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CLIMATE INFORMATION SERVICES FOR URBAN RESILIENCE

LEARNING FROM THE DANISH EXPERIENCE WITH CLOUDBURST MANAGEMENT

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Key messages

I Climate information services can bring together relevant climate and socio-economic information to pave the way for climate resilient planning and improved decision-making

II The use of climate information services on the urban scale by the city of Copenhagen to facilitate enhanced and cost-effective flood protection promises significant co-benefits in terms of job-creation and tax revenues

III High future market potential for uptake of climate information services on the urban scale contrasts with low actual demand due to a number of barriers, e.g.

a. lacking access to data of high accuracy, relevance and quality including detailed climate projections and socio-economic information;

b. lacking methodological consensus on analyses feeding into climate information services questions usefulness and legitimacy for decision-makers;

c. absence of large-scale demonstrators serving as best practice cases.

IV Targeting research and innovation funding at (i) fostering integration of different data sources of high quality, (ii) improving confidence in and regionalisation of climate models, (iii) demonstrating added value of climate information services for urban climate resilience, (iv) enhancing transfer of experience in European city networks

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What to find in this policy brief?

RECREATE is a 5-year project running from 2013 to 2018, funded by the European Commission. It is carried out by a consortium consisting of 16 key partners from European research and industry and is led by the Joint Institute for Innovation Policy (JIIP). The overall objective of the project is to support the development of the European Union's research and innovation funding programme Horizon 2020, with a specific focus on the part *Societal Challenge 5: Climate Action, Resource Efficiency and Raw Materials*.

Dear Reader,

We are very pleased to present you with the third of our series of RECREATE Policy Briefs. These documents translate the key outcomes of the project into policy-relevant messages. The first four RECREATE Policy Briefs are directly based on the so-called Evidence-Based Narratives (EBNs) developed in the project. The purpose of the EBNs is to describe, in a narrative form, the potential but also the risks and remaining challenges of particularly promising innovations in the DG RTD priority areas of Systemic Eco-Innovation, Nature-Based Solutions and Climate Information Services. Ultimately, the objective is to support DG RTD with the formulation of future H2020 Work Programmes.

Policy Brief no. 3 discusses the potential of climate information services (CIS) in the context of improving urban resilience. CIS integrate climate data and models on the one hand with socio-economic assessments and thus help urban and other spatial planners to increase resilience of cities and of the built environment in general. The present document focuses on the example case of the City of Copenhagen, which has integrated CIS in its Climate Adaptation Plan, largely seen as one of the worlds most advanced such plans. It shows how CIS, in addition to effectively contributing to increasing urban resilience, also bear a substantial economic potential.

The reasons why the uptake of CIS has been limited so far are manifold. Amongst others, they relate to the availability and the quality of data, the lack of methodological consensus, the absence of large-scale demonstrators as well as missing incentives for business actors to invest in this field. All these factors present a clear case for public R&I funding and other forms of policy interventions. This Policy Briefs concludes with a set of detailed recommendations how public policy could help to tap and further develop the potential of CIS.

On behalf of the entire RECREATE consortium, we wish you a good read and look forward to your feedback. If you would like to find out more about the project, please visit our website www.recreate-net.eu or send an email to info@recreate-net.eu.

Kind regards,

Robbert Fisher
Project Coordinator

Using Climate Information Services to increase urban resilience

Climate information services (CIS) can provide urban actors with relevant integrated data to help guide short- and long-term planning and strategies to improve climate resilience. European Research and Innovation Policy can foster the demonstration, uptake and transfer of successful examples of using urban CIS.

I What is the problem? What is the suggested innovative solution?

