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The role of hydrological and water quality models in the application of the ecosystem services framework for the EU Water Framework Directive

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The hydrological cycle is intimately linked with environmental processes that are essential for human welfare in many regards including, among others, the provision of safe water from surface and subsurface waterbodies, rain-fed agricultural production, or the provision of aquatic-sourced food. As well as being a receiver of these natural benefits, the human population is also a manager of the water and other natural resources and, as such, can affect their future sustainable provision. With global population growth and climate change, both the dependence of the human population on water resources and the threat they pose to these resources are likely to intensify so that the sustainability of the coupled natural and human system is threatened. In the European Union, the Water Framework Directive is driving policy and encouraging member states to manage their water resources wisely in order to maintain or restore ecological quality. To this end, the ecosystem services framework can be a useful tool to link the requirements in terms of ecological status into more tangible descriptors, that is the ecosystem services. In the ESManage Project, existing environmental system models such as hydrological models and water quality models are used as the basis to quantify the provision of many hydrological and aquatic ecosystem services by constructing indicators for the ecosystem services from the modelled environmental variables. By allowing different management options and policies to be compared, these models can be a valuable source of information for policy makers when they are used for climate and land use scenario analyses. Not all hydrological models developed for flood forecasting are suitable for this application and inappropriate models can lead to questionable conclusions. This paper demonstrates the readily available capabilities of a specially developed catchment hydrological model coupled with a water quality model to quantify a wide range of biophysically quantifiable water-related ecosystem services such as water provision (river flows, groundwater recharge and vegetation transpiration), flood regulation or nutrient and sediment retention. This combination of models will be used to carry out scenario analyses on IPCC climate change scenarios as well as various land use scenarios. Results will be presented for a test catchment in the Republic of Ireland.