European Commission

HELIX Report Summary

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Periodic Report Summary 1 - HELIX (High-End cLimate Impacts and eXtremes)

Project Context and Objectives:
HELIX assesses potential climate change impacts and adaptation for global warming above 2 ºC. With the target of limiting global warming to 2ºC becoming increasingly difficult to achieve, policymakers, businesses and other decision-makers need to begin to plan ahead for adaptation to changes in climate associated with higher levels of global warming. This requires coherent information on the potential conditions which may need be adapted to, and the consequences of different courses of adaptation action. Alongside this, ongoing international negotiations on limiting global warming also require clear information on the consequences of different levels of climate change.

While a vast array of projections, scenarios and estimates of future climate change and its impacts already exists, much of this is conflicting, unclear, of unknown levels of certainty and difficult to apply to inform decisions. The rate of future change will be a critical factor in the vulnerability or resilience of societies to the changing climate, because ongoing economic development will affect the sensitivity of societies to weather and climate, and adaptation measures will require time to be identified, planned and implemented. Interdependencies between different impacts, both biophysical and socio-economic, make the problem even more complex.

A further issue is that decisions relating to climate change often require information over a wide range of scales, from global to local. The information currently available is often inconsistent across these scales. Different methods are used for addressing different questions, and lack of consistency can lead to confusion and potentially exposes decision-makers to risks of poor decisions, either because incomplete information is available or because the available information is too varied and inconsistent to be useful.

HELIX is addressing these issues by developing a clear, coherent, internally-consistent view of a small, manageable number of “future worlds” under higher levels of global warming reached under a range of physical and socio-economic circumstances, including consideration of different adaptation scenarios, supported by advice on which aspects are more certain and which less certain. These are being delivered through groundbreaking scientific research across a range of physical, natural and social science disciplines, in close engagement with experienced users of climate change information to ensure appropriate focus, clarity and utility. Both the research and the engagement with users consider a range of scales from global to local, with internal consistency across the scales being a priority.

The objectives of HELIX are:

1. Develop coherent, internally-consistent global scenarios of the combined natural and human world at 2, 4 and 6ºC global warming, including reaching this level early (2060s) or later (after 2100) and with and without pro-active adaptation planning by society. The focus will be on land and coastal impacts and their socio-economic consequences: food, water and energy security; coastal and river flooding; infrastructure; ecosystems and biodiversity; health; migration; and risk of conflict

2. Provide additional detail for focus regions of Europe, northern sub-Saharan Africa and South Asia, with active contribution from stakeholder groups and decision-makers in the regions.

3. Provide a reliable assessment of confidence in the different components of these scenarios, based on a comprehensive assessment of uncertainties throughout the different component of the projections

4. To ensure the research addresses the needs of decision-makers, through both its implementation and communication.

Project Results:
We are using two high-resolution Atmospheric General Circulation Models, EC-Earth and HadGEM3 driven by sea surface temperature and sea ice from the 5th Coupled Model Intercomparison Project (CMIP5) multi-model ensemble. The simulations with EC-Earth are complete, and those with HadGEM3 are underway. These will later be used to drive the models assessing the impacts of high-end climate, and also some key impacts-related quantities will be analysed. The

socioeconomic scenarios, the assumptions of population, gross domestic product and energy production driving the rates and causes of high-end climate change, are also in preparation.

For stakeholder input to the regional work, workshops were held in the UK, Senegal, Ethiopia, India and Bangladesh during May-August 2014. Participants were from a range of backgrounds, including government departments, commercial companies, NGOs and local farmers. This gave important insight into the very wide range of perspectives on the potential user needs for HELIX climate impacts and adaptation assessments, and motivates further work on establishing our key focus in line with user needs. Research is progressing in each region. New 25km Regional Climate Model (RCM) simulations have been performed for Europe in collaboration with EURO-CORDEX, ready for use in driving the impacts models. For South Asia, the JULES model is being further developed to include a glacier model which will be used to simulate changes in the glacier surface mass balance and ice dynamics in the Himalayas, a critical impact on the region. In Africa, simulations with the ORCHIDEE (Organising Carbon and Hydrology in Dynamic Ecosystems) and GLAM (General Large Area Model for crops) are underway using climate projections from the Inter-Sectoral Impacts Model Intercomparison Project (ISI-MIP), and relationships between climate and migration are being studied

We are testing our models against observations by performing simulations with a number of the land impacts models driven by observed climate data to assess the model performance in replicating observed trends and/or impacts of key climatic events. This is in collaboration with the ISI-MIP Phase 2 project, which also involves other models from outside of the HELIX project, that allows for a wider model intercomparison and will allow us to benefit from expertise in the broader community.

