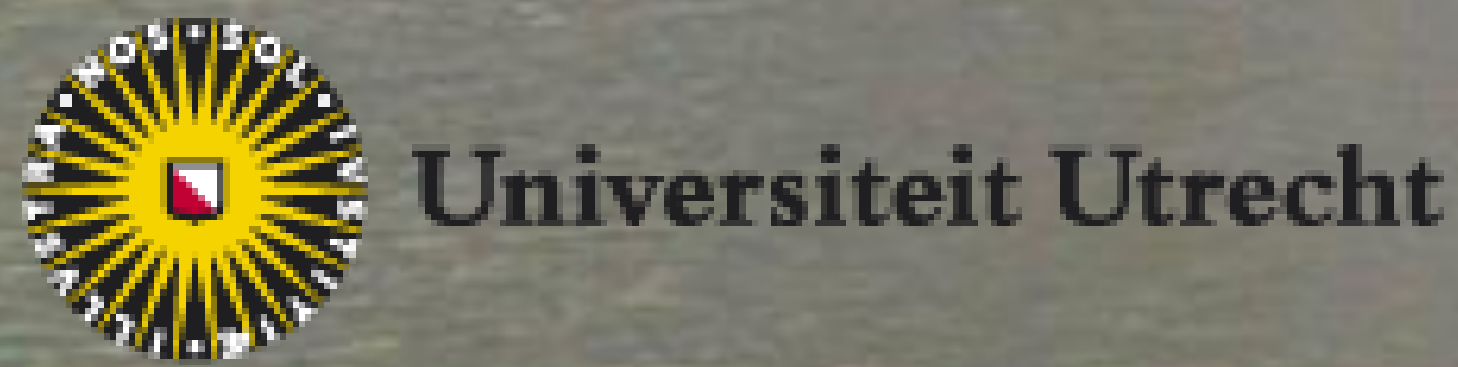


A sediment budget for the 'Kleine Noordwaard' in the Biesbosch area, the Netherlands



E.C. van der Deijl^a, M. van der Perk^a, W. Zonneveld^a, E. Verschelling^{a,b}, H. Middelkoop^a
^a Utrecht University, Faculty of Geosciences, The Netherlands
^b Deltares, the Netherlands

1. Introduction

Many deltas in the world are subject to drowning and loss of land due to accelerated soil subsidence, sea level rise and sediment starvation. Effective delta restoration requires a thorough understanding of the rates and mechanisms of delta aggradation and their controls.

This study aims to quantify the **rates** and **patterns** of aggradation in the 'Kleine Noordwaard', (Fig.1) a former polder area in the Biesbosch area in the south-west of the Netherlands, in which water and sediment have been reintroduced since 2008.

