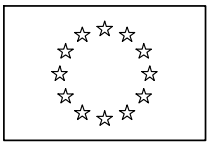

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COMMISSION STAFF WORKING PAPER

RESEARCH JOINT PROGRAMMING INITIATIVE ON CLIMATE CHANGE: 'CONNECTING CLIMATE KNOWLEDGE FOR EUROPE'

Accompanying the document

COMMISSION RECOMMENDATION ON THE RESEARCH JOINT PROGRAMMING INITIATIVE 'CONNECTING CLIMATE KNOWLEDGE FOR EUROPE'

{C(2011) 7410 final}

EXECUTIVE SUMMARY

The Commission proposes more strategic cooperation between EU Member States on research and development to address major societal challenges. One way to do this is the recent joint programming approach advocated by the European Council and the European Commission as one of the critical element to implement the European Research Area (ERA). Joint Programming Initiatives (JPI) involve Member States engaging on a variable-geometry basis in defining, developing and implementing strategic research agendas. "Connecting Climate Knowledge for Europe"[1] has been proposed as one such JPI.

Europe has set ambitious goals both in terms of climate change mitigation and adaptation. It is now fully recognised that extraordinary international efforts will be required to combat or avoid negative consequences of climate change, while pursuing other social, economic, health and environmental objectives. This awareness is becoming a critical parameter in decision-making at all levels and in all policy areas. Climate change considerations have to be integrated into a complex framework of existing and developing policies, planning and management processes. Besides, there is a growing recognition that well planned investments in climate mitigation and adaptation may also lead to economic opportunities, generating employement and promoting technological innovation. Against this background, the cost of early and carefully designed climate action is expected to dwarf the potential costs of inaction. However, assessment and communication of costs and benefits or risks need to be further improved, while these will strongly affect the extent to which societies, regional and local authorities or even companies will invest on precautionary, mitigation and adaptation measures.

The Europe 2020 strategy foresees a transition to a green, resource-efficient economy as a potential new paradigm for sustainable economic growth. Furthermore, the strategy stipulates that the EU must continue to work on world wide solutions to the climate change challenge.

Climate knows neither political nor administrative borders, hence climate challenges cannot be fully addressed by any individual country alone and require a vast multidisciplinary expertise. To overcome the societal, environmental and economical dimensions of the climate challenges, Europe needs to strengthen its scientific and technological knowledge base and to cooperate more intensively on climate research.

A considerable amount of relevant climate research has been undertaken and is still being performed at all levels in Europe, including national and regional programmes and EU-funded research. However, while excellent research has been carried out throughout Europe, there is room for further developing synergies and increase efficiency. The current individual efforts in EU Member States in climate research appears to be complex and rather fragmented. Many research networks and organisations at European, national and regional levels defined climate research strategic agendas in relative isolation, leading to overlapping or competing research activities that often lack a critical mass.

A concrete step in the direction of combining national research efforts and making better use of current public resources in climate research is the establishment of a Joint Programming Initiative (JPI) in this field. Such a JPI could significantly contribute to supporting the EU 2020 agenda for a smart and sustainable growth through the consolidation of the S&T basis regarding climate processes and changes.

[1] Joint Programming Initiative "Connecting Climate Knowledge for Europe" – Maturity analysis submitted to the EC on 10th June 2011.

In December 2009, the Council advocated[2] a common European initiative in the field of climate change and invited the Commission to contribute to the preparation of such a JPI, combined with an assessment of the state of play of research in this field. The Commission has therefore prepared this Staff Working Paper as a complement to the Commission Recommendation on the research joint programming initiative "Connecting Climate Knowledge for Europe".

The envisaged outcome of this JPI is the generation of knowledge supporting the emergence of a sustainable and climate-resilient European society. It defines a number of milestones: a European decadal climate prediction system to help assessing climate change on a crucial planning time scale, the establishment of advanced cimate services, a better understanding of societal transformation processes and the development of integrated assessment tools to assist informed decision-making. Each of these are considered basic features of a European research landscape empowering stakeholders to define a vision of sustainable societies as well as commensurate development pathways, taking account of systemic constraints including societal transformation capabilities.

TOWARDS JOINT PROGRAMMING

In its communication from 15 July 2008, entitled "Towards joint programming in research: Working together to tackle common challenges more effectively", the Commission called for the implementation of a process led by the Member States to step up their cooperation in the R&D area in order to better confront major societal challenges of European or worldwide scale, where public research plays a key role. Thereafter, with the Council conclusions of 2 December 2008, the dedicated configurations of CREST and the High Level Group for Joint Programming (GPC) were established with a view to identifying and substantiating the first list of a limited number of joint programming themes. The pilot JPI on combating neurodegenerative diseases, in particular Alzheimer's, was launched with the Council conclusions of 3 December 2009, which also welcomed the identification and substantiation of the first wave of themes for JPIs in the areas of “Agriculture, food security and climate change”, “Cultural Heritage and Global Change: a new challenge for Europe”, and “A healthy diet for a healthy life”. The six JPI themes of the second wave, which include ”Connecting Climate Knowledge for Europe” (referred to as JPI Climate in this document), were identified and substantiated in the Council conclusions of 26 May 2010.

The kick-off meeting of the JPI Climate was organized on behalf of the German Federal Ministry of Education and Research (BMBF) on 23-24 April 2010 in Berlin. This was followed by three workshops to discuss orientations and process of the Strategic Research Agenda that took place, respectively, in Brussels on the 5-6 October 2010, in Vienna on 24-25 January 2011 and in Brussels on 30-31 March 2011. The first Governing Board meeting was held in Helsinki on 30-31 May 2011. This latter meeting was attended by representatives of all Partner Countries (AT, BE, DE, DK, FI, FR, IE, IT, NL, NO, SE and UK), one observer country (SI), one observer organisation (NordForsk), and the Commission. On that occasion, both the Vision and Governance Documents were consolidated, and the structure of the Governing Board was agreed, with the Commission confirmed in its role of non-voting Member of the JPI Climate.

On 10 June 2011, the German co-chair of the JPI Climate submitted to the Commission on behalf of the twelve Partner Countries a revised version of the JPI Climate proposal refining amongst other things the vision of the JPI, its governance structure, the intended added value,

[2] Council conclusions 17226/09
http://register.consilium.europa.eu/pdf/en/09/st17/st17226.en09.pdf

benefits and impacts, updating the list of JPI Partners and Observers, and giving the initial version of a mapping of national public research activities in Partner Countries and related letters of intent expressing their commitments to participate in the JPI activities. A maturity assessment of the proposal was performed by the Commission resulting in the decision to consider it sufficiently mature to launch the preparation of a positive EC recommendation of the JPI Climate.

THE CLIMATE CHANGE CHALLENGE

There is now clear evidence, as presented in the 4th Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC[3]), that humankind is contributing to significant changes in the Earth climate system and that these changes are adversely affecting air, water and soils, biodiversity, natural and man-made ecosystems, humans, communities and economic activities. It is also clear that if nations do not act quickly to reduce substantially the emissions of greenhouse gases, global temperatures will rise significantly within the following decades with uncontrollable consequences that will harm the living conditions of many countries around the globe, especially the least advantaged. Furthermore, it is equally clear that, even in case of success of mitigation efforts undertaken over the next two to three decades to limit global temperature increase to 2°C above preindustrial levels, the changes in global climate induced by historical emissions will require significant adaptation challenges.

Climate change research findings and IPCC assessments have provided the basis for global policy action, such as the UN Framework Convention on Climate Change (UNFCCC[4]), the Kyoto Protocol and Copenhagen Accord adopted at the UNFCCC conference in Copenhagen (December 2010). The EU together with its international partners is now aiming at a new comprehensive global agreement tackling climate change which will set priorities, commitments and goals for the near to long term.

