EGU2020-5710
https://doi.org/10.5194/egusphere-egu2020-5710
EGU General Assembly 2020

The effect of climate change on sediment distribution and delivery within the Rhine-Meuse Delta

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The morphological and hydrological equilibrium of many deltas worldwide is changing due to anthropogenic activities. A key example of such a delta is the Rhine-Meuse Delta (RMD) in the Netherlands. It is home to an important shipping and economic centre (Rotterdam) and thus has been strongly affected by anthropogenic activities. Changes include embanking, narrowing and deepening of channels, major dredging and sediment relocation, the building of ports and harbours, and dam building upstream. There is currently a net annual loss of sediment from the delta. Considering current and future sea level rise it is crucial that the RMD receives sufficient sediment or it risks drowning, increased flood risk, decreased ecological area and channel bed degradation.

Here, we estimate the future delivery of suspended sediment from upstream using BQART, and the volume and sediment flux from the sea using a 1D morphological model. We ignore bedload fluxes as they make up a small proportion of the annual supply. We use these estimates to investigate sediment redistribution between channels in the RMD based on suspended sediment-discharge relations. Projections for 2050 and 2100 are presented based on region-specific climate scenarios for discharge and sea level and incorporate projected future upstream reservoir construction. The sediment concentration in the branches is compared with discharge-area relations and current bed level trends to demonstrate potential sedimentation-erosion trends for individual branches.

Projections for the 21st century indicate that sediment delivery to the RMD from upstream is likely to decrease slightly, while sea level rise will cause tidally driven suspended sediment delivery to move further inland. It is estimated that the already negative sediment budget of the delta will be exacerbated by dredging, which removes all incoming sediment at the coastal boundary. The severity of sediment starvation depends on the climate change scenario. Our work indicates that certain channels will be at risk of erosion due to this sediment starvation, whilst other branches will experience net sedimentation. Sediment input from the coast could also reach further inland, assuming current dredging practice remain unaltered, which could provide an opportunity for the system to regain equilibrium. We recommend that a sustainable sediment management strategy is undertaken in the region to counteract the negative effects of sediment starvation.