The Rhine Delta – a record of sediment trapping over time scales from millennia to decades

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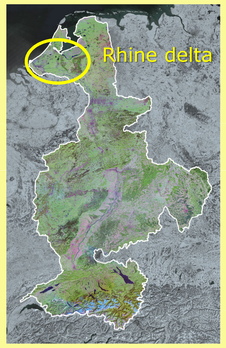
1. The delta as sediment trap



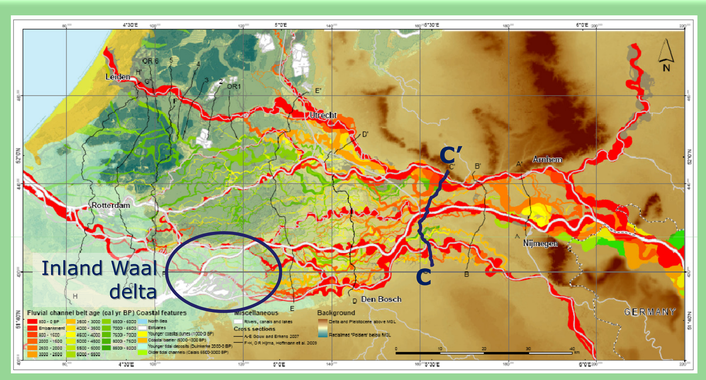
The floodplains of the Rhine delta form the last trap for fine sediments from the Rhine basin before the river reaches the estuary.

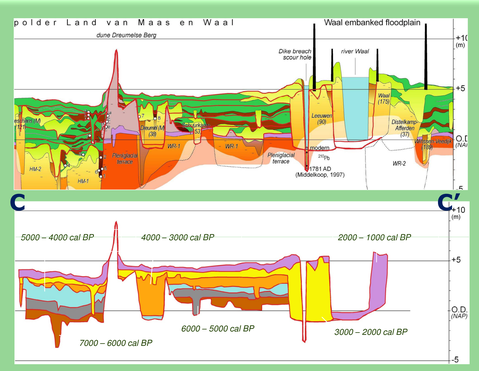
The amounts of sediment trapped in the delta have been affected by human impacts in the upper basin as well as by channel modifications in the delta.

To determined the effects of these impacts we quantified the amounts of fine overbank sediment trapped in different compartments of the delta over different time slices since 6000 BP.

For each time scale we applied a different method to calculate sediment volumes and their ages.

This poster summarises the results published as: Middelkoop et al. (2010), The Rhine Delta—a record of sediment trapping over time scales from millennia to decades. Special issue Journal of Soils and Sediments, doi 10.1007/s11368-010-0237-z



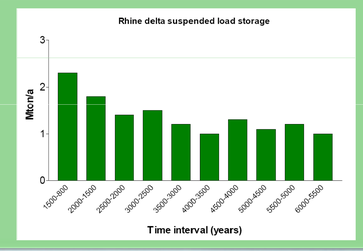


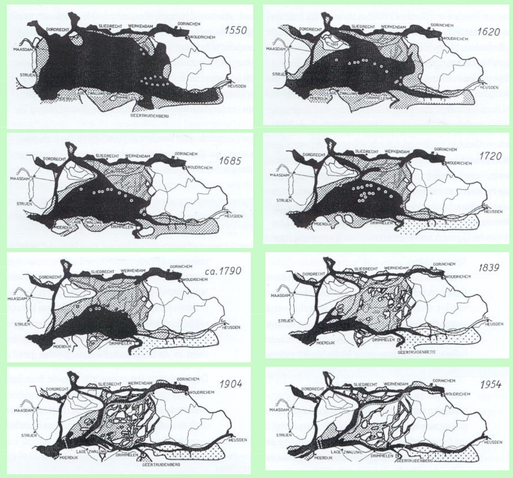
2. Natural delta: millennial time scale

The Holocene Rhine delta contains a well preserved geological record of sediment deposition.

Method: Using our coring database we determined the amounts of sediment trapped over the past millennia using 8 detailed cross sections. Age control was based on >200 ^{14}C-datings.

Results: Sediment accumulation significantly increased after 2000 BP.





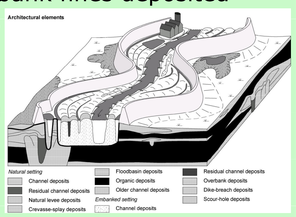
3. Embanked rivers: century time scale

Due to embankment between 1200 and 1350 AD, sediment deposition was limited to narrow zones along the main channels. After the St. Elisabeth flood in 1421 AD, the Waal branch formed an inland delta.

Method: Using coring data we calculated the amount of overbank deposits. Historic river maps were used to reconstruct post-depositional erosion of floodplains, and the growth of the inland delta.