We are critically assessing the standard practice of using meteorological data from climate models to drive separate impacts models rather than simulating impacts processes as an integral part of the climate model. This standard practice allows a wider set of impacts models to be used, which are often more sophisticated and detailed than is possible within climate models, and it also allows for systematic biases in climate model output to be accounted for. However, this practice also potentially leads to a loss of internal consistency between the climate projections and impacts, due to the different models and also the breaking of feedbacks. We compared projections of changes in river runoff and vegetation productivity simulated by two version of the land surface model JULES within and outside of the HadGEM2-ES climate model, and found somewhat different behaviour. This adds a further dimension to uncertainty in climate impacts projections that was not previously accounted for, suggesting that ‘bias-correction’ methods, while increasing the realism of present-day simulations, may not necessarily increase the credibility of projections of future change. Further work will scrutinize the meaning of this model uncertainty.

Main results so far:

Recent global emissions, and those projected for the next few years on the basis of Gross Domestic Product, are tracking the Intergovernmental Panel on Climate Change (IPCC) high emissions scenario.

By the 2060s, the high emissions scenario leads to global warming exceeding 2°C in all IPCC climate models. The fastest-warming models simulate 4°C warming by this time.

With high emissions, 90% of the IPCC models 4°C by the end of the 21st Century, and the fastest-warming model simulates 6°C by this time.

At any of these levels of global warming, local changes may be larger or smaller. Greater warming is projected over most land areas, especially continental interiors. Warming is also greater nearer the poles, but smaller over most ocean regions.

2°C global warming is associated with approximately 4°C in the Arctic

4°C global warming is associated with approximately 5-6°C in continental interiors and 8-12°C in the Arctic

Uncertainties in regional rainfall changes are very large. In all focus regions of HELIX – Europe, West Africa, East Africa and the Indian Sub-Continent – some models project wetter conditions while others project drying. This uncertainty becomes larger at higher levels of global warming.

Potential Impact:
The final results of HELIX are expected to be a set of scenarios which demonstrate the range of possible states of the environment in key regions and across the globe in relation to food, fresh water, flooding and biodiversity at specific global warming levels (SWLs) of 2, 4 and 6°C, and the potential (or limits) for societal adaptation to these states. The potential impacts of these results will be a contribution to improved decision-making on long-term adaptation to climate change, through improved awareness and understanding of the risks associated with potential changes in regional climate. The economic impacts of this, in conjunction with advice from other ongoing scientific research, could be to contribute to better spending decisions in relation to long-term adaptation to climate change by the Commission, governments of EU member states, other governments, the private sector, non-governmental organisatins and civil society. This could include either or both: (i) avoidance of unnecessary expenditure on adaptation measures for threats which may actually be low risk, and/or (ii) improved confidence or urgency in expenditure on adaptation measures for threats which are high risk. HELIX should not, and will not, be the sole source of information on which such decisions will be based; nevertheless, our research will make a direct contribution to the wider knowledge base and also make

indirect contributions by demonstrating improved methodologies which can be taken up by future research.

Wider societal implications, again through HELIX contributing as part of a wider knowledge base, could include improved resilience of society to long-term climate change as a result of improved adaptation or avoided maladaptation, and/or indirect benefits from reduced opportunity costs of unnecessary adaptation. Moreover, we expect that our communication of our research will lead to an improved public understanding of science relating to climate change. This could have further implications for public engagement with public policy on climate, and potentially even contribute to an influence on the popular mandate for such policies. We note that this influence could be in either direction – ie: either an increase or decrease in support for specific policies – depending on our exact results.

Specifically, the results of our research on the plausible range of changes in freshwater availability and crop yields could contribute to an understanding of the risks or opportunities that climate implies for water and food security, which could help inform policymaking for international development and long-term infrastructure planning, alongside other considerations. Similarly, our research on the range of implications for human health and the two-way relationships between climate change vulnerability and migration could also contribute to policymaking in support of the long-term development of healthcare support and settlement planning. Our research on the range of potential impacts on ecosystems and biodiversity may contribute to policy and long-term planning on conservation. In all cases, HELIX will be just one source of information, but nevertheless should contribute to an improved evidence base to help place such policymaking on a firmer footing.

These impacts of our research are most likely to be seen in relation countries included in our Focus Regions; Europe, northern Hemisphere sub-saharan Africa (Senegal, Kenya and neighbouring countries), and south Asia (particularly India and Bangladesh). This could include national governments, regional and local authorities within these countries, wider organisations above the National level (eg: the European Commission), multi-national organisations and other large corporations, NGOs. However, since HELIX also has a global scope as well as our focus regions, the research could also lead to impact in other countries outside of our focus regions and at the global level via the United Nations.

List of Websites:

www.helixclimate.eu

Subjects

Environmental Protection

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