Floodplain sedimentation regulating vegetation productivity on small rivers?

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Abstract
Sediment input and associated nutrients were quantified along a vegetation gradient from the river channel to the floodplain margin in five nature reserves on four small rivers. The amount of sedimentation during the flood season of 2003-2004 was measured using sediment traps. Grain-size and nutrient analyses of the trapped sediment samples were carried out. The biomass of the vegetation is different for all investigated areas and varies between 900 g/m^2 and 200 g/m^2. Especially in the Kapperbult area on the Drentsche Aa, the biomass decreases with increasing distance from the river. Measured amounts of sediment in the Kapperbult area are small and strongly decrease with increasing distance from the river: 2.7 kg/m^2 close to the river and 0-0.07 kg/m^2 far from the river. Likewise, nitrogen and phosphate input through sedimentation also decrease with increasing distance.

Figure 1. Location of the study sites

Introduction
Flooding or water retention in combination with nature development is not in all situations without risk for the vegetation (Commissie Waterbeheer 21^e eeuw, 2000; Raad voor het Landelijk Gebied, 2001). Especially vegetation in nutrient-poor conditions will have considerable harm from flooding with nutrient-rich water. The hypothesis is that differences in biomass productivity are explained by differences in sedimentation. Quantitatively, however, the input of nutrients like nitrogen and phosphate by flooding is largely unknown (Sival et al., 2002).

The main question in our research is: what is the relationship between input of nutrients by sedimentation and the productivity for different vegetations along a gradient from the river to the floodplain margin? Is the input from sediments comparable to the input from floodwater, atmospheric deposition, mineralization and groundwater? We investigated five nature reserves on four small rivers in the Netherlands (Dommel, Drentsche Aa, Reest and Overijsselse Vecht; Fig. 1). In this paper we will mainly present results from the Kapperbult area on the Drentsche Aa.

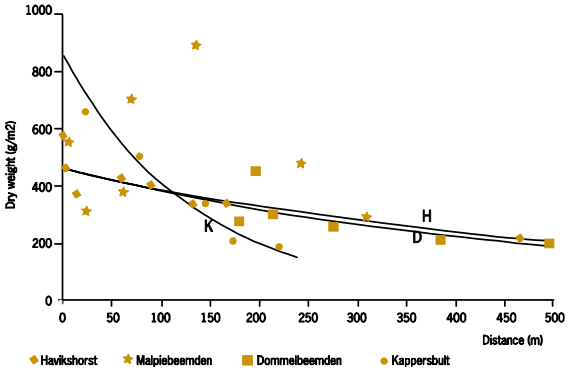

Figure 2. Vegetation biomass (g/m^2) along a gradient from the river to the floodplain margin of all investigated sites

Methods
To characterize the soil and vegetation, an inventory of both was included in the research. The standing crop of the vegetation was measured in the summer by cutting the vegetation. After drying, the vegetation sample was weighed and analyzed on N and P. Sediment traps were placed along vegetation gradients across the levee and floodbasin to the floodplain margin, in each of the study areas. After flooding, the traps were collected and the trapped sediment was analyzed on: (1) quantity, (2) texture, (3) N and P content. Special attention was paid to spatial patterns of these variables in relation to floodplain geomorphology.

Results
The biomass of the vegetation is different for all investigated areas and varies between 900

g/m^2 and 200 g/m^2 (Fig. 2). With increasing distance from the river the biomass decreases and this effect is most pronounced in the Kappersbult area on the Drentsche Aa. Low-productive vegetation (<400g/m^2), assumed to be most sensitive to nutrient input by flooding, is present far from the river.

A borehole cross-section at the Kappersbult reveals an approximately 60-cm-thick clayey and peaty clay bed on underlying peat that fills the deep Drentsche Aa palaeovalley (Fig. 3). Further away from the Drentsche Aa the clayey bed rests on fine (loamy) sand representing a coversand ridge bordering the palaeovalley. These subsurface data suggest a recent increase in sediment input, although the absolute date of this change is unknown. The composition of the topsoil reflects the present sedimentary processes. The impact of sedimentation history (and the resulting spatial variation in subsurface composition) on present vegetation productivity is still under study.

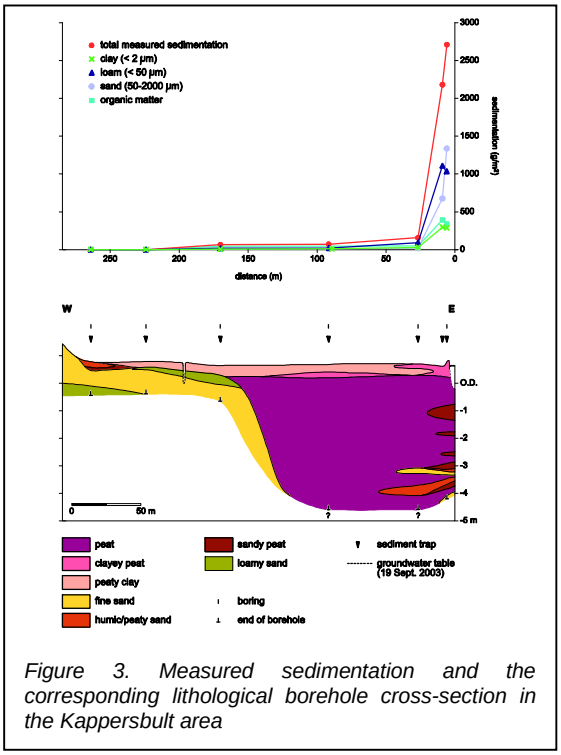

Figure 3. Measured sedimentation and the corresponding lithological borehole cross-section in the Kappersbult area

In January 2004, most study areas were flooded, with a maximum flooding duration of one week. The amounts of sediment deposited in the Kappersbult area strongly decrease with increasing distance from the river: 2.7 kg/m^2 close to the river and 0-0.07 kg/m^2 far from the river. Absolute amounts of deposited clay and organic matter, although being much lower, show a comparable spatial trend. Nitrogen and phosphate amounts also decrease with increasing distance from the river (Fig. 4). Nitrogen input varies between 90 kg/ha close to the river and 5 kg/ha far from the river (for obtaining an estimate of total input, an atmospheric deposition of 30 kg/h must be added). Phosphate input varies between 45 kg/ha close to the river and 1 kg/ha far from the river.

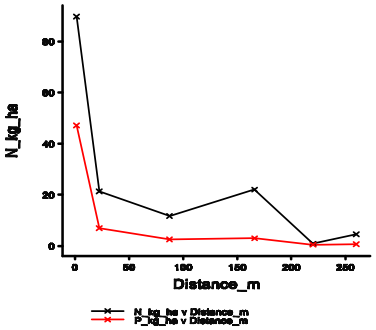

Figure 4. Amount of sediment input of nitrogen (N) and phosphate (P) (kg/ha) along a gradient from the river to the floodplain margin in the Kappersbult area

Conclusions

In the Kappersbult area the textural composition of the sediments that are presently being deposited, matches the composition of the topsoil, indicating no recent changes in the sedimentary processes. In this area the biomass of the vegetation seems to depend on the nutrient input from sediments: both significantly decrease with increasing distance from the river. These results suggest that increasing sedimentation, associated with increased flooding/water retention, may cause a change from low-productive floodplain grassland into high-productive floodplain grassland. Generally, this process will involve a strong decrease in the amount of species present in the vegetation.

Acknowledgements

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