respect, **fostering public-private-partnerships** would not only facilitate the development of market-fit climate solutions, but also unlock the financial capacities and engagement from diversified parties to catalyse climate action.*

Regarding **resilience monitoring and forecast,** MARCO has concluded:

- **Engaging with the climate services community to challenge the market intelligence** is important to be able to renew and monitor the intelligence outputs on the market of climate services in the EU. it will be important to collect further feedback from the stakeholders and create a space for discussion, clarification and re-allocation of the input market data.
- **Strengthening and harmonizing climate resilience legal frameworks** would be important to allow forecasting of market evolution by explicitly referring to the use of climate services.
- In this respect, also **tracking climate finance schemes and investments** both in public and private domains is important, but still challenging.

Regarding **awareness raising,** MARCO concluded:

- ***Showcasing success stories** is important to highlight, how climate services can lead to better decision-making. In doing so also aspects of quality issues, economic (co-) benefits and trust building are addressed.*
- Sufficient specific sectoral and or geographical reference materials are needed to **raise awareness of specific sectoral or regional / local climate-related risks and opportunities**

The synthesized recommendations from the two projects are summarized in table 4 in Annex 1.

6. POSSIBLE NEXT STEPS FOR THE EU AND OTHER ACTORS

Finally we present here suggestions for more concrete next steps the EU could consider regarding the promotion of the gainful use of climate services across society.

Outreach to other policy areas

There are several sectors where current mainstreaming practices regarding climate and sustainability in fact do need to account for the role of climate services, but seem to have so far not done that to a significant extent. Other sectors such as urban planning and related domains show already significant activity, but one can observe substantial implementation gaps between various enlightened profiled (often larger) actors and other not so well-endowed ones. Constructively feeding into the mainstream process may be expected to help. Similarly, there is already a dialogue going on regarding standardization including C3S, ISO and national normalization institutes. It is worthwhile to consider either a broadening of this dialogue or establishing parallel dialogues, including user groups (even though these are indirectly also represented in ISO and national standardization organisations). In the latter case standardization can also include harmonization of terminology and product categories. With respect to the development, provision and uptake of climate services the following EU level dialogues could be set up or existing ones reinforced:

- Dialogue with the Sustainable Finance initiative in the EU
- Structured dialogue with organisations representing urban, regional and infrastructure planning – this may also offer opportunities for addressing tourism
- A cluster of structured dialogues with organisations representing various segments of agriculture – the intro-European differences in climate risks and the distinction between segments inside and outside the EU's Common Agricultural Policy call for a cluster rather than 1 dialogue
- Structured dialogue with organisations representing health care and DRR
- Broaden dialogue on standardization, including also various user perspectives, e.g. urban planning (e.g., ICLEI, C40), engineering and accountancy expert organisations, commercial W&CS providers

Facilitate the transition from development to service provision

A widely shared view was that the transition from newly developed climate service to regular provision of such a service is often difficult, not the least due lack of viable resourcing models for this type of products, which will often need updates. There seems a need for demonstrating the viability of various resourcing models under different circumstances. Furthermore, all kinds of collaborative forms seem often fitting but these would benefit from guidance on resourcing, sharing of responsibilities, sharing of property rights, etc. Last but not least the tendency to link rather strict separation of public and private service domains to open data policies, shows some signs of risking to be counterproductive as willingness to innovate melts away.

- LIFE+ subsection with projects aiming to prove viable business models
- In the same LIFE+ subsection also attention for exploration of collaborative structures
- FP9 projects on the effects of market segregation on eventual innovation performance in relation with open data policies (this could cover also other information services with large societal significance)

- FP9 projects for the development and validation of practically applicable methods for valuation of climate services (also applicable to valuation of other similar services)
- Demonstration of the methods in several case studies (C&S)
- The results of the above projects should be fed into a EU wide market observatory (see below)

Monitoring and market places

From the various types of investigations in both projects can be clearly inferred that lack of transparency in terms of choice in climate service products, and in terms of the variation in needs and capabilities of (end)users regarding climate services, is a widely felt obstacle. Consequently, services that facilitate selection of products and providers, as well as indicate how demand is evolving, are clearly beneficial for more effective innovation, provision, selection and use of climate services. For this reason the establishment of some kind of observatory has been advocated in MARCO. Next to or in conjunction with such an observatory a few internet based market places could be developed. Such market places preferably include also options for brokerage. Both for the observatory and the market places applies that some kind of financial support is needed for the establishment of such facilities. The extent to which continued support is necessary depends on the organizational set-up and functionalities of these facilities as well as on the evolution of the climate services market in Europe and beyond.

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ANNEX 1 SYNTHESIS OF EU-MACS & MARCO RECOMMENDATIONS

TABLE 4: SUMMARY AND INTEGRATION OF KEY EU-MACS AND MARCO RECOMMENDATIONS

EU-MACS / MARCO	Matching CS Supply and Demand	Innovation	Data, Infrastructure & Services	Quality Assessment	Others
Identification of market opportunities	• Develop CS addressing capacities, language, performance indicators & risk management systems of end-users	• Link public & private providers to develop more advanced CS • Develop more advanced seasonal to decadal CS			• Strengthen market development in Central & Eastern EU Member States • Support market development in new priority sectors
Providers database	• Develop user-friendly & relevant tool to enable selection of appropriate CS providers & products • Offer human assistance for getting to the best options	• Increase visibility of CS providers on a "market place"	• Harmonisation: common data format, standards for data records & exchange	• User involvement advisable (at all stages, along the entire value chain) • Emphasis on "actionable" info ("strategic intelligence"), supporting decision-makers in better informed decision-making	• Improve & mainstream the taxonomy and/or the classification of CS
Business models & market intelligence		• Develop more creative & diverse business models for specific types of providers • Foster PPP • Develop specific investment instruments/ programmes oriented towards SMEs & early-stage developments • Use full spectrum of applicable innovation policy means (D5.2, Ch. 5)		• Derive quality assessment criteria also from direct collaboration with users	
Resiliency monitoring & forecast			• Integrated (regional) climate cum impact models needed (socio-technical, socio-economic, etc.) • Improve resolution of climate information, needed, e.g., for adaptation (often local)		• Engage with CS community to challenge market intelligence • Strengthen & harmonize climate resilience legal frameworks • Track climate finance schemes & investments
Awareness raising	• Raise awareness of specific sectoral or regional climate-related risks & opportunities	• Use innovative, timely instruments of attracting attention (e.g. visualization, apps for starting to use CS, influencer, peer endorsement)	• Showcase success stories (what're high quality CS good for)		
Others				• Transparency in use of climate-related data & in underlying assumptions • Quality assessment important for CS development & provision	• Monitor & communicate benefits and cost-effectiveness of using CS