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Carbon fate in a large temperate human-impacted river system: focus on benthic dynamics

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During the last decade, several studies highlighted the important role of fluvial networks in regional and global carbon (C) budgets. Therefore, for sustainable C management, in-river C processing needs to be well understood. The Seine River from the Paris urban area to the entrance of its estuary (220 km) is studied here as a pertinent example of a large human impacted river system subject to temperate climatic conditions. We assess organic C (OC) budgets up- and downstream one of the world's largest waste water treatment plants and for different hydrological conditions through hydro-biogeochemical distributed modelling. The fine representation of sediment accumulation on the river bed allows the quantification of the effect of pelagic and benthic processes on OC export towards the estuary and on river metabolism (i.e. net CO_2 emission). OC export is significantly affected by benthic dynamics during the driest periods, when 25 % of the inputs to the system is transformed or stored in the sediment layer. River metabolism is also significantly affected by benthic processes, whatever the hydrological conditions. On average, benthic respiration accounts for one third of the total ecosystem respiration along the studied stretch (0.23 out of 0.86 gC.m-2.d-1). These results stress the major influence of benthic dynamics, and thus of physical processes such as sedimentation and re-suspension on C cycling, in large human-impacted temperate river systems and on C export to the estuaries. Even though the importance of benthos processes was already acknowledged by the scientific community for headwater streams, this work highlights its importance for downstream river systems and opens the door to new developments in the quantification of C emissions by global models, in which biogeochemical processing and benthic dynamics must be taken into account.