

Sediment management in the Dutch Rhine: an integrated approach for navigation, safety against flooding and ecology

Pol Hakstege¹

¹Rijkswaterstaat, Ministry of Infrastructure and Environment, P.O. Box 24057, 3502 MB Phone: +31-(0)-653645227
Utrecht, The Netherlands

E-mail: pol.hakstege@rws.nl

Abstract:

The hydro-morphology of rivers, estuaries and coastal has been changed on many locations by human interference. Measures include the construction of dikes for safety against flooding, drainage of land for agriculture and regulation of rivers for navigation. These measures, necessary for development, have side effects such as land subsidence, erosion and loss of natural habitats.

Especially low-lying coastal, deltaic and fluvial areas that face land subsidence and erosion have become more vulnerable for the consequences of climate change such as sea level rise and increased frequency of storms. In river basins changes in seasonal precipitation may lead to floods and droughts and have consequences for sedimentation and erosion patterns.

This paper focuses on sediment management in relation to morphological effects resulting from measures for navigation, flood protection and ecological recovery. The Dutch Rhine is presented as a case study.

The river Rhine forms an important axis for navigation from main port Rotterdam to Germany, where frequent dredging is necessary to maintain the fairway. However dredging operations may cause hindrance for navigation and should be minimised.

Safety against flooding cannot only be ensured by heightening of dikes along rivers, in addition more space has to be made for water, where this is feasible. The Dutch programme Room for the River aims at enlarging river discharges by a number of measures such as deepening, or widening of river beds, lowering of floodplains, construction of side channels and relocation of dikes. In general increase of flood conveyance capacity will lead to a decrease in flow velocity and increase in sedimentation.

Measures for ecological recovery of river systems for the Water Framework Directive, such as ecological river banks and side channels also have an impact on the morphology of the river bed.

Both programmes are in progress and it is expected that these measures will contribute to bottlenecks for navigation leading to more frequent dredging.

Riverbed degradation in the upstream part of the Waal and Rhine is a consequence of regulation of the river, which has narrowed and steepened the course of the river bed leading to higher flow velocities and

erosion. A second cause is shortage of sediment due to sand extraction in the past, embankment of floodplains and little input of sediment from upstream (Germany). Erosion of the river bed is further progressing leading to serious problems in the near future for navigation e.g. due to limited access to locks and barriers formed by resistant layers. In order to maintain the sediment balance it is required that sediments from dredging have to be relocated within the river system, but this is not sufficient to solve the problem.

The interactions and consequences of measures for navigation, flood protection, ecological recovery and erosion control are very complicated and difficult to predict with models. Understanding of the hydro-morphological system is crucial to find solutions.

It is expected that the described trends will continue in the future: more extreme discharges, need for ecological mitigation, river bed degradation and demands for increased navigation.

The strategy to face these challenges is twofold: an increase of dredging activities within the limits of hindrance and safety for navigation and the implementation of additional structural measures for example longitudinal dams.

Sediment management remains of vital importance to arrive at an integrated sustainable approach.