The European contribution to the global post-2012 policy action is largely based on climate change research findings and IPCC assessments[5]. In March 2007, the European Heads of State or Government confirmed the EU policy goal to keep the global temperature increase to less than 2°C above preindustrial levels, calling for substantial reductions of global greenhouse gas emissions in order to avoid dangerous climate change[6]. For the EU, the 'triple 20 objective' was set: 20% reduction of greenhouse gas emissions, 20% improvement in energy efficiency, 20% of energy coming from renewable sources by 2020. The Green Paper from the European Commission 'Adapting to Climate Change in Europe – Options for EU Action'[7] initiated a further line for EU action: *'reducing uncertainty by expanding the knowledge base through integrated climate research'*, emphasizing issues such as understanding and forecasting of impacts, developing comprehensive datasets, modelling tools and technologies, and fostering cooperation and networking with the scientific community in EU and non-EU countries. Due to the inter-linkages between climate change action and other socioeconomic and environmental aspects, including air pollution and land use, present and future climate change policies will have profound effects on other objectives that the EU is pursuing, in particular regarding the protection of human health, biodiversity and natural and built environment.

3 http://www.ipcc.ch
4 http://unfccc.int
5 Commission Staff Working Document, SEC(2008) 3104 final
6 http://www.consilium.europa.eu/ueDocs/cms_Data/docs/pressData/en/ec/93135.pdf
7 Ref. White paper

As indicated below, the role of research to tackle climate challenges in the context of international policies and actions to combat climate change is pivotal. Its importance is becoming more evident in the knowledge-based society of the 21st century, where the role of science in policy making is pervasive, providing problem analysis, new knowledge and concepts and innovative solutions.

A SUBSTANTIAL RESEARCH EFFORT IS NEEDED

A substantial and coordinated European research effort is needed to tackle the climate challenges and to deliver the needed supporting methodologies, indicators, models, guidance, practical experiences, standards, tools and technologies.

In the light of current EU climate policies, the following climate research priorities in Europe and beyond have been identified:

Future climate, an issue of scale: There is a recognised need to improve climate projections at regional and local scale, including for cities, and on shorter-term timescales (years to few decades) and to quantify climate impacts on the quality of our environment (air, water and soil) as well as the probability of changes in the frequency and intensity of extreme weather events. Improvement of longer-term projections of climate change (21st century and beyond) is also needed, in order to assess trends and the potential for abrupt and irreversible changes in the climate system.

Suitable Global actions: Research should assess the feasibility, implications and affordability of actions associated with the proposed global targets in Europe and globally. Emphasis should be given to the 2°C target (endorsed by the EU, the G20 and the Copenhagen Accord). Research should also consider other types of targets and quantify the regional impacts on both humans and nature. In addition, the socio-economic implications of reaching the global targets must be carefully assessed, including costs, risks and impacts.

Adaptation to the effects of climate change: Building upon a strong information base, research should identify appropriate options and develop technologies for adaptation, with the goal of enhancing the adaptive capacity of societies, ecosystems and economic sectors to the adverse effects of climate change. Research on adaptation should contribute to, *inter alia*: 1) developing methodologies, observation systems and prediction tools for the assessment of present and future impacts and vulnerabilities; 2) identifying adaptation options and assessing their effectiveness and their potential impacts, costs and benefits; both costs of action and costs of inaction shall be considered; 3) defining policy choices and relevant institutional and financial frameworks; 4) developing quantitative and evidence-based methods for the evaluation of adaptation policies and measures. In addition, adaptation to temperature changes higher than the 2°C target should be considered. Adaptation considerations should also be included in research activities all relevant policy sectors; 5) enhancing the understanding of behavioural and institutional changes, of the cognitive aspects of climate risk perception, and of the communication of uncertainties. Finally, attention should be given to the dissemination and communication of adaptation knowledge, in particular via the EU Clearinghouse[8] on adaptation that will be launched in 2012.

Vulnerability and resilience to climate risks: There is a need to assess and quantify vulnerability and increase societal resilience to climate change and its associated disaster risks through improved assessment of impacts and multi-risks analyses, as well as enhanced

[8] The concept note of the EU Clearinghouse is available at the following internet address: http://circa.europa.eu/Public/irc/env/cc_impacts/library?l=/public_1

disaster risk reduction strategies and response. Key areas include: human health, vulnerable ecosystems, important economic sectors and infrastructure. Important challenges at global level, such as ocean acidification due to increased CO2 emissions, should be urgently addressed.

Climate services: The World Climate Conference-3, held in late 2009, established a Global Framework for Climate Services in order to strengthen production, availability and application of science-based climate prediction and services. Successful development of such services will require innovative solutions in the following areas: long-term observing systems with global coverage, further development of models, data analysis and forecasts systems across a range of timescales (seasonal, inter-annual, decadal). In addition the establishment of successful provider-user partnerships and an open-access policy for data and information are essential.

Detecting and attributing climate change: We have enough scientific evidence to start acting through adaptation and mitigation measures. However, a better understanding of the causes and evolution of climate change will allow us to act with greater efficiency and accuracy.We need to further understand the fundamental processes governing past and present climate, in order to better detect and attribute climate change (e.g. human vs. natural influence) and distinguish climate change trends from climate variability.

Technologies and mechanisms for major emission reductions: As for the current decade, greenhouse gases emission reductions are essentially an implementation issue with currently available and near-market technologies. Meeting our ambitious longer–term (2050) reduction targets also requires strengthening of research and innovation activities on key mitigation technologies, which are most often enabled by information and communication technologies, and methodological options. These include the promotion of: energy and resource efficiency, user's behavioural modifications and adaptive pricing of emission patterns enabled by ICT, renewable energies, carbon capture, storage and re-use, alternative fuels, and reduced emissions from land-use, land-use change and forestry (e.g. agriculture and deforestation). In addition, the costs, risks and impact of technologies and mechanisms must be carefully assessed.

Policy coherence: Given the cross-cutting nature of climate mitigation/adaptation policies and measures, and in view of exploiting synergies and identifying and avoiding potentially detrimental interactions with other policies, there is an additional need for research on the coherence of climate policies with respect to other relevant policies of the European Union and its Member States and regions.

RESEARCH ORIENTATIONS OF THE JPI CLIMATE

The proposed JPI intends to contribute to some of these key research challenges. The JPI Climate proposes a multi-disciplinary approach for joint programming, encompassing the economic, ecological, societal and technological facets of the climate challenges with four main research targets. It will attempt to set the framework for the crucial contribution of science to establishing a learning community across Europe capable of developing sustainable and resilient European societies. To this end, the JPI Climate proposes a systemic approach that links the fundamental questions about the dynamics of natural and social systems driven by environmental changes, the interactions and feedbacks involved, and the risks and challenges to societies and their environments. In the context of this JPI, "climate knowledge" is understood in a broad sense, including all kinds of scientific knowledge on causes and consequences, risk assessment, costs and benefits of climate change, as well as possible responses. The JPI has identified four major research strands that need to be developed:

(1) Future climate projections and need for more accurate information

Based on the existing Earth System Models (ESM) we are able to estimate the amount of temperature increase over the next 100 years (mainly as function of different emissions-scenarios). These climate projections are based on mathematical representations of the climate system in numerical models and forced by assumption of future emissions of greenhouse gases. There is increasing confidence that such models can represent the physical processes that are necessary for reliable simulations of future climate changes.

Models continue to improve. Their complexity and resolution increases with growing computer power and they become capable to resolve smaller-scale features, as changes in extreme weather events. Further improvements in regional-scale representation are expected along with expansion of computing facilities. A large gap, however, exists in the field of future perspectives regarding climate variations and changes between the timescales of weather forecasts and century-long climate projections, as provided by the IPCC-scenario climate simulations.