Using climate information services to improve urban resilience

More than half of the world's population (54%) is now living in cities and it is expected that this share will increase to two thirds by 2050, with the largest urbanisation trends occurring in Asia and Africa.[1] Both the increase in the number of urban dwellers in general, and also of the vulnerable urban poor in megacities and city agglomerations in the Global South highlight the urgency for cities to improve and maintain its service provisions in the face of global change. Water scarcity, extreme heat and (coastal, river and rainwater related) flooding events directly or indirectly (e.g. through reduced food yields in peri-urban areas) affect urban areas and their inhabitants in industrialising and industrialised countries.[2] Hence, cities around the globe must both strive to mitigate climate change by reducing emissions and to adapt to climate change by building resilience.[3]

Reliable and actionable climate information services (CIS), which integrate climate data and models with socio-economic assessments (see definition and Figure 1 below), are expected to improve and help guide both mitigation and adaption measures because they enable targeted systemic interventions adapted to the respective urban (micro-) context and because they scale-up the cost-effectiveness of such measures.[4]

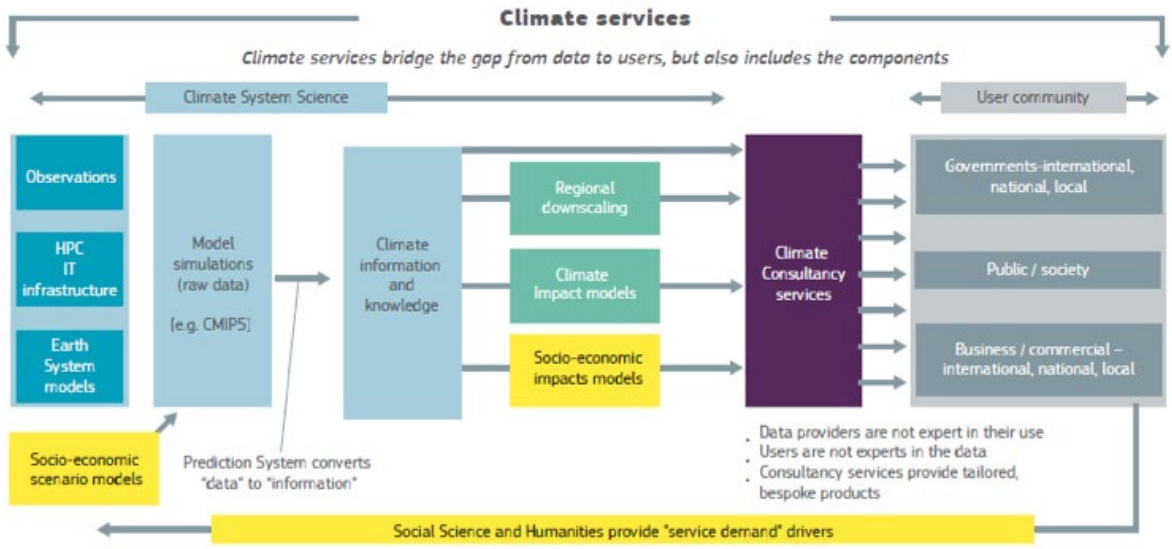
Likewise CIS are expected to facilitate improved decision-making for example on efficient mitigation policies, resilient infrastructures, novel business opportunities, and future investments. Therefore, CIS can also ease improved urban planning in response to non-climatic drivers such as the growing global trend towards greener, smarter and more sustainable cities with a high quality of life.

> CIS cover "the transformation of climate-related data — together with other relevant information — into customised products such as projections, forecasts, information, trends, economic analysis, assessments (including technology assessment), counselling on best practices, development and evaluation of solutions and any other service in relation to climate that may be of use for the society at large. As such, these services include data, information and knowledge that support adaptation, mitigation and disaster risk management."[5]

Urban climate information services: Looking to Copenhagen's Climate Adaptation Plan

CIS are being investigated as a means to foster the city of Copenhagen's Climate Adaptation Plan, which is generally hailed as one of the world's most ambitious examples of urban adaptation and a model to learn from. Within a period of only 5 years Copenhagen suffered considerable economic damages amounting to more than 1 billion EUR in insured losses from reoccurring cloudbursts and associated severe flooding, including the rare extreme events

