JPI Climate (WG4) Strategic Research Programming White Paper on:

"Economics of the cost and benefits of climate change impacts and adaptation"

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1. Introduction and background

This short document addresses the main research gaps in the area of the cost and benefits of climate change impacts and adaptation with a particular emphasis on this last. Indications are the outcome of an ongoing debate within the Joint Programming Initiative Climate (JPI Climate). They are intended to be used in the JPI Climate discussion, therefore they have a scientific angle and an academic target. Nonetheless the policy relevance and the relevance for policy makers remain in fact a key selection criteria of the themes suggested.

Antecedent of this work is a short note prepared by the Euro-Mediterranean Center on Climate Change (CMCC) for discussion at the JPI Climate WG4 meeting on the 5th October 2012 in Vienna, incorporating some feedback from the CIRCLE 2 meeting being held the same days and substantiated in the appendix 2 to the document: "Proposal for a new JPI Climate WG4 research theme and associated FTA: socio-economic analysis of climate response options".

This document will be submitted to the June 2013 JPI Climate Governing Board meeting.

Suggestions are listed with a tentative logical ordering and grouped per “thematic” areas. But the specific sequence chosen, in addition to be subjective, does not want to indicate ranking of importance.

Suggestions for research thus start with the knowledge gaps in the field of climate change impacts and adaptation costs and benefits (sections 2.1 and 2.2); then tackle different aspects of the “integration” peculiar to adaptation research not yet satisfactorily addressed (sections 2.3 to 2.5); institutional issues and the role of preferences in adaptation policies are mentioned in sections 2.6 and 2.7 respectively. Section 2.8 finally focuses on the key issue of communication between science and policy making.

2. Research areas/priorities

This section introduces the main research areas in which advancements are needed to allow better (more comprehensive, systematic, consistent, comparable, robust) assessments in the science and policy of adaptation.

2.1 Expand the knowledge base on climate damages, and avoidable damages

Notwithstanding undeniable advancements, the understanding of climate dynamics and of the interactions triggered with the environmental and the social economic dimensions are far from perfect. On the one hand this depends on our imperfect knowledge of the behavior of the climate system (as for instance recently stressed by the IPCC (2012)), of the environmental system response and ultimately of the societal reaction. On the other hand on the inherent unpredictability of many aspects of the studied phenomena. Imperfect knowledge and stochastic component are particularly pervasive in many aspects of the individual and collective behaviour; in predicting the evolution of societies over the very long term; in evaluating goods and services without the support of any observable market transaction (non market/existence values) and often with a lack of primary studies for

benefit transfer. This makes it difficult to provide "objective" evaluations on the costs and benefits associated with environmental policy interventions; calls for a continuous improvement in methodologies, tools and data to provide reliable estimates of climate change damages; but also requires to properly incorporate, deal with and communicate uncertainty (Swart et al., 2009, Saltelli and D'Hombres, 2010).

As to specific impact areas, at least the following, all linked to the assessment of the cost of current and future climate variability, need research improvements:

1. Sea-level rise and how to deal with the uncertainties related to it. The messages from the natural sciences are still rather vague and especially decision making needs to have a better understanding of the various scenarios and their implications.
2. Weather extremes, in particular heavy precipitation, impacts and best responses. The focus should be placed in estimating current exposure and risk, their evolution and the timing and types of adaptation measures.
3. Prolonged drought and optimal water supply and demand-side management A complete study covering the whole of Europe, based on a common methodology and thorough analysis of the uncertainties in a well designed economic framework is still missing.
4. Health, broadly considered (direct and indirect impacts, vector-borne diseases, heath stress, mental health)

Attaining to the social dimension, more effort should be devoted to capture asymmetries of impacts and vulnerability across different social groups. Currently the distributional (equity) aspect of climate change impacts is mostly confined to inter-country comparison.

