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Using probabilistic climate information for UK water resource planning

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Water companies in the United Kingdom have considered climate change in their water resources plans for more than a decade. Over this period, UK Water Industry Research (UKWIR) funded a series of studies that provided changes in UK hydrology and practical methods for including climate change in water resources plans. Following the dissemination of the probabilistic UK Climate Projections 2009 (UKCP09, Murphy *et al.*, 2009), UKWIR launched an initial study of the impacts of these new scenarios on future water resources (Christierson *et al.*, 2009). This paper presents an initial assessment of the impact of UKCP09 on river flows at a national scale for the 2020s and the implications for water resource planning.

UKCP09 provide for the first time probabilistic projections, available as statistical distributions of changes in climate variables under the A1B emissions scenario. The probabilistic nature of UKCP09 represents an opportunity to move to a risk-based impact and adaptation decision-making framework, but propagating such probabilistic information into impact studies is particularly challenging. A practical approach has been developed here by applying a Latin Hypercube Sampling to monthly distributions of changes over UK river-basin regions and perturbing historical climate series. A hydrological modelling framework developed for the previous national-scale assessment (Vidal & Wade, 2007) has been applied here to 70 catchments across the UK. This framework is based on two model structures widely used for climate change impact studies: PDM, a lumped conceptual model, and Catchmod, a semi-distributed conceptual model. It also makes use of the Generalized Likelihood Uncertainty Estimation (GLUE) methodology to provide information on model parameter uncertainty.

River flow changes for the 2020s are presented in a probabilistic way, with maps of quartile values as well as detailed distributions for two catchment case studies: the Ribble at Arnford, a small mountainous catchment located in north-west England, and the Thames at Kingston, a large catchment with high levels of abstractions located in south-east England. Results show a decrease in mean annual flow over most of the UK, with negative median values of all monthly changes except in winter over the western and northern mountainous areas. Furthermore the results indicate a high likelihood of a significant decline in summer flows. Finally, an analysis of variance showed that the major part of the uncertainty in river flow changes comes from the spread in climate projections, with only 10% due to the hydrological modelling.

Results are found to be quite consistent with the previous assessment based on individual projections from 6 GCMs under the A2 scenario (Vidal & Wade, 2007) in terms of overall decrease of central estimates and geographical split. The reduction in summer low-flows—critical for water resources, especially in south-east England—appears however more limited with UKCP09. Although most expected changes are within natural variability, UKCP09 suggest drier hydrological conditions overall, and the spread of results is greater than in previous assessments. Studies at the water resource zone and regional scales will now be needed to derive implications for Deployable Output and to check the robustness of water resource plans.

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Vidal & Wade (2007) Guidelines for resource assessment and UKWIR06 scenarios. UKWIR report 06/CL/04/8. ISBN 1-84057-431-3

Christierson *et al.* (2009) Assessment of the significance to water resource management plans of the UK Climate Projections 2009. UKWIR report 09/CL/04/11. ISBN 1-84057-547-6