Figure 1: The essence of climate services



Source: European Commission 2015[4]: 45, adapted

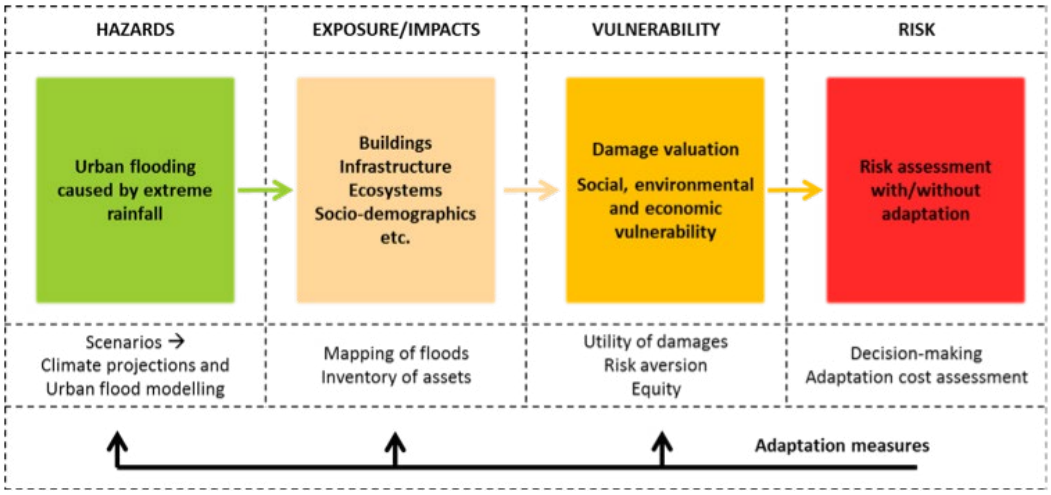
in August 2010 and in July and August 2011. In response the city recently initiated a comprehensive set of trans-disciplinary analyses to form the basis for implementing enhanced and cost-effective levels of protection against such future events in a changing climate.[6]

As one result of these analyses, a spatial planning tool and novel CIS was innovated, which allows screening of flood risk through integrating different sources of information (e.g. present and future climate data, urban topography, dynamical flood modeling and socio-economic factors) in a spatially explicit form. The core of this tool is a detailed, high-resolution Geographic Information System (GIS)-based landscape model that allows identifying depressions and sinks prone to flooding (so-called bluespots) in Copenhagen's urban landscape (innovated by Danish Companies NIRAS and COWI).[7] Though focusing on flood risk the CIS is designed to accommodate the screening of different planning and adaptation options and thereby to facilitate the optimal use of different elements of adaptive measures into the wider local master plans and urban development projects in Copenhagen (see Figure 2 below).

In such a framework, the relevant data or models for evaluating the increased risk due to climate change[9] is a function of climate-related hazards through an inventory of elements in an area in which hazard events may occur (exposure) and their vulnerability to such adverse events. Typically, data and models are provided by different actors and experts including both commercial and academic entities. As a result high levels of expertise are often required to carry out the combined analyses needed by urban planners and adaptation decision-makers. The climate information service developed for the City of Copenhagen is inherently a visualization tool whose principal objective is to bring together different data sources and to make it feasible for e.g. the Technical Administration of Copenhagen to overlay different data layers and to carry out simplified screening analyses in terms of facilitating decision-making and implementation.

The tool described here was successfully used and has played a central role in developing the Cloudburst Management Plan of Copenhagen[6], forming the basis for outlining a portfolio of nearly 300 individual projects across each of seven catchment areas in Copenhagen. It is planned that the 300 projects will be implemented gradually over a period of 20 years, based on a prioritization to be amended as new knowledge (e.g. based on new or improved CIS) or new technological innovations become available.