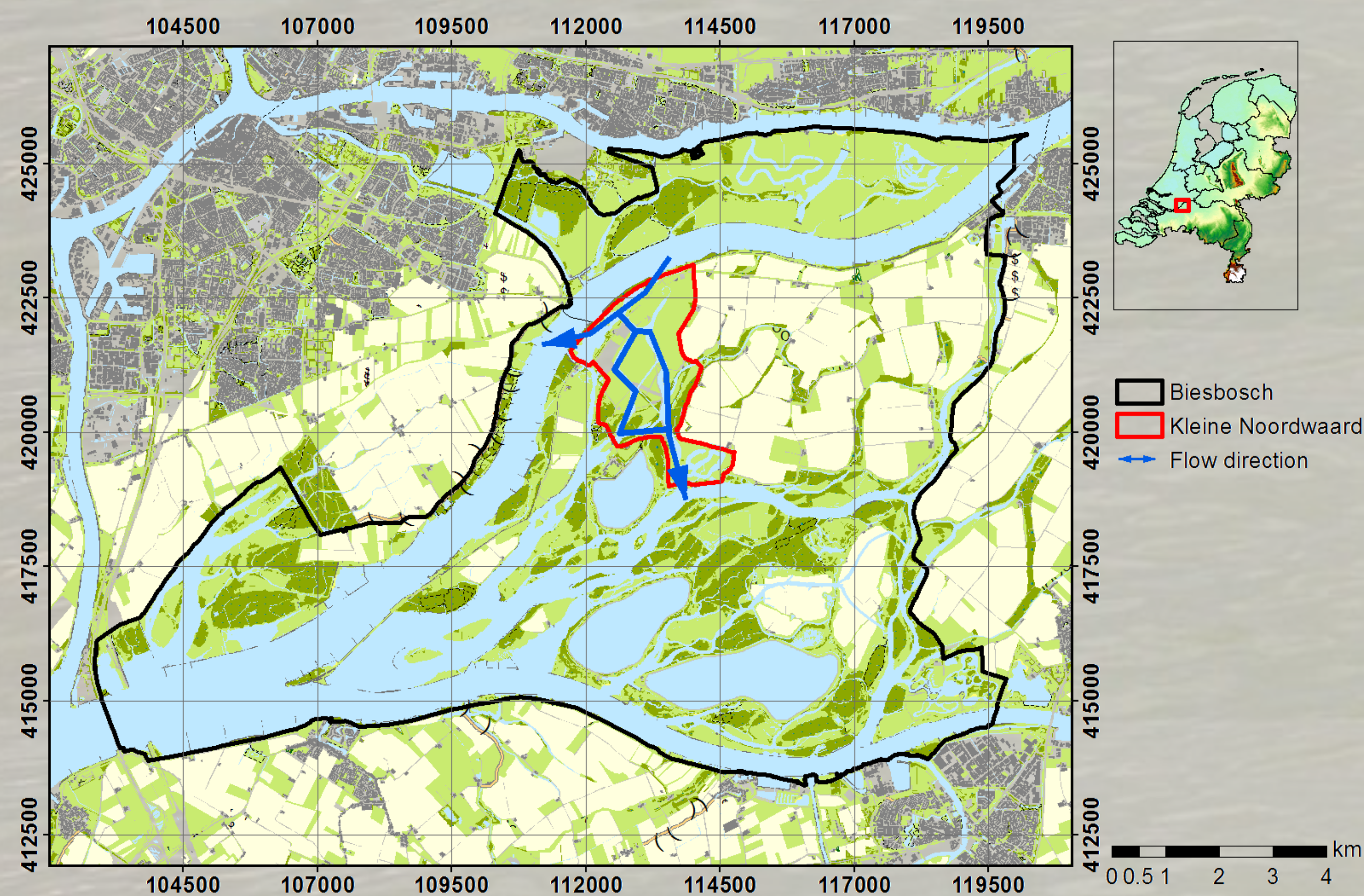


Fig. 1 Former polder area 'Kleine Noordwaard'

2. Methods

The following data were used to derive the sediment budget :

- Digital elevation model (Actueel Hoogtebestand Nederland)
- Multibeam echosounder data (bathymetry of main channels)
- Field measurements of the thickness of mud or sand deposited on the compact, former polder soil surface (Fig.2). For this, we sampled multiple transects across the study area using a transparent corer tube.
- Location and height of the cut banks measured using a dGPS device and a ruler (Fig.3).



Fig. 2 Core with sediment deposited on the former polder surface



Fig.3 Height of measurement of cutbanks

3. Results

Channels

Consecutive measurements of channel bathymetry showed that $57.4 \times 10^3 \text{ m}^3$ of sediment was retained in the channels between March 2009 and March 2012 (Fig.4), which corresponds to an sedimentation rate of 17 mm/yr.