Finally, perhaps more relevant under an academic point of view, it is worth stressing that the role of active learning especially on the cost-effectiveness of mitigation/adaptation technologies and, more in general, on inertias and irreversibility associated to climate, environmental and social dynamics is not well characterized and would require more investigation. Findings on the effects of stochasticity are not yet conclusive (Golub et al. 2011).

2.2 Investigate the potential costs entailed by autonomous adaptation processes

According to the IPCC (2001) autonomous adaptation can be defined as: "adaptation that does not constitute a conscious response to climatic stimuli, but is triggered by ecological changes in natural systems and by market or welfare changes in human systems. It is also referred to as spontaneous adaptation".

This form of adaptation, even though not sufficient to eliminate climate change impacts and susceptible to mal-adaptation, can provide important support to planned adaptation in damage reduction (Bosello et al 2010). Nonetheless, especially top-down analyses, assume that autonomous adaptation is readily available at no cost (see e.g. Eboli et al. 2010, Ciscar et al 2010, Aaheim et al., 2010) and do not treat satisfactorily the possibility of transition costs, economic and social frictions, delays in adjustments, effects of non market goods and the eventuality that, because of these, adaptation becomes maladaptation. Under the scientific and policy point of view it is thus important to better quantify the costs and

benefits of autonomous adaption, especially when it provides public good or positive externalities (Tompkins and Eakin, 2011, Malik et al., 2010).

2.3 Develop methods to analyze adaptation costs and benefits in the context of broader policy issues

The majority of adaptation actions are not specific to climate change, but consist of strategies that are being implemented for other reasons. The issue here is to reduce vulnerability to several impacts that societies would be (or are) anyway experiencing and that climate change is exacerbating rather than creating. Accordingly, a fruitful investigation approach should be that of mainstreaming vulnerability reduction rather than adaptation in decision making. Therefore appropriate quantitative and qualitative methodologies should be developed to understand the broader social and policy context in which adaptation is implemented, and identify synergies and trade-offs with existing policies (e.g., energy, urban development, integrated flood risk management, ecosystem management, spatial planning, mitigation etc.). This requires the confrontation of economic findings versus findings from other disciplines.

Against this "integrated policy" approach, many issues are particularly relevant, but poorly investigated quantitatively:

- costs, benefits, forms and role of adaptive capacity, in facilitating successful implementation of adaptation measures and policies;
- current (and future) adaptation deficit in different countries/regions (Parry, 2009). Note that this particular issue does not pertain only to developing countries, but also to the EU, in particular Eastern European countries.
- the relation between incremental and transformational adaptation (Moser and Ekstrom, 2010). While the first "aims to improve efficiency within existing technological, governance and value systems" the second "may involve alterations of fundamental attributes of those systems" (IPCC 2012). It is thus important to understand the decision-making processes which influence transformations of societies and understand and then govern the shift from incremental adaptation towards transformational adaptation (Stafford Smith et al., 2011 and Kates et al., 2012).

This is not only an issue in developing countries, but applies also to European economies.

A further example of integrated analysis of adaptation in a wider policy context is that of the strategic interaction of adaptation with mitigation in climate change agreements. A stream of theoretical literature started to analyze under which conditions joint negotiations on adaptation and mitigation make climate change policies more successful (Kane and Shogren, 2000; Antweiler 2011, Bréchet, et al. 2010; Buob and Stephan, 2011), but applied exercises in this area are still very few.