Figure 2: Schematic flow of an adaptation analysis



Source: Fischer et al. 2015[8]: 172

II Environmental and economic potential of the solution

Urban climate information services: great market potential meets low actual demand

However, while for the above reasons the market potential for CIS in cities is expected to be high, current markets for CIS in urban areas seems largely immature. Business opportunities are growing only at a slow pace and mostly within the existing sector for consultancy and engineering due to little sustainable demand from users. A main reason for low actual demand could be that many European cities are, if at all, only taking initial steps of adaptation planning. A recent analysis of the urban response to climate change in Europe reveals that 72% of large and medium-sized European cities have no adaptation plans in place[10]. Furthermore, main consumers and investments derive almost entirely from the public sector and local governments. Hence cities, as well as private companies and investors, represent a huge unrealized market potential.

There are only few studies, which have tried to estimate the actual value of the global market for climate information services, and none, which have focused specifically on urban issues:

1. According to recent analyses by Environmental Business International (EBI), the global market in 2012 for climate information services defined here as (i) Climate Risk Assessment & Analysis (ii) Climate Adaptation Planning (iii) Analytical & Information Systems was in the order of 729 million US-$ (650 million EUR).[11]
2. Conversely, the Government of the United Kingdom have estimated that the global market for commercial weather and climate services related to both adaptation and mitigation in 2010/2011 reached a value as high as 26.6 billion £ (36.5 billion EUR) of which 46% alone accounted for dedicated climate services.[12]

Although these two estimates are not directly comparable as they are based on different sets of assumptions and rely on different methodologies, both suggest a global market of considerable size.

Through an optimal use of sustainable urban drainage system as opposed to more traditional (and expensive) piping-based solutions wherever feasible, potential return-on-investment follows from the massive co-benefits incurred by implementing cost-effective adaptation options. In the case of Copenhagen these are expected to yield expected "profits" in the range of 700–900 million EUR (see table 1 below).

In addition, indirect returns-of-investment will be secured through attracting investors to a future-proof, resilient city in a broader perspective. This includes promoting the business proposition of the city's commercial partners in order to facilitate new business opportunities to stimulate economic growth and job creation – and ultimately increased tax revenues for the city. As part of this strategy, Copenhagen co-founded the very successful "Copenhagen Cleantech Cluster" supported by European Union Structural Funds and Cohesion Funds, which is now part of the Danish CLEAN innovation cluster (http://cleancluster.dk/).

Approximately 90% of the funding for adaption measures will be procured through increased water taxes. The remaining 10% will have to be found within the city's operation budgets in terms of savings from implementing the blue-green infrastructure (as opposed to piping-based solutions) and by pooling resources from different administrative areas, i.e. considering adaptation as an integral part of the city's sustainable urban development.

Potential future market

Estimates of the global market potential for climate adaptation – let alone for CIS – are highly uncertain even for present day conditions. Some estimates expect the global market to continue to grow towards 2020 by as much as a factor of three compared to the present.[11] The market for storm water management, which is a main concern for cities worldwide, is expected to peak around 2030 – with services related to the implementation phase likely to carry the highest potential.[13] For Denmark, estimates see market potential for storm water management support peaking earlier than globally, around 2020 (see Figure 3 below).

Based on climate projections of severe increases in the frequency and intensities of extreme rainfall events, high market potential for CIS to support climate adaptation is seen for:

- Parts of North America, particular along the east coast and west coasts, which are dominated by extremely high economic densities and high (and increasing) levels of urbanization;
- Large parts of Asia, in particular along the coasts of Japan, China, South Korea, and India, which are dominated by urban areas, generally growing at a very rapid pace (except for Japan); economic densification in these areas is also extremely high and increasing;
- The northern parts of west Europe (including Scandinavia), which have a high economic density; in many places larger cities have grown together creating extensive urban areas dominated by large impervious surface fractions.[13]

An increasing number of serious floods events and extreme heat waves throughout Europe in recent years have turned the spotlight to adaptation. As a result, many cities and local governments as well as private citizens and companies have started to invest in the development and implementation of adaptation measures at different scales[10]. CIS can help reducing vulnerabilities through reductions in exposure and sensitivity and increasing adaptive capacity of a city. As CIS facilitate the dissemination of highly trans-disciplinary information (e.g. combining relevant findings from future climate scenarios, hydrological modelling, physical planning, vulnerability models, and economic valuations of damages and of the costs and benefits of adaptation), CIS can be expected to play a key role in urban adaptation.

