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# Integrated modelling of river output change during the 21st century

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To explore the evolution of a human impacted river such as the Seine River (France) over the 21st century, we constructed future scenarios for three presumably important driving factors. Climate change is based on GCM simulations driven by the SRES-A2 scenario of radiative forcing. To explore a reduction in nitrate pollution from agricultural origin, we constructed a scenario of good agricultural practices, introducing catch crops and a 20% decrease in nitrogen fertilisation. We estimated future point source pollution using assumptions of population growth and technological improvement that are consistent with scenario SRES-A2. This leads to reductions of 30 to 75% compared to 2000, depending on the pollutants.

To sort out these scenarios from the perspective of their impact during the 21st century, we coupled five models addressing separate components of the river system, namely the crop model STICS, the hydrogeological model MODCOU, the land surface model CLSM, a statistical model of water temperature, and the biogeochemical model RIVERSTRAHLER, which describes the transformations and fluxes of C, N, P and Si between the main microbiological populations, the water column and the sediment, along the entire river network down to the outlet to the Seine estuary.

The results of this numerical exercise indicate that the potential changes to the Seine River system during the 21st century shall not lead to severely degraded water quality. The relative impacts of the three future scenarios are clearly different regarding nitrate and the other terms of water quality. Nitrate pollution will continue to increase during the 21st century unless preventive measures are implemented over the entire water-

shed, and climate change will enhance this trend. In contrast, the anticipated reduction in point source inputs, especially in phosphate, will markedly reduce eutrophication and the additional impact of climate change should be beneficial. The latter impact is driven by the warming of the water column, which enhances algal growth in spring and the loss factors responsible for phytoplankton mortality in late summer (grazers and viruses). Overall, climate change may prevent the exhaustion of dissolved silica in the river network and benefit to Diatoms in the coastal zone.