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A north-south divide in Europe: the future freshwater eutrophication response to land use and climate interaction

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Catchment-scale biophysical models were applied to eight river-systems across Europe to assess the effects of projected changes in climate, land use, nitrogen deposition and water use on water quantity and quality. The sites represent key climate and land management types and include three lakes and one reservoir with flow, river and lake nitrogen and phosphorus concentrations, and lake chlorophyll concentrations, modelled for baseline (1981-2010) and scenario (2031-2060) periods. Long-term trends and seasonal variations in the modelled variables were simulated well for the baseline period, though typically the simulated flows and concentrations had lower variance than the observations. The projected effects on water flows differed between north and south. In the north and mid-latitudes, increased evaporation was balanced to some extent by increased precipitation, leading to relatively small effects on annual flows though seasonal effects were apparent. In the south, increased temperatures and lower precipitation reduced water flows considerably making climate change the greatest threat to freshwater ecosystems. Elsewhere across Europe, the projected effects of climate change alone on nutrient concentrations and loads were small. The effects of credible land use changes on nutrient concentrations and loads were larger. However, there were exceptions, with differences in the response between sites dependent on the mixture of diffuse and point source inputs. Modelled lake chlorophyll changes were not generally proportional to changes in nutrient loading. Overall, the results suggest that eutrophication in the 21st century will depend on more that precipitation changes alone and that large-scale implementation of green agricultural policies will be effective to reduce eutrophication despite projected climate change.