Employment effects, social and environmental benefits

While there is very limited evidence of new jobs being created as a direct result of establishing CIS, several of the companies involved in service provision to the city of Copenhagen report that over the last few years they have had to expand their specialist staff considerably in order to accommodate increasing demands

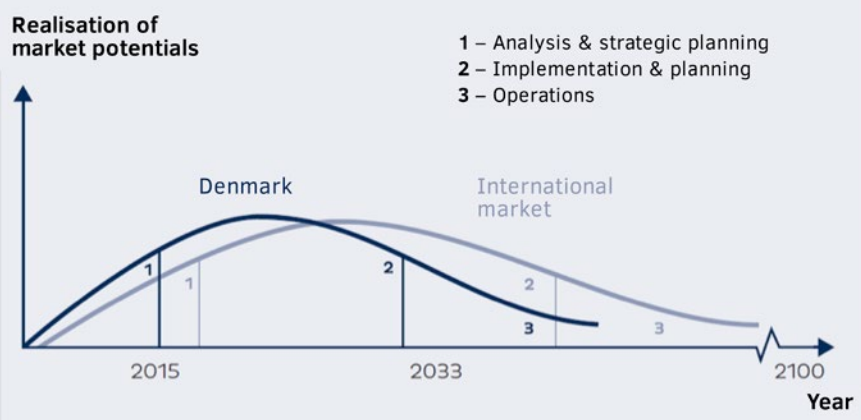
Table 1: Economic assessment of costs and benefits of adaptation in Copenhagen (in billion EUR)

Rainwater	Traditional urban drainage solutions*	Combined solution*	Combined solution (Ministry of Finance method)**
Damage costs without adaptation	2.2	2.2	2.4
Costs of adaptation	2.7	1.5	1.4
Reduction of damage costs	2.2	2.2	2.3
Profits	-0.5	0.7	0.9

Note: Values shown are estimated market prices including a net tax factor of 17% and a tax distortion loss of 20% based on prior economic analyses of the cloudburst and adaptation plans. Solutions are assumed to be implemented over a 20 year time frame with an additional 0.5% added in terms of operating expenses. The exception to this relates to private investments within property boundaries, which are assumed implemented over a time frame of 70 years.

* Numbers in the first two columns use a 3% discount rate.
** The rightmost column uses the 2013 guidelines by the Danish Ministry of Finance, describing a decreasing discount rate.

Figure 3: Expected structural development of the global market potential for storm water management over time



Note: Based on estimates from a variety of sources e.g. World Bank, UNFCCC, Environmental Business International, etc. Figure reproduced with permission from Smith Innovation (in Danish). The x-axis shows the projected year, the y-axis the expected realization in market potential. The dark blue curve outlines the expectations for the Danish market, the light blue curve expectations for the global market. The three phases indicated by numbers are: 1 – Analysis & strategic planning, 2 – Implementation & planning, 3- Operations

Source: Smith Innovation (2012)[13]: 79, adapted

for their expertise and tools to assist cities worldwide with adaptation to climate change. However, no absolute numbers are available with respect to direct job creation effects of CIS.

Evidently, jobs will be created as Copenhagen fully enters the implementation phase of the 300 planned interventions in the city. It is clear that the vast majority of these cannot be directly related to the CIS, but to the implementation of the overall strategy made possible by the CIS tool described above. Planned investments in climate change adaptation, i.e. through traditional piping-based and nature-based solutions, are expected to create up to up to 13.000 new jobs within the 20 year time frame of implementation – including jobs related to improvements and development of urban spaces this total amount could climb up to 15.000 new jobs (most of these jobs will be created in the construction and engineering sectors)[6]. The estimated new jobs figures would yield increased tax revenues in the order of 200 to 300 million EUR in Copenhagen[6]. Interestingly, if one would generalize these estimates to future non-European markets with high potentials like North America and Asia, this would suggest that the majority of new jobs and tax revenues created, e.g. in the construction and engineering sectors, as a result of improved and more cost-effective decision-making on adaptation (and mitigation) in all likelihood will also be created locally in these regions.