As economic and other societal planning horizons usually span the next 10 to 15 years, decision makers are mostly requesting information on developments on the a decadal timescale. But predictions at shorter timescales might raise the awareness of the rate at which the climate is actually changing. In turn this would be an enabler for realising change through societal actors. Thus, the next step in climate research must address - in a novel model approach - the development of a decadal climate prediction system which will provide reliable information on climate changes (including extremes) on this decadal scale. As part of a common European research framework it is necessary to ensure that the outcome of decadal predictions can also be interpreted on a regional and sub-regional scale.

This research topic represents one of the pressing issues in climate research to provide climate predictions at all of the relevant timescales required by the end-users.. It is also part of the agenda of the World Climate Research Program (WCRP) under the synonym of “seamless prediction”. As such, an extension to a global decadal climate prediction system should be envisioned.

Different sources of uncertainty have also to be considered in climate predictions and modelling, in particular those arising from natural fluctuations of the climate system, from imperfect predictability of future greenhouse gases emission scenarios of, and from intrinsic modelling uncertainties and limitations affecting decadal predictions. Research should address

these most important reasons of uncertainty for European climate predictions on decadal timescales.

(2) Needs for better climate services

The science community finds itself increasingly exposed to various groups of stakeholders asking specific questions about consequences, probabilities and uncertainties related to climate change. Such actors are decision-makers and other stakeholders from Member States administrations, industry and other private enterprises, other policy and planning institutions as well as scientists using data for climate-related research. However, although future climatic conditions for specific regions and timeframes can be estimated with the aid of a broad array of tools developed from climate research efforts, it is worth noting that each model has its strengths and weaknesses, for instance due to particular underlying assumptions or approximations. While these limitations are of great significance for the reliable interpretation and use of different climate scenarios, research should look at ways to communicate this information in a more transparent and comprehensible way to the end-users. At the present time, the communication of climate knowledge to decision-makers and relevant stakeholders is not based on a structured approach. In many cases the complexity of such a task seems to go beyond the capacity of existing management and policy instruments. Nevertheless, many users do in fact routinely deal with available climate change information and take decisions on the basis of their understanding. Most of them lack the expertise to appropriately translate data from e.g. climate models and scenarios into the context of their concrete decisions or applications. Scientists find themselves often challenged to assist users in understanding this information, including the nature of its uncertainty and the choice of optimal tools for their needs (which could be climate projection tools but also more qualitative decision making tools).

This calls for an enhanced interface between science and policy and is one of the reasons why it was stressed (e.g. during WCC-3[9]) that relevant climate knowledge must not only be made available, but also contextualized and interpreted so that decision makers are empowered to act upon this information. The term "climate services" refers to the fact that usually consultations between scientific and non-scientific experts are needed before climate information can be employed appropriately in strategic planning. Ideally, data would be prepared or even generated with the application in mind and appropriately put into perspective (e.g. user driven scenario development).

Besides communication and organizational aspects, the provision of climate services does pose a number of genuine challenges regarding the methodological basis and the understanding of the role and limits of science. Addressing such challenges will be key to fully tap into the potential of the EU knowledge base for the purpose of climate service delivery. Such challenges include:

Understanding the customer side: In order to make modelling and scenario output useful for concrete decision-making and to encourage appropriate use of information generated through modelling approaches, it is essential to comprehend how decision makers both in private and public sectors make use of scenarios and how climate information is processed.

Survey of the supply side: There is a wealth of experience on how to organize participative scientific processes to ensure an involvement of relevant stakeholders and allow reaching results that meet their real concerns. It would be useful to assess and

[9] WCC-3 reference

compare different approaches in the field of climate service development, e.g. considering the development of standard methodologies, feedback processes into the modelling community and the climate sciences, etc.

Other potentials for cooperation: Further fields of cooperation could include, for example, co-operation on scientific and methodological connectivity, ensuring data access and interoperability, and standardization. It is important to increase comparability and compatibility of climate data also across borders. There is potential in particular for more consistency in data formats, data storage and data provision. Cooperation could also include methodological approaches (e.g. downscaling techniques).

(3) Better understanding societal transformations

Approaches to climate change are based predominantly on natural sciences, technological innovation and – more recently – economics. There is an urgent need, however, to address through multi-disciplinary approaches the broader societal context if quality of life is to be maintained and improved in a sustainable manner in the face of climate change. In particular, it is important that social sciences are integrated into research efforts at an early stage, in order to better understand the social dimensions of climate change. This will include research into potential social, economic and political problems which are expected to be determined by climate change, as well as the possible challenges, conflicts, trade-offs and opportunities which are likely to be brought about by mitigation and adaptation measures.

Successful response to the challenges of climate change – in terms of mitigating the risk of climate impacts on society as well as building societal capacity to cope with inevitable consequences – requires scientific insights on both potential and expected impacts of climate change on societies and economies as well as a thorough understanding of conditions for innovative response strategies. Such societal aspects must encompass the awareness of the challenges (e.g., physical and economic impacts), the commitment to tackle them (e.g., planning horizons, responsibilities) and the resources (e.g., financial means, human resources) to deploy response measures. In particular, the need to engage in large scale and cross-cutting information and training on climate change, especially on adaptation, requires further research as most organisations (companies, administrations) are not prepared.

One particular societal aspect already affected by climate change is human health. Direct consequences such as higher mortality due to heath waves in Europe are already observed and expected to increase by 30 000 deaths per year by 2030[10]. In addition, a series of indirect consequences linked to air and water quality, redistribution of communicable diseases as well as increased migration represent major threats to human health for which appropriate and integrated responses will have to be developed if a satisfactory level of wellbeing is to be maintained.

Europe has taken a lead in the global efforts to reach an agreement on climate change mitigation and adaptation and intends to continue to do so. These efforts aim to establish Europe as a best-practice example of a sustainable yet wealthy society. Hence, the demonstration that high quality of life is compatible with a "carbon free" society with significantly reduced resource demand and usage is a question at the heart of Europe's credibility and its future societal and economic stability. Although the future face of European societies and the pathways to get there will differ according to specific traditions and characteristics of individual countries, a joint European effort to develop visions of transition

[10] PESETA report http://peseta.jrc.ec.europa.eu/docs/Agriculture.html

and understand possible pathways holds the promise to be much more successful than individual attempts.

(4) Needs for improved decision-making

In order to meet the EU climate objective for 2020 and the envisaged transition to a low carbon economy by 2050, Europe is facing a structural transformation which may have to be profound in some areas. How to shape this transformation whilst promoting prosperity and welfare is one of the crucial challenges of our time. We may trade-off greenhouse emissions stabilization levels and their potential climatic consequences against the costs, risks and benefits associated with the measures required for reaching such levels. To this end, risks, costs and benefits of different mitigation and adaptation options need to be explored and communicated in an intelligible way to decision makers.

There is a wealth of models available to support strategic decisions in response to climate change, but the scope of analytic approaches used by different communities is far from consistent. For example, robust assessments of low-stabilization pathways consistent with the 2°C stabilization goal of the EU are not really available. The same is true for the development of robust adaptation strategies, which require deeper understanding of impacts and vulnerabilities. Also risks and uncertainties regarding the stability of societies must be taken into account as well as non-monetary valuation methods or instruments to quantify damages not expressed in monetary terms. Those are barely available, which makes it difficult to express for example indirect and higher-order economic effects of climate change impacts (like welfare implications from ecosystem change).

