The **CLIMSAVE** Project
Climate Change Integrated Assessment Methodology for Cross-Sectoral Adaptation and Vulnerability in Europe

Assessing the robustness of climate adaptation measures in the face of uncertainties

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There is an increasing amount of research on policy robustness in the area of climate change adaptation, in particular focusing on possibilities for effective, long-term policy responses in the face of uncertainties about future climate change, technological advances and socio-economic development. The overall aim of this work in the CLIMSAVE project was to examine whether adaptation responses are "robust", by looking at whether they would reduce vulnerability to climate and socio-economic changes across sectors, scales and scenarios.

To assess the robustness of adaptation options, the following steps were required. First, it was necessary to cluster the adaptation options into so-called policy archetypes that can be tested using the CLIMSAVE Integrated Assessment (IA) Platform, since the objective was not to test the performance of individual measures but to test broader policy strategies. The four policy archetypes are described briefly in Box 1.

Second, the IA Platform was run assuming "no adaptation" for the 2050s timeslice for the four CLIMSAVE socio-economic scenarios developed for Scotland and Europe and for two climate scenarios. Results were analysed for four sectors (i.e. biodiversity, flooding, water exploitation and food provision). Third, the IA Platform was run for the clusters of adaptation options associated with each of the four policy archetypes for the same scenarios and analysed for the same sectors. Finally, for each of the runs, the number of vulnerable people was calculated.

The results are analysed using the following questions:

- Do each of the policy archetypes reduce vulnerability at both the Scottish and European levels?
- Do the policy archetypes reduce vulnerability in all socio-economic scenarios?
- Do the policy archetypes reduce vulnerability in both climate scenarios?
- For any socio-economic scenario combined with a selected climate scenario, do the policy archetypes reduce vulnerability in all sectors?

Box 1: Policy Archetypes used in the Robustness Analysis

Ecosystem-based Adaptation (EbA) The goal of EbA is to protect or improve to the integrity and health of ecosystems and habitats so that nature retains capacity for adapting to changing complex pressures and conditions, such as climate change.

Market-based Adaptation (MbA) The major objectives of market-based adaptation (MbA) are fund raising/mobilization for adaptation activities; efficient allocation of funds that are available for projects aiming to avoid climate change related damages; promotion of adaptation by various stakeholders; and sharing of financial risks in the context of climate change (e.g. transfer of risks through insurance-based mechanisms).

Technology-based Adaptation (TbA) The goal of TbA is to adapt to climate change and variability through the use of technology such as irrigation, flood defences and advanced early warning systems.

People-based Adaptation (PbA) The goal of PbA is to adapt to climate change and variability using human and social capital. This includes education and awareness-raising, building of networks to respond to climate change and changing institutions (including regulation).

In addition to the adaptation options covered by the CLIMSAVE IA Platform there are other so-called "soft options". A qualitative assessment of the robustness of these options was carried out.

Applications of the CLIMSAVE IA Platform involve a number of inherent uncertainties arising from the underlying data, the goodness-of-fit of the meta-models to their underlying process model and from the propagation of errors through the chain of coupled meta-models. A qualitative and quantitative uncertainty analysis was undertaken with the Platform in order to rank the vulnerability indicators used here in terms of their relative uncertainty. This provides further evidence in support of the robust policy assessment.

The results show that the use of policy archetypes enables an analysis of policy robustness across scales, sectors and scenarios using the CLIMSAVE IA Platform and expert judgement. The People-Based Adaptation (PbA) policy archetype is generally the most robust option according to the results. This is clearly a result of the inclusion of two measures in this archetype that increase coping capacity (human and social capital). The analysis also showed that the vulnerability to flooding had the lowest level of uncertainty associated with its calculation by the IA Platform. This is consistent with the observation that adaption options were generally positive for this indicator across policy archetypes and across scenarios.

It should be noted that we have not explored the robustness of combinations of policy archetypes, which would indeed be more reflective of the reality of responding to vulnerability to climate and socio-economic changes. The methodology developed in this study would be suited to such an exploration of robustness of combinations of archetypes.