Building climate resilience is generally considered as a strategic part of sustainable urban development. Hence, using CIS – at least the way it has been used in Copenhagen – will also facilitate the "greening of cities" by the use of nature-based solutions like Sustainable Urban Drainage Systems. The use of NBS in cities is often associated with extensive environmental and social benefits, e.g. in terms of ecosystem service provision, biodiversity conservation and human welfare[14]. The combination of CIS and NBS and its ambitious climate plans has helped Copenhagen brand itself as a living lab and world leader in this area, which according to the Confederation of Danish Industry has helped attract considerable global investments, and which have also in turn had a positive impact on Danish exports, in particular in the clean-tech sector.

III Good practice examples

Success factors for fostering the use of urban CIS: learning from Copenhagen

Some European cities like Copenhagen are front-runners and provide evidence of the economic benefits that combining urban climate adaptation with sustainable urban development may deliver. The development of tailor-made CIS integrating climate information with socioeconomic data and models is crucial to facilitate improved decision-making for resilient cities future – and helps guiding investments in adaptive infrastructures and capacities. Urban CIS may furthermore support (large-scale) uptake of nature-based solutions in cities, e.g. by helping to provide proof for their adaptive capacity value as opposed to more traditional solutions.

In 2013 the Danish Government in agreement with the Local Governments in Denmark committed all Danish municipalities to carry out local analyses of the risks towards flooding due to extreme precipitation and based on this to develop local climate adaptation plans. Not only did this commitment create demand for consulting services from companies and hence contributed to some job creation directly linked to CIS, but also did it foster capacity and competence building on the municipal level and hence increase adaptive capacity to urban flooding in Denmark.

The tools and CIS tested in Copenhagen have demonstrated a significant potential for commercialization and are in the process of being transferred to a number of other cities, including the city of New York. The cities of Copenhagen and New York have recently signed a partnership agreement aiming to bring technologies developed in Copenhagen to New York and vice versa.

European and global networks like the Covenant of Mayors and ICLEI (Local Governments for Sustainability) also provide excellent means for knowledge diffusion and market stimulation worldwide. The City of Copenhagen has a very active dissemination strategy, which is realised through these and other international networks. The dissemination strategy includes Master Classes in Climate Adaptation, which are taught to other cities in collaboration with leading Danish engineering companies, which again contributes to the commercial exploitation of services implemented in Copenhagen.

Finally, Copenhagen also takes active part in European and nationally funded research and innovation projects.

IV Barriers to implementation

Barriers and challenges to using (the full potential of) CIS

Despite the promising market, economic and environmental potential of using CIS for building urban climate resilience, there appears to be only very limited uptake. Several barriers explaining this limited uptake could be identified:

Access to and quality of data	· CIS inherently depend on the quality and availability of physical, socio-economic and other data; access to socio-economic data is a great challenge due to (i) issues of data privacy, confidentiality or commercial interests; or (ii) lacking or insufficient socio-economic and demographic data needed to make informed decisions; · Quality and relevance of the different data sources are very heterogenous across countries and cities within countries, affecting CIS' ability to become reliable and actionable tools; · Models on which the data generated are based, need to be accompanied with an easily understandable interpretation of primary model output. As uncertainties associated with model assumptions and output cannot be eliminated, uncertainties and probabilities must be openly communicated and considered; · Ability of climate projections to be downscaled robustly to urban scales has yet to mature, challenging the value of urban climate analyses.
Open access	· Dilemma of intellectual property rights vs. open access: » Intellectual property rights play a significant role for the commercial exploitation of CIS, hence commercial actors may exhibit opposition towards a general policy of open access to data and data products thus limiting business development in the urban CIS market; » Incentives for business actors to engage in co-development and co-production of CIS with academia and users are often valued to be low, since they do not generally obtain exclusive rights to the outcomes, which can make the products difficult to commercialize.
Methodological legitimacy	· A lack of international methodological consensus on how to carry out analyses feeding into CIS, such as cost-benefit analyses, reduces the validity and legitimacy of such analysis; · This poses a challenge to decision-makers for credibly and robustly identifying the most cost-effective adaptation and mitigation solutions at the urban scale - the usefulness of integrated cost-effectiveness and cost-benefit analyses to facilitate improved decision-making is often questioned[15]
Research funding	· Commercial actors often experience a lack of incentives for engaging in extensive collaborative research & development activities because – unlike academic institutions – commercial actors are often only eligible to receive external co-funding requiring significant contribution of own resources.

