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Setup of research

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Causes of long-term bed degradation in rivers: setup of research

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Introduction

The Dutch Rhine is one of the most intensively used river for shipping; hence ensuring navigability of its branches is one of the most important aspects of river management (e.g. Mosselman et al., 2004), in addition to flood safety. Yet, studies showed that the upper Dutch Rhine is degrading at a rate of 1 to 2 cm per year (e.g. Sieben 2009) and degradation is also observed in other European rivers e.g. the German Rhine, the Elbe River, and the Danube River (e.g. Frings et al. 14a,b). This ongoing bed degradation is problematic for (a) navigation, in the area of non-erodible layers, (b) structures (e.g. bridges, groynes and underground cables) and (c) ecology due to lowering of the ground water level in the floodplains (Gölz 1994).

The degradation in the Dutch Rhine (Fig. 1) has various causes: the 19th and 20th century large-scale river training, extensive dredging in the past, coarsening of the sediment supply from Germany, and construction of dams in its tributaries (Blom 2016). However, their relative contribution is still unclear. To minimize the negative effects of bed degradation and for optimal design of future mitigation measures, it is crucial to understand the causes of bed degradation processes and their relative contributions.

In the last decade degradation in the Bovenrijn seems to halt, which may be due to bed coarsening caused by river training and coarse sediment nourishment in Germany (Blom 2016).

Currently, degradation problems in German Rhine are dealt with through a combination of engineering works and sediment management measures such as sediment nourishment (Gölz 1994). This research will assess the causes of long-term bed degradation (human and natural changes) and their relative roles focusing on the Rhine River, the Danube, the Elbe and other degrading rivers.

As degradation is a problem, characterized by large temporal and spatial scales, climate change is expected to play a role by affecting the water and sediment supply and sea level and this research will assess this effect.

Objective

The main objective of this research is to improve our understanding of the relative contribution of the causes of long-term bed degradation in Rhine and other degrading rivers. That is, the research is intended to quantify past channel adjustment processes, mainly bed degradation and bed surface coarsening over time and space, and to predict future trends, in bed elevation and bed surface texture, resulting from past interventions.

General approach

The research will proceed by coupling literature survey, analysis of measured datasets and numerical modelling. Fig. 2 presents the approach of the research. The relative effects of the causes of bed degradation will be first assessed using a 1D numerical research code, for quick insight on the effects of measures. The code solves the flow (1D shallow water equations or the backwater equation), bed level and bed surface texture (using the Exner and Hirano equations). The numerical modelling will involve schematic cases and river cases and will distinguish initial, transient and long-term responses. In dealing with prediction of future trends, the effects of climate change, for example on discharge and sediment supply and sea level change will be accounted for by developing scenarios. In a later stage, 2D numerical model will be setup to properly account for the presence of two river bifurcations (Pannerdens Kop and IJsselkop) and the effects of bend sorting.

Future work

As the preparation of the workplan is nearly finished, the next step is analysing sets of measured data for possible trends in boundary conditions, bed elevation, and bed surface texture. Numerical modelling to assess the relative effects of causes of bed degradation on schematic cases is about to start.

Acknowledgements

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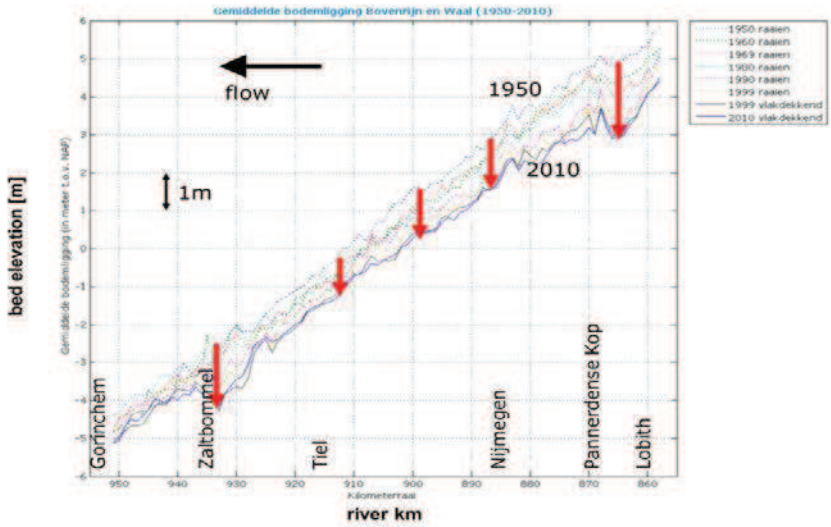

*Figure 1: Bed degradation in the Upper Rhine and Waal in the last 60 Years (*Blom 2016*; data courtesy: Rijkswaterstaat)*

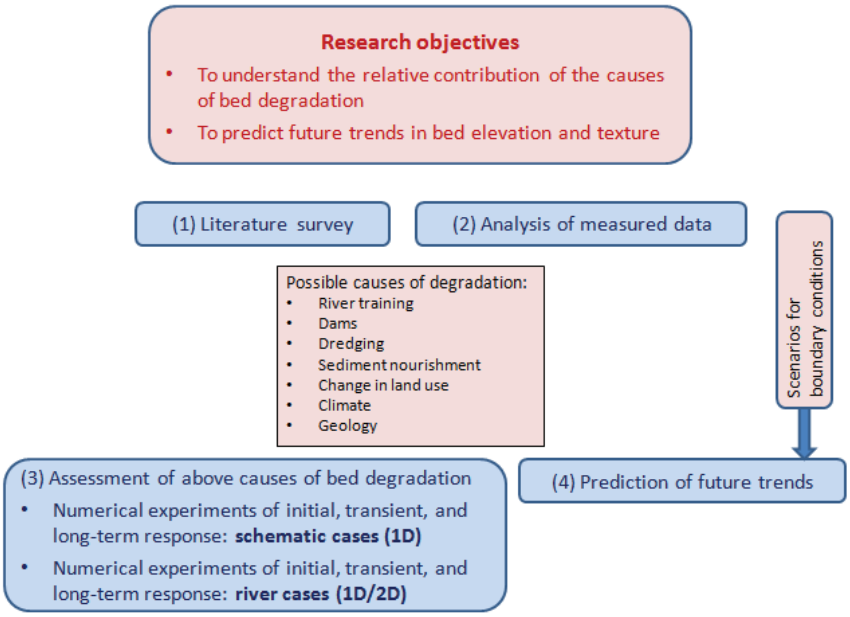

Figure 2. Approach of research (numbers indicate chronology of the research)