The IPCC process revealed another shortcoming: there is still a lack of consistent socio-economic scenarios allowing robust assessment of adaptation and mitigation strategies in conjunction. There is, however, little incentive for each of the modelling communities to start and define interfaces and move towards interlinking of models and tools. This is why the JPI Climate proposes a model inter-comparison platform as part of this joint programming initiative, which would be challenged to work towards a robust understanding of various possible development pathways consistent with EU climate policy and projected climate futures. This approach would be complemented by a European Integrated Modelling Forum aiming to harness the collective capabilities of participating experts from Europe and beyond, including both modellers and users of models on an equal footing, to contribute to the consistency and coherence of various approaches and also to identify high priority directions for future research.

RESEARCH ACTIONS AT MEMBER STATES LEVEL

The JPI Climate has performed in 2011 a first inventory of public climate research programmes operated by the Member States involved in the JPI. Based on the preliminary mapping carried out by the JPI Climate, the cumulated research effort of these twelve Member States (and of Associated States) is roughly estimated to overtake an overall public investment of 140 Mio € per year. In its first assessment, the JPI Climate has identified more than forty key research programmes addressing climate challenges in the twelve JPI Member Countries.

The stratregic orientations for climate research often lies with various Ministries with focus ranging respectively from education, culture, research and innovation to environment, ecology and sustainable development, agriculture and forestry or economic affairs and industry. These ministries are often supported by one or several research Councils, Departments, Agencies, Academies of Foundations to update their strategic research planning and implement a range

of national research programmes. The mapping indicates that a majority of the JPI Partner Countries run climate-specific programmes that vary in scope from fundamental to applied research, development, innovation and research in support of decision-making regarding mitigation or adaptation options.

Among those climate-dedicated programmes, the most often referenced themes include research on the understanding of the climate system and the consequences of climate change, studies of adaptation and mitigation options (in support of national climate change adaptation/mitigation strategies), and their mutual interrelation. Research programmes also cover the development of observation systems.

Information on the state of research in Member States is, however, still fragmented and non-homogeneous. The above estimate of 140 Mio € per year only concerns the twelve Member countries, and it is not yet possible to provide budget figures for the EU Member States as a whole. A very short overview of relevant programmes and research actors in the Member States concerned is reported below. It is based on the Country Summary Reports compiled by the JPI Climate in their maturity template delivered in early June 2011 as well as additional information collected from other countries which are not part of this JPI (Iceland and Spain). Revisions of the research mapping are foreseen as the initiative will develop:

In **Austria** the Austrian Climate Research Programme (ACRP) was created in 2008 under the auspices of the Austrian Climate and Energy Fund. It promotes climate- and energy-related research in Austria through regular calls for research proposals, and is planning to initiate a platform – the ACRP Forum – to ensure the integration, mutual cooperation, external visibility and international outreach of ACRP-funded research activities. In addition, the Ministry of Education, Science and Culture has launched the proVision (provision for nature and society) programme running for the period 2004-2013, which investigates the impact of climate change on ecosystems, regional development and quality of life; the programme seeks to establish long-term cooperation between science and practice and supports Austrian researchers involved in international research projects. Finally, the research programme StartClim was launched in 2002 by the climate research initiative AustroClim in the form of a flexible instrument funding short term projects (focusing on climate change adaptation) on an annual basis. The annual research budget reported in the mapping has been estimated to 4.1 Mio €.

In **Belgium**, the Belgian Science Policy Office (BELSPO) is funding climate and atmosphere-related research within the framework of the Science for a Sustainable Development programme (2005-2012) which contributes to developing scientific knowledge and instruments aiming to analysing the processes, studying the impacts and evaluating policy measures, thereby promoting dialogue and information exchanges between scientists, decision-makers and other involved actors at international, European and national levels. The annual research budget reported in the mapping has been estimated to 9 Mio €.

In **Denmark** the Danish Council for Strategic Research provides funding on a yearly basis (since 2009) to projects dealing with climate adaptation, including coastal protection, climate sensitive industries such as agriculture and industry, sewerage and building, urban infrastructure, health and prevention etc. Research is focused on a greater understanding of how human activities affect the climate in interaction with natural processes. The challenge is to increase the proportion of renewable energy and reduce dependence on fossil fuels, ultimately aiming to create a renewable and

environmentally sustainable energy system. The annual research budget reported in the mapping has been estimated to 5 Mio €.

In **Finland** the National Basic Research Programme on Climate Change (FICCA) of the Academy of Finland, running from 2011 to 2014, promotes multidisciplinary expertise and research environments in order to intensify research on climate change and achieve synergy benefits. Another programme, the Finnish Funding Agency for Technology and Innovation (Tekes), launched in 2011 and running until 2014, funds programmes on Low Carbon Economy in cooperation with business organisations and associations, companies, universities, research institutes and public administrations. The annual research budget reported in the mapping has been estimated to 3 Mio €.

In **France** several research programmes are currently funding research initiatives related to climate change. The National Research Agency (ANR) plays a growing role in funding research project in the field of climate change research through the Research Programme on Global Environmental Changes & Societies (GEC&S). The emphasis is on improving the understanding of global environmental changes and supporting better governance on adaptation and mitigation issues, taking account of social and human dimensions. The Ministry of Ecology, Sustainable Development, Transport and Housing (MEDDTL) finances since 1999 a research programme on Management and Impacts of Climate Change (including adaptation issues), which focuses on the development of knowledge to support policies on climage change in France. The programme (GICC) promotes multidisciplinary projects, mixing on the one hand physical and biological sciences for a better knowledge of the impacts and social sciences to explore mitigation and adaptation options on the other hand. Another programme started in 2006 and running until 2011, the LEFE programme (Liquid Coatings and the Environment), funds projects aiming to increase fundamental knowledge in various physical, chemical and biological processes in the atmosphere and oceans and their interactions with land surfaces and ecosystems, and to develop and operate state-of-the-art observation systems and prediction models. Finally, the French Climate Modelling Infrastructure supports the development and use of two global climate models representing the complexity of the earth climate system. These models are extensively used for climate projections (IPCC AR4, AR5) and to investigate mechanisms of climate variability. Global climate models are used for impact studies and to force regional models. The annual research budget reported in the mapping has been estimated to 57 Mio €.

In **Germany** climate change research is also funded by several programmes. The main sources of funding is from the Federal Ministry of Education and Research (BMBF): The C3Grid-INAD programme (2010-2012) aiming to extent the existing infrasctructure for general access to climate data, in particular for enhancing and facilitating the cooperation of researchers of different institutions. The Climate Service Center (CSC) depending of the same ministry provides knowledge about the climate system, data of regional simulations and long term monitoring data in Germany of various climate variables. The programmes started in 2009 and will run until 2013. Another programme, called KLIMZUG (Managing Climate Change in the Regions for the Future), is running during the period 2008-2014. It is complemented by the MiKlip programme on Decadal Climate Predition (2008-2014) which develops a system for climate predictions for up to a decade ahead with the final goal to establish a decadal climate prediction system that can be applied by an operational agency such as the German Meteorological Service. The IAGOS

programme (In-service Aircraft for a Global Observing System) is another initiative running during the period 2011-2015, which has the objective to install new instruments in airplanes of the civil aviation in order to take measurements of the composition of the atmosphere, aerosols, clouds and condensation trails. A further programme, ICOS (Integrated Carbon Observation System) is a new European research infrastructure launched in 2011 (until 2014) for quantifying and understanding the greenhouse balance of the European continent and its adjacent regions. The IPPC-AR5 Data Pool project (2009-2014) is funded to install and operate the German data pool as part of the IPCC 5th Assessment Report data federation. Finally, the CMIP5 Consortial Calculations Programme (2010-2012) provides a German contribution to the data base for the IPCC 5th Assessment Report and a data base for national developments of adaptation and mitigation strategies through state-of-the-art global and regional climate projections. The annual research budget reported in the mapping has been estimated to 31.3 Mio €.