Market structure and entry	• Consultancy/engineering companies dominate the market for urban CIS and in many cases have already provided similar solutions similar integrating climate data and socio-economic models for many years as part of traditional consultancy; this creates considerable reluctance among commercial market actors to change this business model in favour of a more collaborative model; • Many cities maintain long-lasting economic relations with specific commercial actors and companies take advantage of such long-lasting relationships; this may slow down development and maturation of the market for urban CIS and pose an entry barrier to newcomers to penetrate the market with (potentially superior) CIS products; • There is a clear absence of large-scale demonstrators to serve as best practice cases i.e. demonstrating the added value of CIS as means to facilitate climate resilient urban planning with a holistic focus, including nature-based solutions.
Differences in objective and	• "Academic business model" where success is measured primarily in terms of number of publications in leading journals may lead to academic embargoes of results publication due to the requirements of the scientific journals; this can seriously affect the commercial partner in fulfilling their contractual obligations with customers as the new information cannot be used before the embargo period ends; • Validity of CIS delivered commercially may be questioned, showing demand from customers to involve independent researchers, e.g. a professor at the local university, at least in the proofing of commercial end-products; • Commercial actors, in particular SMEs, rarely possess the skills and expertise to ensure that innovations in the field of climate services are valid and developed in accordance with state-of-the-art and proper scientific practices.

V Policy support needs

Need for actions in European Research and Innovation Policy

Previous and current research on CIS has mainly been funded by public sources including regional, national and European-funded actions, and mainly in the context of research. As more and more cities will begin to reduce emissions and adapt to climate change it is highly likely that the demand for urban CIS will increase dramatically, which in turn should stimulate investments by the private sector. At the present however only few frontrunners – mainly larger European cities – are investing or are planning to invest large funds in adaptation, and many must adopt more or less "exotic" financing schemes to ensure sufficient funds for the implementation. Therefore, large-scale innovation in the field of urban CIS is unlikely to take place in the short term without public funding to support research and development activities.

In 2015 the European Commission Directorate General for Research and Innovation published "A European research and innovation Roadmap for Climate Services"[4]. The roadmap outlines a number of planned policy initiatives and funding opportunities (to be implemented, for instance, through JPI Climate, Horizon 2020 (Societal Challenge 5), and the Copernicus Climate Change Service (C3S), and other funding instruments also at the national level) aiming at stimulating the growth of new and existing commercial markets for CIS in Europe across all sectors with a much higher share of consumption by the private sector.

Underlying the activities to step-up and integrate funding for CIS, the roadmap covers aspects that were identified as barriers in this brief. For instance,

- its call for "improving the predictive capacities across time and spatial scales" addresses the need for improved confidence in climate projections, higher quality data and better spatial granularity of climate modelling output;
- the call for "co-design of service products to be established with relevant stakeholders" corresponds to both a need for increased user-readiness and for validity of commercially delivered CIS;
- and the C3S expected to deliver progressively by 2020 on relevant climate variables, indices and information for several economic/societal sectors on a free and open access basis, which reflects the need for wider and homogenised access to robust climate data.[16]

The roadmap's ambition and calls for action are partially already reflected in the Horizon 2020 Work Programme 2016/2017 for SC5, which aims to support better linkages between CIS and the demand of end-users to eventually improve the uptake in real decision-making processes.[17]

On the one hand this necessitates the provision of a consistent and authoritative Europe-wide set of climate simulations at appropriate spatial and temporal scales. The call SC5-02-2017: Integrated European regional modelling and climate prediction system[18] foresees the generation of a unique ensemble of climate predictions to become the reference climate information from regional to local scale across to enable the building of appropriate regional, national and local risk assessments and adaptation programmes.