2.4 Better integration between top-down and bottom-up approaches in adaptation assessment (Collect and analyse case studies on specific adaptation strategies and generalize the result)

GHG emissions generate a global externality, however climate change impacts, mitigation, and adaptation effects, are highly differentiated locally. Accordingly, also the economic assessment of adaptation costs and benefits needs to integrate different investigation scopes and scales. A country/regional perspective is needed to define strategic priorities for adaptation investments; a regional, spatially-explicit detail is necessary for the assessment of environmental impacts and cost/effectiveness of adaptation measures. A solid top-down/bottom-up integration is thus crucial in adaptation research (Pat et al. 2010). However, current top-down models analyzing adaptation (see e.g. Agrawala et al. 2010, Banh et al. 2010, de Bruin et al. 2009, Hof et al 2009), albeit remaining useful in highlighting trends and rough "orders of magnitude", are still too aggregated to offer really informative quantitative insights on the opportunities offered by adaptation strategies, and by their combination. Conversely, bottom up analysis of adaptation, which is rapidly expanding, is still largely scattered and incomplete (Agrawala et al. 2011). Notwithstanding interesting attempts to organize the evidence gathered so far (e.g.: Agrawala and Fankhauser 2008, Parry et al. 2009), much more can be done to systematize the already rich information available. Useful support in this can be provided by the increasing number of on-line adaptation portals like the EEA European Adaptation Platform, the KomPass platform and the Adaptation Atlas, by on-going FP7 research projects like CLIMSAVE, MEDIATION and BASE or regional initiatives like BALTADAPT or the German KLIMZUG program developing regional adaptation strategies or the collecting best practice examples.

Consider then, that there are many early adaptation measures already in place, which can offer a really useful support to get better ex post data on the effectiveness, costs, transferability of these.

In summary: bottom-up studies should be collected and then consistently integrated to define adaptation costs and effectiveness per domain in order to develop better top-down estimates of adaptation costs and effectiveness at the country, European and possibly world level. This requires appropriate integration and scaling methodologies for adaptation across different areas and geographical scopes. On the other hand it would be necessary to expand the portfolio of adaptation options that top-down approaches can consider.

2.5 Analyze the two sided relationship between adaptation and social- economic development

Large part of the initial adaptation debate and of the subsequent discussion on adaptation finance, was mostly focused on quantifying adaptation needs and on defining the financial "processes" needed to raise, govern and monitor adaptation spending. Less attention has been devoted on how to design and prioritize adaptation actions to maximize its climate change damage reduction effectiveness and to foster social and economic development (Fankhauser and Burton, 2010). There is indeed a strict and recognizable two-way connection between development and adaptation/adaptive capacity (Burton 2009, 2010; Schipper, 2007, McGray et al. 2007). Nonetheless, both sides of this relation are poorly

investigated quantitatively (Bowen et al 2012). In particular: structured and systematic research is needed to quantify the pro growth nature of adaptation expenditure, its potential positive effects on social-economic variables like employment, technological development or innovation diffusion, welfare, but also the potential conflicts between adaptation and growth or between growth policies which do not mainstream climate change vulnerability reduction in planning.

2.6 Analyze the institutional framework and existing governance structures to identify potential barriers to adaptation and measures to overcome them

While for mitigation instruments, a large body of literature is available, the analysis of the effectiveness of and conditions for various financing-economic-regulatory instruments and institutional frameworks to promote successful adaptation is still in its infancy. Against this background two main fields of investigation seem promising 1) how to reconcile public and private initiative in adaptation, removing barriers/enhancing synergies, (this issue is linked to the complementary role of autonomous and planned adaptation – see section 2.5 above – and to the development role of adaptation see section 2.7 below). 2) Due to its "local nature" adaptation tends to be considered as a private or "club" good. Consequently it is also assumed to require a somehow lower coordination effort than mitigation. Many adaptation strategies, however, affect different sub-national administrations, communities and stakeholders within a community (think for instance to programs to increase water efficiency/conservation to be decided at the basin level). Thus the implementation of adaptation strategies poses at the sub-national level as many coordination challenges as those observed for mitigation at the super national level. More research on this is thus needed to identify institutional barriers between administrative units and stakeholders, and proper strategies/best practices to remove them.

Institutional economic approaches could provide a methodological basis to analyze these multi-level and cross-sectoral problems that call for technological and/or institutional solutions to reduce local, regional, national or international vulnerabilities (Paavola, 2007; Ostrom, 2007; Thiel, 2010).