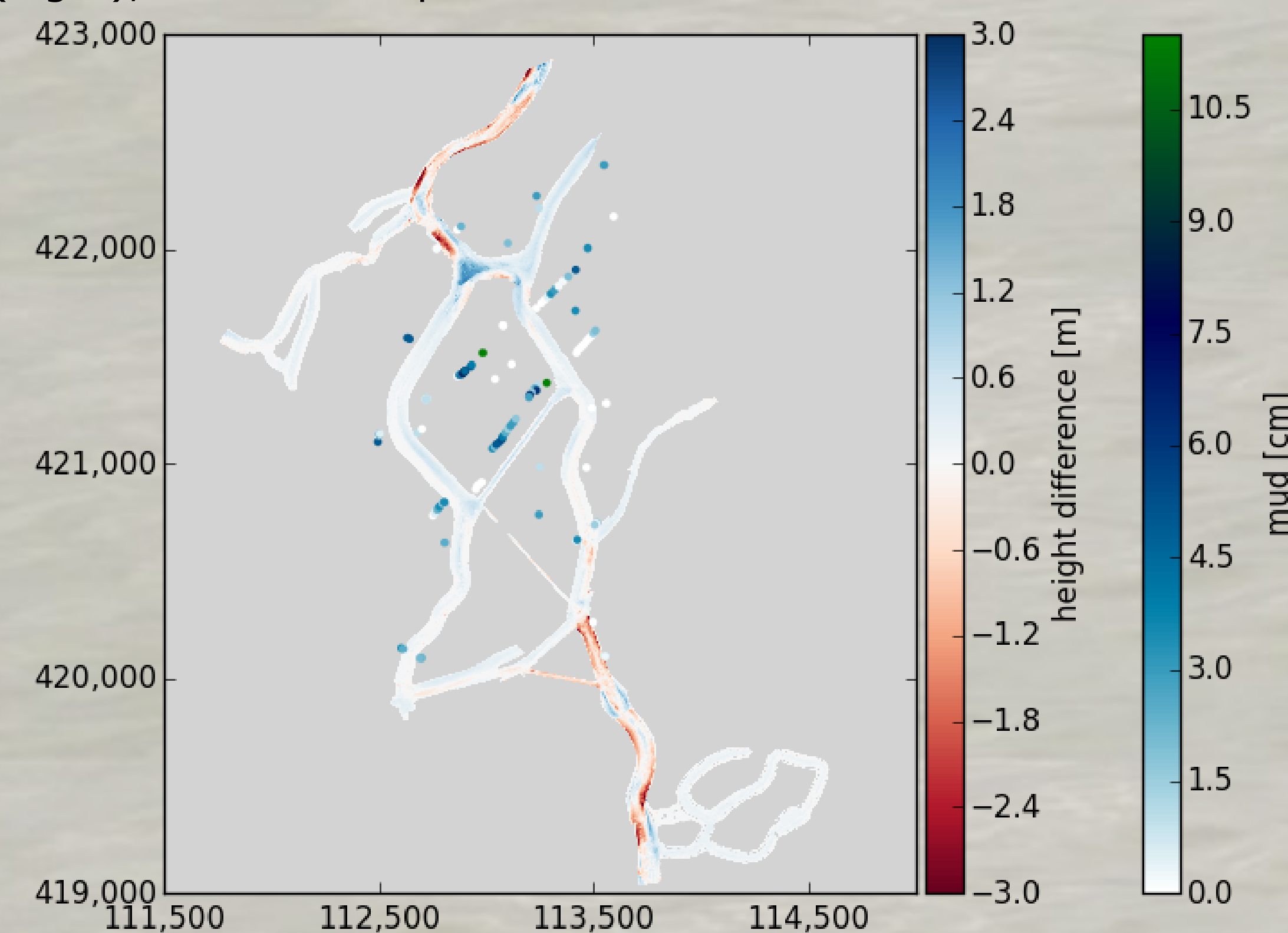


Fig. 4 Difference in bed elevation between March 2009 and March 2012. Dots represent mud accumulation on the intertidal flats between May 2008 and Oktober 2014.

Sedimentation and aggradation primarily took place in the central part of the former polder area, whereas channels near the inlet and outlet of the area underwent considerable erosion. The north-south cumulative change in bed volume (Fig.5) turns positive around y-coordinate 421940, suggesting that the same amount of sediment, eroded near the inlet (Spiering polders) is deposited within about 200 m downstream.