In **Ireland** the Climate Change Research Programme (CCRP) funded by the Department of Environment focuses on greenhouse gas (GHG) management systems, Ireland and future climate, climate solutions and transition management, transboundary air pollution and short-life climate forces. The programme started in 2008 and runs until 2013. The annual research budget reported in the mapping has been estimated to 3.6 Mio €.

In **Italy**, the Strategic Programme for Sustainable Development and Climate Change has been launched in 2005 under the umbrella of the Italian Ministries of Environment, Land and Sea, of Education, University and Research, and of Agriculture, Food and Forestry. The programme aims to support research on climate, climate change, vulnerability and impact assessments, climate observations and modelling, studies of innovative instruments for the implementation of the Kyoto Protocol and of soil carbon sinks, socio-economic impacts of climate change on energy, industry, insurance, transport and tourism, as well as on aquatic ecosystems, biodiversity, human health, marine biology, forestry, agriculture, and the Mediterranean area. This is complemented by the AgroScenari large-scale research project funded by the Ministry of Agriculture (2008-2013) which aims to identify and assess adaptation measures to climate change for some major Italian agricultural production systems. Finally, the Sino-Italian Cooperation Programme for Environmental Protection launched by the Ministry of Environment in 2000 funds cooperation projects with China in areas including climate change adaptation. The annual research budget reported in the mapping has been estimated to 1.6 Mio €.

In **Spain**, the Ministry responsible for research, development and innovation is MICINN. Three Directorate Generals are directly related to this JPI, covering the areas of Research, Technology Transfer and International Affairs. Within the "Plan Nacional de I+D+I" – the Spanish National Plan for Research, Development and Innovation – climate research is mainly funded through the National Programme for Fundamental Research. Other Programmes related to Innovation, applied research or International activities devote additional funds to climate issues. The National Plan covers all areas of science and technology. There are no scientific priorities as such, although five major horizontal strategic areas have been identified, including climate change. The National Programme for Fundamental Research funds research projects targeting Universities and Research Institutes. These projects are intended to address scientific and technological problems identified within the scientific community. Stakeholders can be involved, but funding can only be applied to two types of private

entities: Technological Centres and non-profit institutions. Proposal evaluation focuses on scientific and technological excellence. Innovation activities can be funded through a number of specific calls for proposals, including the INNPACTO and CENIT projects. National organizations are targeted in these programmes, and evaluation takes innovation into consideration, assigning less importance to scientific excellence. No budget figures have been provided.

In **The Netherlands** the Netherlands Organisation for Scientific Research launched a programme in 2011 (running until 2014) on Water and Climate, which focuses on the exploration of gaps in our understanding of the global climate system linked to water-related processes, such as the role of water vapour and clouds in the enhanced greenhouse effect, continental drought and the role of vegetation linked to it, dynamics of extreme precipitations, and the role of water in the tropospheric and stratospheric circulations. Besides, the Ministry of Economic Affairs and the Ministry of Infrastructure and Environment jointly finance the Knowledge for Climate programme (KfC) which started in 2008 and will run until 2014. This programme aims to develop the knowledge needed to climate-proof the Netherlands. It relates to regional, national and international adaptation strategies focused on hotspots with a time horizon of up to 2050 and in certain cases up to 2100. The annual research budget reported in the mapping has been estimated to 8.2 Mio €.

In the **United Kingdom**, the Natural Environment Research Council (NERC) is the main research funding organisation for climate change research along with the UK Met Office. The Joint Weather & Climate Research Programme (JWCRP) started in 2009 as joint initiative between NERC and the UK Met Office with the objectives to ensure that the UK has access to internationally competitive tools and infrastructure for maintaining its world-leading national capability in observing, understanding, modelling and predicting weather and climate and their impacts. Similarly, NERC and the UK Met Office along with the Science and Technology Facilities Council (STFC) fund the Next Generation Weather & Climate Prediction (NGWCP) programme to ensure that the UK has access to world class tools for climate prediction in the future; the programme runs from 2010 to 2014. NERC is also funding a wide range of programmes relevant to the JPI Climate, namely: the APPRAISE programme (2005-2014) on Aerosol Properties, Processes and Influences on the Earth's climate; the FREE programme (2005-2010) on Flood Risk from Extreme Events; a programme on Storm Risk Mitigation through Improved Prediction & Impact Modelling (2009-2013); the RAPID-WATCH programme (2007-2013) aiming to deliver a decade-long time series of the strength and structure of the Atlantic Meridional Overturning Circulation (MOC); the QUEST programme (2003-2010) on Quantifying and Understanding the Earth System; a research programme on Quantifying Uncertainty in Predictions of Climate Change & Climate Impacts (2009-2011); a programme on Aerosols and Clouds (2010-2014); an Artic Research Programme (2010-2014); a programme focused on Changing Water Cycle (2009-2013); the Ocean Surface Boundary Layer programme (2010-2014) aiming to develop a fundamental improvement in weather and climate prediction on timescales from a few days to centuries. NERC has also launched in 2010 a Knowledge Exchange Funding network to connect NERC-funded science to those organisations that will develop climate services in the UK. Finally the Living with Environmental Change programme runs over 10 years (2010-2019) with the objective to optimise the coherence and effectiveness of UK environmental research funding and ensure government, business and society have the foresight, knowledge and tools to

mitigate, adapt to and capitalise on environmental change. The annual research budget reported in the mapping has been estimated to 14 Mio €.

Joint activities are also developed by Denmark, Finland, Iceland, Norway and Sweden:

The Top-level Research Initiative (TRI) sub-programme on Effect Studies and Adaptation to Climate Change aims to improve knowledge about society's capacities for adaptation and the risks and opportunities that the effects of climate change may bring the Nordic region. This sub-programme was opened in 2009 and will run until 2014. Another TRI sub-programme focuses on Interaction between Climate Change and the Cryosphere, aiming to reinforce Earth System research cooperation in the Nordic region and beyond, to improve our understanding of the cryosphere stability and dynamics, to specify cryosphere parameters in the Earth System models and to support science driven questions of high interest to society, science, industry and/or national infrastructure. The sub-progeamme was launched in 2010 for a period of five years. Its annual research budget reported in the mapping has been estimated to 4.8 Mio €.

ACTIONS AT EUROPEAN LEVEL

Policy dimension

The international climate policy is driven by the UNFCCC[11] process, in particular by the recognition that global warming should not exceed 2°C above the pre-industrial level, which is equivalent to 1.2 °C above today's level (taking into account that currently global temperature has increased already by approximately 0.8°C over the past hundred years). Climate change research[12] in the context of UNFCCC will have to answer the central question of the feasibility and regional implications of this target and how efforts could be shared. UNFCCC also calls for adaptation actions aimed at minimising the adverse impacts of climate change. In addition, the preparation of the 5th Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) which will assess new scientific results will provide solid ground for policy making as part of a continuous process.

The European Council of March 2010 supported the five headline targets of the Europe 2020 Strategy, which includes climate and energy. It highlights the importance of structural and technological innovation changes required to move to a low carbon, resource efficient and climate resilient economy by 2050. This will allow the EU to achieve its emission reduction targets and to strengthen the capacity for disaster prevention and response. This process is central to society and has to be backed by a broad knowledge base fed and updated continuously by sound science and research for decreasing vulnerability to climate risks.

The EU is committed to a 20% emission reduction below 1990 levels in 2020, and to reach a 30% reduction on a conditional basis. Following the Communication on International Policy Post-Copenhagen[13], the Commission is now preparing a new communication on assessing the impacts of lifting the ambition level beyond 20% for greenhouse gas emission reductions by

[11] United Nations Framework Convention on Climate Change

[12] Research on climate change has been defined according to IPCC and UNFCCC frames as research contributing to: (1) understanding of the past, present and future of the climate system and its processes, (2) quantification of climate change impacts on humans and nature, (3) identification and assessment of mitigation and adaptation options

[13] Communication from the Commission – International climate policy post-Copenhagen: Acting now to reinvigorate global action on climate change, COM(2010) 86

2020[14]. In this context, research will be engaged towards a low-carbon society to reach the emission reduction target.

