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Halsnæs, Kirsten; Kaspersen, Per Skougaard

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Key drivers and economic consequences of high-end climate scenarios: uncertainties and risks

Kirsten Halsnæs & Per Skougaard Kaspersen*

DTU Management

*Corresponding author email: pskk@dtu.dk

The consequences of high-end climate scenarios and the risks of extreme events involve a number of critical assumptions and methodological challenges related to key uncertainties in climate scenarios and modelling, impact analysis, and economics. A methodological framework for integrated analysis of extreme events and damage costs is developed and applied to a case study of urban flooding for the medium sized Danish city of Odense. Moving from our current climate to higher atmospheric greenhouse gas (GHG) concentrations including a 2°, 4°, and a high-end 6°C scenario implies that the frequency of extreme events increase beyond scaling, and in combination with economic assumptions we find a very wide range of risk estimates for urban precipitation events. A systematic sensitivity analysis including 32 scenario combinations demonstrates that alternative climate scenario assumptions as well as economic assumptions together result in risk estimates with a very large variation. We find that a major source of uncertainty relates to the climate scenario uncertainty, in particular related to the probability of tail events associated with high consequences to society. The economic assumptions, particularly on risk aversion factor and discount rate, are both very important and contribute to a very large variation of risk estimates. Furthermore, the actual level of damage costs associated with different levels of precipitation intensity is important in determining the risk levels. The latter is a challenge to impact modellers, and the accuracy of damage cost studies could benefit from the availability of more context-specific studies on impacts on physical assets, human welfare, and risk perception, and on how the full range of economic activities in the city could be affected. In the context of uncertainty and decision making, the results of the sensitivity analysis seen from a climate modelling perspective and from an economic perspective can be interpreted in different ways. Uncertainties related to the climate scenarios reflect both the state of current climate modelling and statistical downscaling approaches applied to the case study, as well as more general uncertainties related to global decision making on climate change mitigation and future temperature levels. In terms of adequately eliciting these uncertainties in an integrated framework, an ensemble of comprehensive model experiments, specifically designed to decompose the variance, which take into account key factors such as the scenario and model uncertainty is required.