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The implications of using large ensembles of climate scenarios for the management of river ecology in an English chalk stream

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Climate change is likely to impact on freshwater ecology, the delivery of regulatory commitments to ecological status and the management of water resources. It is becoming increasingly important for European environment agencies to use and develop methods to aid planning and abstraction licensing procedures and policies in the face of climate change and with the introduction of the Water Framework Directive.

Studies have been carried out in the past to investigate the implications of climate change for biodiversity. However, predicting the future is fraught with uncertainty, an area which has not been dealt with in great depth in the past. This study has been undertaken to draw on the results of new methodologies to address the uncertainties inherent in modelling future climate and assess their usability for decision-making in water resources allocations specifically in considering interactions between flow and invertebrate communities

The River Itchen was chosen as the case study catchment on the strength of having a long-term coupled ecological and flow dataset and having been an area of intensive study in the past. It is a chalk stream located in the south of England and a candidate Special Area of Conservation. It has also been designated a Special Site of Scientific Interest achieved due to the number of rare species, and the richness of the macro-invertebrate community in the river catchment.

An ensemble of 246 transient simulations for future climate was obtained from ClimatePrediction.net which were then used to drive a rainfall-runoff model. In order to link the modelled river flow to ecology, the Lotic Invertebrate Flow Evaluation score has been used where the invertebrate community is linked to flow largely through sensitivity to water velocity and siltation, driven by flow variability at sites with fixed channel dimensions

The large ensemble of climate scenarios and thereby flow and ecological indices allows the exploration of the risk of the river of not meeting environmental flow targets in the future. Three sets of environmental flow targets which were drawn up by the Environment Agency for England and Wales for the River Itchen were tested and show that it may be difficult to maintain a natural chalk stream invertebrate community in the River Itchen in the future. The ensemble also shows low flows regularly extending from August to December which could result in the loss of a high proportion of individuals recruited that year. This would in turn lead to diminished over-wintering populations, with potentially catastrophic consequences for the following years breeding and recruitment programme.

Due to a paucity of quantitative data for the response of macroinvertebrates to multi-year droughts, to provide a richer story, a matrix has been proposed for analysing the effects on biodiversity of the river which combines both the thresholds derived previously and expert opinion on how the ecology of the River Itchen will react to climate change. The matrices also provide a more accessible way of communicating rather complex information to a wider community of decision-makers.

Should large changes in flow arise in the future it is likely that some form of action will be taken to mitigate or adapt to the impacts of climate change. Maintaining the ecological status of the river throug river support, i.e. augmenting river flow by pumping from the groundwater aquifer, has also been investigated. However, by

augmenting the flow, the high flows are also reduced which can be important for scouring the river bed and removing silt to the benefit of the invertebrate community. Therefore at some point further augmentation may need to be curtailed in order to maintain high flows.