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Model based climate change impact assessment of river water quality in Wales

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Climate change is likely to threaten the consistent provision of clean drinking water in the UK, in terms of both water quantity and quality. Water quality could be especially problematic due to projected increases in extreme weather events such as droughts and flooding, both of which have a deleterious impact on water quality.

This study uses the Soil and Water Assessment Tool (SWAT) with UK Climate Projections (UKCP) 2018 data to model the impacts of a worst-case global emissions scenario (RCP8.5), on water quality for five catchments in Wales, UK. Our five study catchments (Clwyd, Conwy, Dyfi, Teifi, and Tywi) cover approximately 21% of the total area of Wales and are an important source of water supply for the North, West, and South-West Wales regions. We use an ensemble of 12 regionally downscaled Global Climate Models as inputs to account for uncertainty in the projections and temporal snapshots are taken for the 2020-39, 2040-59 and 2060-78 periods. We focus on the concentrations of four specific water quality variables: nitrogen (N), phosphorous (P), suspended sediment (SS), and dissolved oxygen (DO).

At all five catchments, SWAT is calibrated using river flow data only, due to the lack of water quality measurements. SWAT parameters related to water quality are kept at their default values. While this approach increases the uncertainty related to the specific values of water quality variables, it does provide the relative changes in specific water quality variables under future climate conditions. Results show that changing river flow patterns, both long term averages and extreme events, have a large impact on water quality. Concentrations of all four water quality variables show clear correlations with river flow. The largest changes in seasonal water quality are generally observed in spring and autumn, especially for P and N concentrations. Sediment concentrations and DO levels have an inverse relationship, with SS levels increasing with increased river flow and DO levels decreasing.

Results of this study are useful for water resource management and planning, especially in terms of the potential adaptation measures required to cope with the additional treatment required at water treatment works. By taking twenty-year snapshots our study also allows for short, medium and long term solutions to be planned.