Results: The total mass of overbank fines deposited after embankment is 640 Mton. An additional 221 Mton was deposited in the inland delta.

About 70-80% of the floodplain deposits were re-eroded by lateral channel migration.

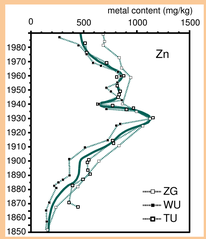


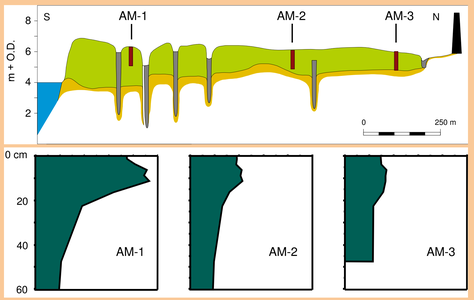
4. Normalized rivers: decennial time scale

After 1850 the channels were normalized by groynes, preventing lateral bank erosion.

Method: Sediments deposited after 1850 were traced by enhanced heavy metal concentrations. The pollution history was derived from sediments in floodplain lakes

Recent deposition was reconstructed using ^{137}Cs profiles.

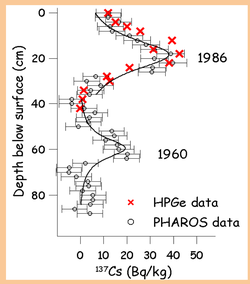


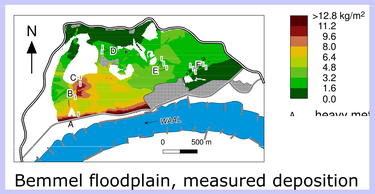


Results: The total sediment deposition over the past century amounts to 173 Mton (10^9 kg).

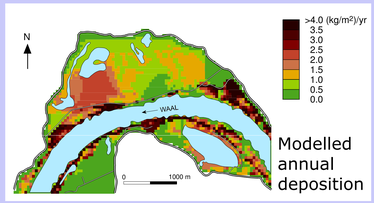
Due to the channel fixation, re-mobilisation of older sediments has not occurred.

However, 166 Mton clay was extracted for brick production.





Bemmel floodplain, measured deposition



Modelled annual deposition

5. Embanked floodplains: Present-day sedimentation rates

At present the total embanked floodplain area is 168 km^2.

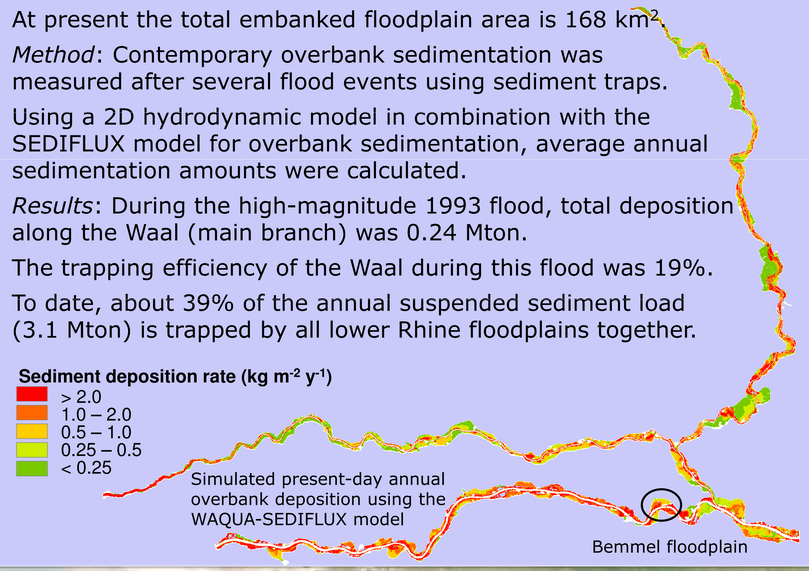
Method: Contemporary overbank sedimentation was measured after several flood events using sediment traps.

Using a 2D hydrodynamic model in combination with the SEDIFLUX model for overbank sedimentation, average annual sedimentation amounts were calculated.

Results: During the high-magnitude 1993 flood, total deposition along the Waal (main branch) was 0.24 Mton.

The trapping efficiency of the Waal during this flood was 19%.

To date, about 39% of the annual suspended sediment load (3.1 Mton) is trapped by all lower Rhine floodplains together.



6. Conclusions

Deforestation in the river basin caused increased deposition rates in the delta after 2000 BP. The bulk of these deposits have been well preserved.

Embankment of the river channels enhanced the annual amounts of deposition, but preservation of deposits was low.

Channel fixation resulted in aggraded floodplains, which reduced the trapping efficiency, but the preservation of the floodplain sediment increased.