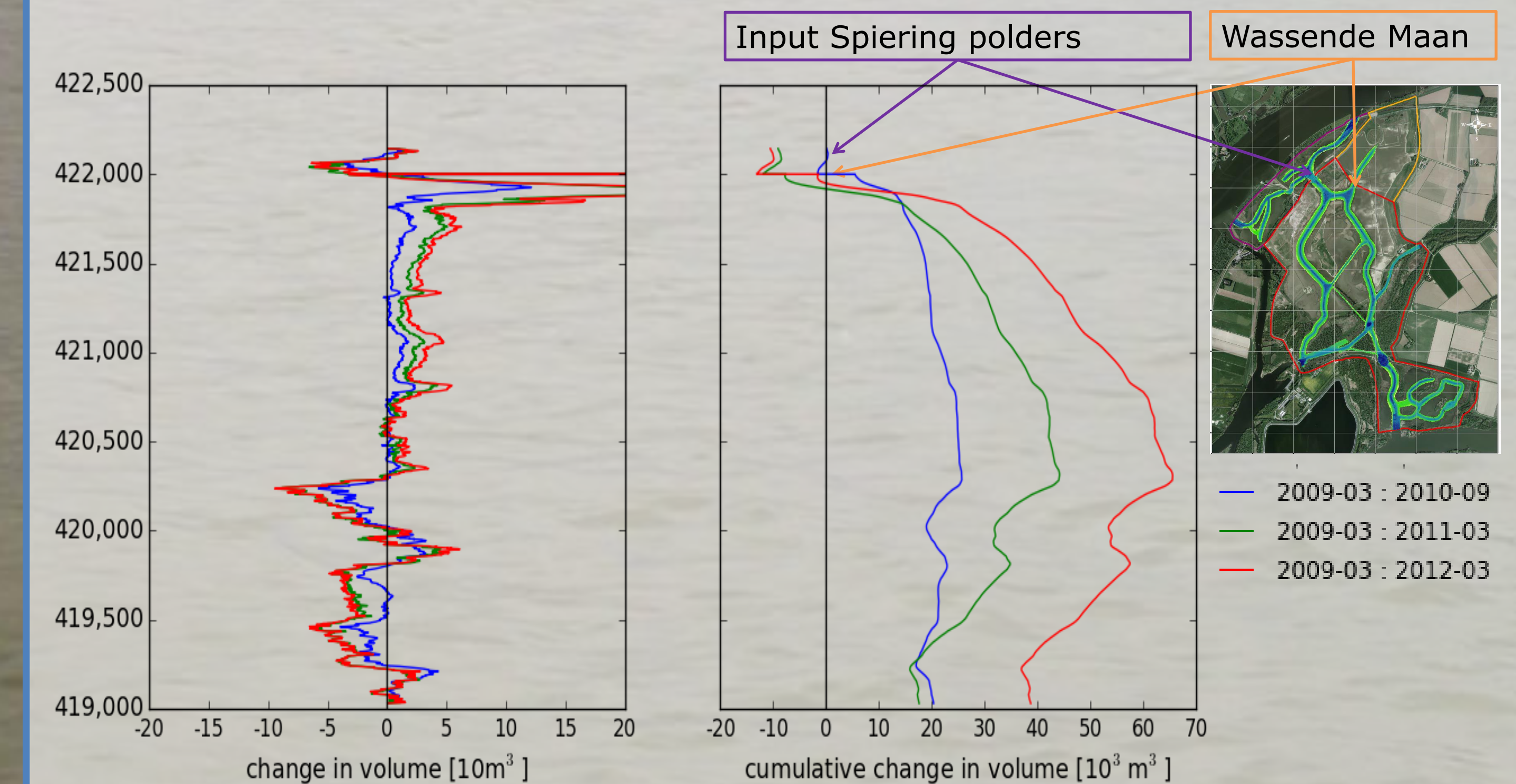


Fig. 5 The (cumulative) change in volume is shown from North to South for the area between the inlet and outlet of the Kleine Noordwaard

Intertidal flats

Approximately 21 mm of mud accumulated in the intertidal area between May 2008 and Oktober 2014 (Fig.4). This corresponds to an accumulation rate of 3,2 mm/yr.

Cut banks

Comparison of the current cut bank position and height with the digital elevation model of the area indicates that only 31 m^3 sediment eroded between 2009 and 2014, which is not significant compared to the sediment deposition and erosion in the channels and on the intertidal flats.

4. Conclusions

The total sediment budget of the 'Kleine Noordwaard' area amounted to $27.4 \times 10^3 \text{ m}^3/\text{yr}$ which corresponds to a net area-average sedimentation rate of 4.7 mm/yr during the first 5 years after depoldering of the area. The channels received $19,1 \times 10^3 \text{ m}^3/\text{yr}$ sediment and the intertidal area $8.3 \times 10^3 \text{ m}^3/\text{yr}$. Remobilisation of sediment by erosion of cut banks occurred at a negligible rate of about $-6 \text{ m}^3/\text{yr}$.

Acknowledgements

This project is financed by the Dutch Technology Foundation STW (proj.12431). We thank Rijkswaterstaat, Staatsbosbeheer and Hans de Boois for their support.