While with the climate and energy package legislation adopted in 2009 the EU already has a binding greenhouse gas reduction target for 2020, the EU has also started analysing long-term strategies to move beyond this up to 2050. In February 2011, the European Council reconfirmed the EU objective of reducing greenhouse gas emissions by 80-95% by 2050 compared to 1990, in the context of necessary reductions according to the Intergovernmental Panel on Climate Change by developed countries as a group. Only this level of ambition will make it possible to keep climate change below 2ºC.

Achieving these deep emission cuts will require a transition to a climate friendly, low carbon economy. With its "Roadmap for moving to a competitive low-carbon economy in 2050", which is contributing to the Resource Efficient Europe flagship initiative As a part of the Europe 2020 strategy for smart, sustainable and inclusive growth, the European Commission is looking beyond these 2020 objectives and setting out a plan to meet the long-term target of reducing domestic emissions by 80 to 95% compared to 1990 by mid-century.

The Roadmap shows how the sectors responsible for Europe's emissions - power generation, industry, transport, buildings and construction, as well as agriculture - can make the transition to a low-carbon economy over the coming decades. The Roadmap provides guidance on how this transition can be achieved in the most cost-effective way, giving insights into what type of technologies and actions need to be implemented and what type of policies the EU will need to develop over the next 10 years and beyond. The Roadmap, based on a comprehensive economic modelling and scenario analysis, also reccomends that the EU meet its emission reductions objective of 80 to 95% largely through internal measures, as well as through Investments and other instruments to support the transition to low carbon economy. Research and development is part of this long term strategy.

Even if we succeed in limiting GHG emissions, our planet will take time to recover from the greenhouse gases already in the atmosphere, and we need therefore to take measures to adapt to inevitable climate change. In April 2009 the European Commission presented its White Paper *"Adapting to climate change: Towards a European framework for action"*[15] which presents the framework for adaptation measures and policies to reduce the European Union's vulnerability to the impacts of climate change. The White Paper outlines four key areas for EU action (developing the knowledge base, mainstreaming adaptation into EU policies, financing, international cooperation on adaptation) which will lay the ground work for the establishment of a comprehensive EU Adaptation Strategy, to be communicated in 2013.

Research Programmes

This section describes main climate change research orientations of past and current EU-funded programmes. For the purpose of the present Staff Working Paper, taking into consideration the scope of the JPI Climate, we considered climate change research as related to the following activities: (1) understanding the past, present and future of the climate system and its processes; (2) quantifying climate change impacts on humans and nature; and (3) identiying and assessing mitigation and adaptation options. In addition, the EU also funds other climate-related research, which covers the development of technologies and practices leading to low-carbon and climate resilient society. The latter will only be described in

[14] Unlocking Europe's potential in clean innovation and growth: Analysis of options to move beyond 20%

[15] COM(2009) 147

relation to FP7.

Climate change research

Climate change research has been considered in the European Commission's RTD Framework Programmes since the 1980s, in particular with projects dealing with global change impacts on water resources. During the 4th Framework Programme (1994-1998), the Environment and Climate Programme supported research projects and networks of excellence in four areas, including "research into the natural environment, environmental quality and global change", the aim of which was to understand the basic mechanisms of the climate and natural systems and their impact on resource management.

In the 5th Framework Programme (FP5, 1998-2002), the Thematic Programme "Energy, Environment and Sustainable Development" included the Key Action "Global Change, Climate and Biodiversity", the aim of which was to develop the scientific, technological and socio-economic basis and tools necessary for the study and understanding of changes in the environment. Projects emphasised global and regional environmental problems that may have a significant impact on Europe, such as climate change, ozone depletion, biodiversity loss or loss of habitats and fertile land. Priority was given to issues covered by international treaties or conventions where the European Community or its Member States are signatories. Integration and synthesis across global change problems received particular attention. This was complemented by the European Network for Research into Global Change (ENRICH), the objective of which was to increase the effectiveness of the Key Action by enlarging its scope in a wider international and global context. Overall, the funding of projects falling under this Key Action approached 300 Mio €.

During the 6th Framework Programme (FP6, 2002-2006), climate-related research was covered by the Thematic Area "Sustainable Development, Global Change and Ecosystems", in particular by the sub-priority "Global Change and Ecosystems" aiming to strengthen the necessary scientific knowledge for the future orientation of the 2001 Sustainable Development Strategy and of the 6th Environment Action Programme while providing the socio-economic tools and assessments and the overall management practices. More specifically, one of the objectives of the sub-priority was to strengthen the capacity to understand, detect and forecast global change and develop strategies for prevention, mitigation and adaptation, in close liaison with the relevant international research programmes and in the context of relevant conventions. Among the seven research areas addressed by the "Global Change and Ecosystems" sub-priority, several addressed directly or indirectly climate change research, in particular the area on "Impact on mechanisms of greenhouse gas emissions and atmospheric pollutants on climate, ozone depletion and carbon sinks", sub-areas dealing with hydrology and climate processes and ecological impact of global change within the "Water cycle, including soil-related aspects" area, the area "Mechanisms of desertification and natural disasters", and the area on "Operational forecasting and modelling including global climatic change observation systems". In addition, one ERA-Net was initiated in FP6, dealing with "Climate Impact Research Co-ordination for a Larger Europe" (CIRCLE). The overall investment in FP6 for climate change research as reported to UNFCCC[16] was estimated at around 350 Mio €.

Within the 7th Framework Programme (FP7, 2007-2013), climate change research is mainly addressed in the context of the "Environment (including climate change)". Theme, which covers integrated research on the functioning of climate and the earth and marine system, including the polar regions, in order to observe and analyse how these systems evolved in the

[16] Report to the UNFCCC, Commission Communication COM(2009)66

past and predict their future evolution including observations (linked to the GEO initiative), experimental studies and advanced modelling and taking into account the anthropogenic forcing. Research addresses the development of effective adaptation and mitigation measures to climate change and its impacts, with particular consideration of the economic and social dimension. Advanced climate change models from the global to the local scale are developed and validated. These models are applied to assess changes, potential impacts and critical thresholds (e.g. for ocean acidity). Changes in atmospheric composition and in the water cycle are studied and risk based approaches are developed, taking into account changes in droughts, storms and floods patterns. Quantification and study of carbon and greenhouse gases (including aerosols) budget are also undertaken. Pressures on environmental quality and on climate from natural and anthropogenic pollution of the air, water and soil are investigated as well as the interactions between the atmosphere, the stratospheric ozone layer, land surface, ice and oceans. Finally, consideration is given to feedback mechanisms and abrupt changes (e.g. ocean circulation), and to impacts on biodiversity and ecosystems, including the effects of sea level rise on coastal zones, and impacts on sensitive areas such as mountain regions.

An estimate of the FP7 EU investment in climate research projects of relevance to the JPI Climate scientific objectives is of the order of magnitude of 150 Mio € per year, approximately of the same size of the annual mean public investments of EU Member States estimated by the JPI Climate itself.

Climate-related research

Climate and climate-related research are also covered by other components, in particular in the themes Energy, ICT, Space, Transport, Food, Agriculture and Fisheries, and Social Sciences and Humanities, as well as by Joint Research Centre (JRC) activities. Some FP7 activities are reported below, together with horizontal actions, such as those for research infrastructures.