On the other hand, as this also requires making developers and users of CIS more aware of the added value of CIS products for end-users in their operational decision-making, a specific call for demonstrators in the climates services domain has been included in the 2016/2017 Work Programme for SC5: SC5-01-2016-2017: Exploiting the added value of climate services, Innovation action under letter a) Demonstration of climate services (2016).[19]

Thus, some of the policy recommendations proposed in the Roadmap for Climate Services at the European level seem already (partially) set to be tackled:

- ✓ Engage stakeholders to (i) facilitate co-design and co-development of CIS; to (ii) support establishment of a viable climate services community that could provide an effective forum to address issues of quality assurance of and access to data; and thus to (iii) ensure that research and innovation in support of CIS is user-driven and science informed;
- ✓ Demonstrate the benefits through pilot and demonstration actions in key economic sectors to showcase the added value of CIS for decision-making and the resulting decisions;
- ✓ Ensure the quality and relevance of climate services through (i) integrating observations and socioeconomic data, and (ii) developing decision-relevant prediction tools and methods.
- ✓ Develop synergies between the supply side and CIS operators through (i) the provision of free and open access data, data products, model results, indices and climate information; (ii) using such products for providing customised high added-value services.[20]

In order to foster development, transfer and uptake of co-designed, user-friendly CIS we suggest that European research and innovation policy could

a) Promote international standards for climate information services for example in the form of an internationally acclaimed quality assurance scheme to ensure that services delivered commercially conform to what at any point in time may be described as sound scientific and engineering practices, e.g. in terms of interpreting correctly the results of climate model simulations and socio-economic models, and to ensure fair competition between market actors.

b) Make (more) use of ERA-Net or Horizon 2020 CSA calls to link cities and city networks regarding exchange of experience and potential transfer of CIS for urban adaptation/resilience;

c) Invite and require conceptualisation of **city-scale** demonstrators in future Horizon 2020 calls to generate market cases, narratives and best practices to be diffused between cities to help mature the market for urban climate information services;

i) Encourage particular consideration of proposals under SC5-01-2016-2017: Exploiting the added value of climate services, letter a), which credibly outline the integration of cities or city networks as demonstrators;

d) Foster sustained long-term investments in both applied and basic research within a number of different areas related to urban issues, including climate modelling and socio-economics in future Horizon 2020 calls beyond SC5-02-2017: Integrated European regional modelling and climate prediction system;

e) Enhance requirements for and assigning higher evaluation scores to Horizon 2020 proposals that credibly outline mechanisms for matching co-funding from Horizon 2020 and European Structural and Investment Funds (ESIF) in order to support the use of different financing models to stimulate adaptation action in European cities including the uptake of dedicated CIS.

f) Launch or invite analyses of how existing barriers for collaboration between research institutions and commercial entities might impact the implementation of Horizon 2020;

g) Provide (more), revise and align incentives to stimulate true co-production and co-development between commercial actors, academia, and end-users in the light of the existing market dominated by consulting companies;

- i) improve the ability and eligibility of private sector participants to apply for Horizon 2020 funding, e.g. as much as possible reducing requirement on SMEs to provide significant co-funding from own resources;
- ii) improve the SME instrument to reduce complexity and time-demand of writing proposals;
- iii) Encourage the development of innovative modes of collaboration between commercial actors, academia, and end-users during proposal writing and project execution via requirements for detailed coordination of both academic and commercial objectives as part of consortium agreements under Horizon 2020 projects;

g) Foster through future calls under Horizon 2020 or JPI Climate or through C3S activities the establishment of international standards for CIS to ensure that services delivered commercially conform to sound scientific and engineering practices, e.g. in terms of interpreting correctly the results of climate model simulations and socio-economic models;

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