2.7 Understand people's preferences to potential climate risks/risk attitude

In addition to purely economic considerations, other issues affect human behaviour also in the context of climate change adaptation, which are as yet insufficiently studied.

This includes for instance the role of risk and uncertainty in shaping mitigation together with adaptation policies (Bosello and Chen, 2010, Felgenhauer and de Bruin 2009, Hallegatte et al. 2012), the role of societal intertemporal preferences and inequality aversion.

Traditional financial and welfare economics could provide useful analytical support to analyze these issues, inform and guide policy decision making. However, they might not be sufficient to evaluate all the far-reaching effects of climate change and adaptation policies. For instance, beside an explicit analysis of distributional consequences on different social groups, geographical regions and political entities, the normative basis for evaluation of policy options should be discussed. Fairness, life satisfaction or individual capabilities could

be important concepts supplementing or even replacing traditional economic welfare measures (Frey, 2008; Sen, 1999; Nussbaum, 2000; Spash, 2007).

2.8 Develop and test guidance on application of a set of relevant socio-economic evaluation methods

Twenty years of integrated assessment analyses on climate change impacts, economics and policies produced an enormous amount of research outputs and an increasingly complex set of modeling tools and investigation approaches leading to often countervailing indications. This process has been accelerated by software development and computational power increase allowing a richer treatment of uncertainty through the introduction of set of complicated functions of random variables, but it also increased the probability of code mistakes and uncontrolled changes of the structural properties of the models (Nordhaus, 2012). This applies to the field of adaptation as well.

Albeit positive under the academic point of view, richness and complexity may risk not only to widen the wedge between science and decision making, but also to weaken the informative content of cost benefit, cost effectiveness analyses or even to undermine science credibility in the absence of proper validation, robustness check and communication strategies.

In addition to data-intensive detailed studies, there is thus an increasing need for a set of relatively simple evaluation methodologies ("light touch" versions of CBA, CEA, MCA, optimal timing, etc.) to support regional and sectoral adaptation decision-making to evaluate and then prioritize different adaptation options. Naturally this simplification does not mean ignoring key data or processes, but providing a better, more useful, transparent communication, e.g. by means of user friendly interfaces that keep robust relationship with the background science. Some recent steps in this direction are taken by both national (e.g. Rosqvist et al 2013) and FP7 (CLIMSAVE or LIAISE) research projects whose aim is exactly to bridge the gap between model developers/scientists and the final users of model results, providing better information on model capabilities and results interpretation as well as easy and operational, but rigorously scientifically funded, support to adaptation cost and effectiveness analyses.

Note that in local impact and adaptation assessments, the diversity of topics to be handled jointly is often quite large (economics, health, environment and social conditions; competitiveness - fairness - public finance capability – split incentives - etc.). This poses particular challenges to these 'light touch' approaches. Benefit transfer methods, like adjusted benefit transfer, benefit function transfer and meta benefit function transfer could help, offering comparably easily applicable solutions for research teams and administrations with limited resources (Pearce, Atkinson and Mourato, 2006). Prerequisite for an accurate benefit transfer are however a sufficient number of high quality primary studies – which is still not granted for many ecosystem services and regions (Bateman et al., 2000; Pascual et al., 2010; Plummer, 2009).

As it is likely that alternative methods will be continued to be applied to impact and adaptation studies, policy makers are also in need of guidance in comparison of case studies and results. This calls for further development of meta-analysis as well as

systematic interpretation guidelines and search engines. The recently started FP7 TOPDAD study is exploring these ideas in co-operation with the CLIMATE-ADAPT portal.

Finally, also a reflection on those features making research, research outputs and their communication strategies successful in reaching and influencing the policy making environment could be important (Butter,1998; Frey, 2006; Hamilton, 1992; Nelson, 1987).

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