The objective of energy research under FP7 is to aid the creation and establishment of the technologies necessary to adapt the current energy system into a more sustainable one, less dependent on imported fuels. Such a system would be based on a diverse mix of energy sources and carriers, with particular attention being paid to lower and non-CO_2 emitting energy technologies, combined with enhanced energy efficiency and conservation, to address the pressing challenges of security of supply and climate change, while increasing the competitiveness of Europe's industries. This includes, beyond renewable energy sources, also energy efficiency, smart grids and carbon capture and storage.

The objective of the Transport (incl. Aeronautics) theme of FP7 is to develop integrated, safer, "greener" and "smarter" pan-European transport systems for the benefit of all citizens, society and of the environment, and for enhancing the competitiveness of the European transport industry in the global market. The activity "The Greening of air transport", for example, aims at developing technologies to reduce the environmental impact of aviation, in order to halve the emitted carbon dioxide, cut specific emissions of nitrogen oxides by 80% and halve the perceived noise. With regard to surface transport, the activity "Greening of surface transport" has the aim of developing technologies and knowledge for reduced pollution and environmental impact on areas such as climate change, health, biodiversity and noise.

In addition, initiatives such as the Clean Sky JTI promise to deliver significant results in terms of more sustainable products and services. It will demonstrate and validate the technology breakthroughs that are necessary to make major steps towards the environmental goals sets by the Advisory Council for Aeronautics Research in Europe (ACARE) and to be reached in

2020, such as 50% reduction of CO_2 emissions through drastic reduction of fuel consumption, and 80% reduction of NOx emissions.

Launched in November 2008, the European Economic Recovery Plan[17] includes components which are directly relevant to climate change research. In particular, the European Green Cars Initiative (EGCI) aims to help the European automotive industry become more competitive through the development of more environmentally friendly vehicles. The scope of EGCI is very wide covering all road vehicles (i.e. passenger cars, buses and trucks), infrastructures and the performance of the transport system as a whole. The long-term research goals of EGCI are: the electrification of road and urban transport, greener heavy goods vehicles, better bio-fuels (second-generation), and logistics. Another component is the Energy-efficient Buildings (EeB) PPP which will devote approximately € 1 billion in the period 2010-2013 to address the challenges that the European construction sector and its extended value chain are facing in their ambitious goal of researching new methods and technologies to reduce the energy footprint and CO_2 emissions related to new, renovated and historical buildings.

Considering that agricultural activities have a considerable impact on - but are also directly affected by - climate change, the Biotechnologies, Agriculture and Food Theme (KBBE) pays special attention to agriculture-related climate change issues in its annual work programmes. Several projects have been funded to identify sustainable mitigation and adaptation options for reduction of GHG emissions in the food and feed production chain - including fisheries (e.g. joint call "Ocean of tomorrow") and aquaculture. Climate change aspects are also addressed by recently selected projects on agricultural soil management, on the potential spread of pests and pathogens in crops and forests - triggered by climate change - on biomass production for greener energy, and on the climate-driven changes in European forest biodiversity and productivity. In line with the above strategy, the KBBE work programme for 2012, continues addressing climate change at different level of priority in several topics, aiming at contributing to the promotion of a wiser use of natural resources in primary production, low carbon efficient agro-food and non-food industry and to increase the mitigation capacity of European forests.

The "Space" Theme supports various climate observation systems, in particular related with GMES (Global Monitoring for Environment and Security) which are of direct relevance to climate related research, and is planning to develop the infrastructure for delivering future European GMES Climate Services.

The "ICT" Theme builds on an extensive research portfolio since FP4 in ICT technologies, systems, applications and services for the environment, including activities related to climate change, which led to innovative solutions for improving environmental monitoring, data and information management, risk and disaster management, and developing web-based services. In FP7, the emphasis has been placed on ICT-enabled solutions for resource efficiency to contribute to a low carbon economy, involving research and demonstration activities on integrated water resources management and in energy efficiency.

In addition to the research activities supported under the Cooperation line of FP7, climate research is also supported by the Ideas programme (Starting and Advance Grants of the European Research Council), by the People programme (climate-related Marie Curie actions) and the Capacities programme.

In particular, the 'Regions of Knowledge' programme under the Capacities part of FP7 supports the development of regional research-driven clusters based on the triple helix

[17] European Economic Recovery Plan COM(2008) 800

consisting of research entities, businesses and the public authorities working together in the pan-European partnership for their common benefit. As the programme is regionally-oriented, some of the supported projects contribute to tackling the climate change challenge at regional level.

In the context of the FP7 Capacities programme, the European Strategy Forum (ESFRI) on Research Infrastructures supports a coherent approach to policy-making on research infrastructures in Europe, some of which are of interest for the climate sector. Moreover, within the international cooperation activities (INCO), projects support bi-regional and bilateral policy dialogues, networking, competence building and prioritization of research areas of interest to addressing the world's major societal changes, including climate change.

Complementing the above framework, the JRC mission provides customer-driven scientific and technical support for the conception, development, implementation and monitoring of European Union policies. It carries out direct actions under a specific programme of the Seventh Framework Programme, with its actions in the field **"**Solidarity and the responsible management of resources" including the agenda "Climate Change". In addition the JRC is mandated to carry out competitive activities that are relevant to its direction actions and supports programmes such as GMES via these activities. The JRC has become increasingly active in Climate and Climate related research since the 5th Framework programme. It has a long history of collaboration with European partners, via participation in the framework programme projects described above. Foci of the JRCs research include observations of the state of climate and climate relevant trace components of the atmosphere, both *in-situ* and remotely sensed, modelling the atmospheric cycling of these components particularly short-lived pollutant species such as tropospheric ozone and atmospheric aerosols and evaluating the impacts of climate change[18],[19] and vulnerability of Europe's environment to climate change. As such the JRC is a user of and also a developer of modules for, Climate and Earth System models, including both ECHAM[20] and the Community Earth System Model system[21]. A current priority of its institutional activities is integrating these model systems with the JRCs existing sector specific impact and vulnerability assessment tools (e.g. forest, agriculture, flood, droughts etc) to develop integrated multi-sectoral impact assessments of future climate policy options.

Related EU level initiatives

As part of its development policy, the EU is, inter alia, financing capacity for the use of satellite earth observation data for environmental monitoring, through the ongoing *African Monitoring of the Environment for Sustainable Development* (20 Mio € from the 9th EDF) which will be expanded to cover climate change specifically under the *Monitoring of the Environment and Security in Africa programme* (37 Mio € from the 10th EDF scheduled for approval in the 2011 Action Plan).

[18] Ciscar Martinez J, editor. *Climate change impacts in Europe. Final report of the PESETA research project*. EUR 24093 EN. Luxembourg (Luxembourg): Publications Office of the European Union; 2009. JRC55391

[19] Jol A, Erhard M, Raes F, Van Minnen J, Swart R, Sastny P, Van Dingenen R, Voigt T, Sander G, Christiansen T, Feyen L, Kristensen P, Harley M, Jones A, Montanarella L, Stolbovoy V, Gentile A, Lavalle C, Micale F, Lazar C, Conte C, Genovese G, Camia A, Durrant T, Amatulli G, Hiederer R, Menne B, Isoard S, Watkiss P, Barredo Cano J. *Impacts of Europe`s Changing Climate - 2008 Indicator Based Assessment*. Luxembourg (Luxembourg): OPOCE; 2008. JRC47756

[20] http://www.mpimet.mpg.de/en/science/models/echam.html

[21] http://www.cesm.ucar.edu/

The European Institute of Innovation and Technology (EIT) has launched in 2010 a Climate Knowledge and Innovation Community (Climate-KIC) to create a community with world-renowned innovation capability and climate change knowledge. Climate-KIC addresses four high-level themes, each of which is critical to Europe's response to climate change: Assessing climate change and managing its drivers, transitioning to resilient, low-carbon cities, advancing adaptive water management, developing zero-carbon production systems. These four areas form the core structural elements of the Climate-KIC, and its innovation, education, entrepreneurship and pathfinder activities encompass the entire chain from the innovative idea to realisation and market deployment. Climate-KIC will explore commercial opportunities by developing sustainable solutions in these areas.

The Marie Curie Actions implemented through the PEOPLE programme provide opportunities for innovative and excellent training, mobility and attractive career development for skilled and high level competence in all scientific disciplines in a bottom-up approach. So far, more than 4% of the projects funded (representing around 81 Mio €) are directly related to climate change while 13% are addressing environment related issues. Raising awareness of cross-borders and cross-sector training and mobility opportunities offered by M*arie Curie Actions* also in climate change could be further enhanced.

Other multi-lateral initiatives

The European Partnership of International Science and Technology Cooperation launched in 2008 aims to develop greater coherence in terms of cooperation by the EU and EU Member States with major strategic partner countries worldwide. A Strategic Forum for International S&T Cooperation (SFIC), composed of high level representatives of the European Commission and the Member States, has been set up to steer the implementation of this new EU/Member States partnership. It has chosen India as a strategic partner country with which to start implementing its first pilot initiative focusing on water-related challenges (including climate change issues).

The Group on Earth Observations (GEO) is coordinating efforts since 2005 to build a Global Earth Observation System of Systems (GEOSS). GEO is a voluntary partnership of governments and international organizations co-chaired by the European Commission. Amongst eights others, GEOSS aims to achieve effective and sustained operation of the global climate observing system and reliable delivery of climate information of a quality needed for predicting, mitigating and adapting to climate variability and change, including for better understanding of the global carbon cycle. In the ten year implementation Plan for GEOSS, a number of climate-related targets have been identified, e.g. accessibility of all the observational data needed for climate monitoring and services in support of adaptation to climate variability and change (including data needed by the WCRP and the UNFCCC), development and facilitation of a comprehensive (atmosphere, ocean, land) global carbon observation and analysis system in support of monitoring based decision-making and related environmental treaty obligations, The European Programme for the establishment of a European capacity for Earth Observation (GMES – Global Monitoring for Environment and Security) represents one of the main European contribution to GEO.

The intergovernmental bottom-up COST initiative for European Cooperation in Science and Technology provides useful experience and input of relevance to the JPI Climate initiative. Its FP7-funded research networks can serve as preliminary pilot tools and fora for the involvement of stakeholders across all scientific disciplines and beyond EU borders. Various climate-related COST Actions, strategic workshops or reports have been contributed notably in the fields of climate-energy-water interactions and extreme events.

Launched in 1992, the LIFE Programme is one of the spearheads of EU environmental funding and has financed 3.115 projects with a contribution of € 2.7 billion. The latest Financial Instrument for the Environment LIFE+ (2007-2013)[22] aims at contributing to the implementation, updating and development of Community environmental policy and legislation, including the integration of the environment into other policies, thereby contributing to sustainable development. In particular, LIFE+ supports the implementation of the Sixth Community Environment Action Programme[23], which as one of four main themes focuses on climate change. The co-financing rate is 50% of eligible costs and projects are selected on the basis of an annual call for proposals launched by the European Commission. According to the ex-post evaluation of the LIFE programme[24] over a ten years period (1996-2006) the LIFE programme has funded 40 projects (3.7%) focusing on climate change-related problems. This proportion increased with the focus given to climate change projects in the application guidelines in the annual calls for proposals under the LIFE+ programme, so far some 14% of the budget allocated to projects was dedicated to climate projects covering areas such as GHG emissions and information campaigns.

THE BENEFIT OF BETTER COORDINATION

Climate change research is a key priority for European research in order to provide scientific support to the EU climate action. In this context, the debate about "Horizon 2020 – The Framework Programme for Research and Innovation in the European Union" identified climate change as a key societal challenge, requiring a wide research effort for improving the knowledge base and developing solutions for action. Horizon 2020, with its high level of integration, will benefit from a strengthened cooperation between Member States through this JPI. In particular, a wide research approach is required to address in a multidisciplinary way the complex challenges related to climate change while taking into consideration the large diversity of regional climate contexts and management practices in Europe.

The European Union contributes through the Framework Programme for research and technological development to the European dimension of research on climate change. However the current European landscape for climate research in the EU member states appears too fragmented. Many research networks and organisations at European, national and regional levels defined their climate research strategic agendas in relative isolation, increasing the risk of overlapping or competing research activities. Joint programming – developed in synergies with EU research programmes – will help providing an overall strategic orientation for climate research in Europe and hence will provide stronger added value, opportunities for economies of scales and a larger critical mass of research. Improved programmatic coordination should multiply the return on existing national public investments. It should also contribute to the completion of ERA in the climate sector which has so far experienced some interesting but not ambitious enough and rather short-term ERA-NETs.

This initiative is very timely in that it will provide a complementary element to the Europe 2020 strategy and its flagships on Innovation Union and Resource Efficient Europe by tackling a major societal challenge through increased cooperation between Member States research programmes.

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22 LIFE Programme: Regulation (EC) n° 614/2007 of the European Parliament and of the Council of 23 May 2007 concerning the Financial Instrument for the Environment (LIFE+)

23 6th Environmental Action Programme (6th EAP): Decision n° 1600/2002/EC

24 Ex post evaluation of the LIFE programme (1996-2006): http://ec.europa.eu/environment/life/publications/lifepublications/evaluation/index.htm#expost

The contribution of joint programming to supporting EU policies, including climate policies and other relevant policies, could also take advantage of the fact that the JPI Climate includes national programmes that can easily link to the regional and local scales where the transfer of new knowledge and tools can significantly facilitate policy implementation.

ROLE OF THE EUROPEAN COMMISSION IN THE JPI

The Commission has been encouraging Member States to pursue common visions and strategic research agendas in the domains identified by the High Level Group for Joint Programming (GPC), including in the climate sector. Considering the high strategic value of climate change research for EU policies, the Commission will actively work for promoting and ensuring synergies and coordination between the EU research programmes, the JPI Climate and other initiatives in the field, such as the ones promoted by the EIT.

The Commission may provide complementary measures for this JPI, which could include support for the management structure and further development of the Strategic Research Agenda, the provision of data, information and analysis on the state of play in this field at EU level. The support to the set up of an operational plan able to implement the challenging goals of the JPI should be included as the main objectives.

The Commission will explore the scope for cooperation on development of concepts and solutions, both at national and at EU level, with a view to promote a holistic approach in Europe for addressing climate challenges. The European Commission will facilitate the uptake of knowledge generated within this JPI into the EU Climate policy making process. Finally, the Commission will facilitate coordination among various JPIs in areas where research might be complementary, in particular with the following JPIs:

Agriculture, Food Security and Climate Change, one of the objectives of which is to contribute to the challenge of food supply in a sustainable manner under conditions where the climate is changing;

Water Challenges in a Changing World, addressing the increasing challenge of the worldwide gap between water demand and availability, which is diversely affected by water scarcity, drought or flood events with frequencies and amplitudes projected to increase in relation to climate change;

Cultural Heritage and Global Change: a new challenge for Europe, which focuses on research aiming to protect Europe's cultural heritage from the many threats to which it is exposed, such as climate change and pollution, increasing urbanisation, mass tourism, human negligence, vandalism and even terrorism;

Healthy and Productive Seas and Oceans, seeking to support the advent of a knowledge based maritime economy, ensure Good Environmental Status of the seas, and optimise the response to climate change and mitigate human impacts on the marine environment;

Urban Europe – Global urban challenges, Joint European solutions, which aims to cover issues of social deprivation and segregation, urban sprawl and congestion, safety and security, environmental degradation, pollution as well as effects of climate change.