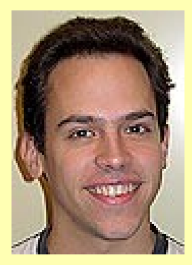
Sediment transport at the Merwedekop

- A comparison with the Pannerdensche Kop and the IJsselkop -

Roy Frings & Maarten Kleinhans

Department of Physical Geography, Universiteit Utrecht, P.O. box 80115, 3508 TC, Utrecht, the Netherlands. R.Frings@geo.uu.nl



Introduction

River bifurcations strongly control the distribution of water and sediment over a fluvial landscape. Understanding this distribution process is crucial for operational river management and for studies on delta formation.

The 3 major Rhine bifurcations are the Pannerdensche Kop, the IJsselkop and the Merwedekop. For the Pannerdensche Kop and the IJsselkop it is known that the sediment distribution is strongly determined by the low mobility of the local bed sediments (see red box).

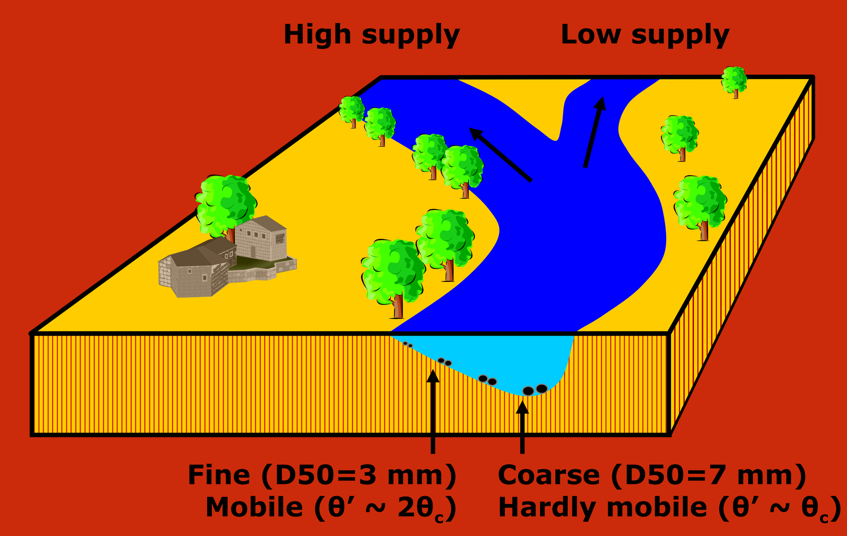
For the Merwedekop, this is unlikely because the bed sediments are very fine and probably fully mobile. The sediment distribution at the Merwedekop, however, may be influenced by tidal effects.

Objective: determining the influence of: **a)** sediment mobility & **b)** the tidal cycle on the sediment distribution at the Merwedekop.

Pannerdensche Kop & IJsselkop

Both bifurcations show a distinct bend sorting pattern in the upstream meander bend. The fine sediments in the inner bend are fully mobile, in contrary to the coarse sediments in the outer bend.

As a result, the bed-load transport into the river branch that originates in the outer bend, is very low. Therefore, the sediment transport in this so-called "outer-bend-branch" may be supply-limited.



(θ', θ$_c$: resp. actual and critical Shields stress)

Sources, a.o.:

- Frings, R.M. (2005): Sediment transport at the IJsselkop during high and low flow periods in 2002 en 2004 (in Dutch). ICG 05/02. Department of Physical Geography, Universiteit Utrecht.
- De Heer, A.F.M. & Mosselman, E. (2004), Flow structure and bed-load distribution at alluvial diversions, River Flow 2004.

Field measurements

All measurements were done by Rijkswaterstaat Zuid-Holland, during the discharge wave of January 2004 (Q_{lobith} = 6740 m³/s).

• Bed grain size	(Van Veen grab samples)
• Bed-load transport	(echosoundings/dunetracking)
• Bed-load grain size	(DNS bed load sampler)
• Susp. load transp.	(ASTM)
• Velocity, discharge	(ASTM, ADCP)
• *And much more*	*(e.g. PFS, OBS, EMS, LISST)*

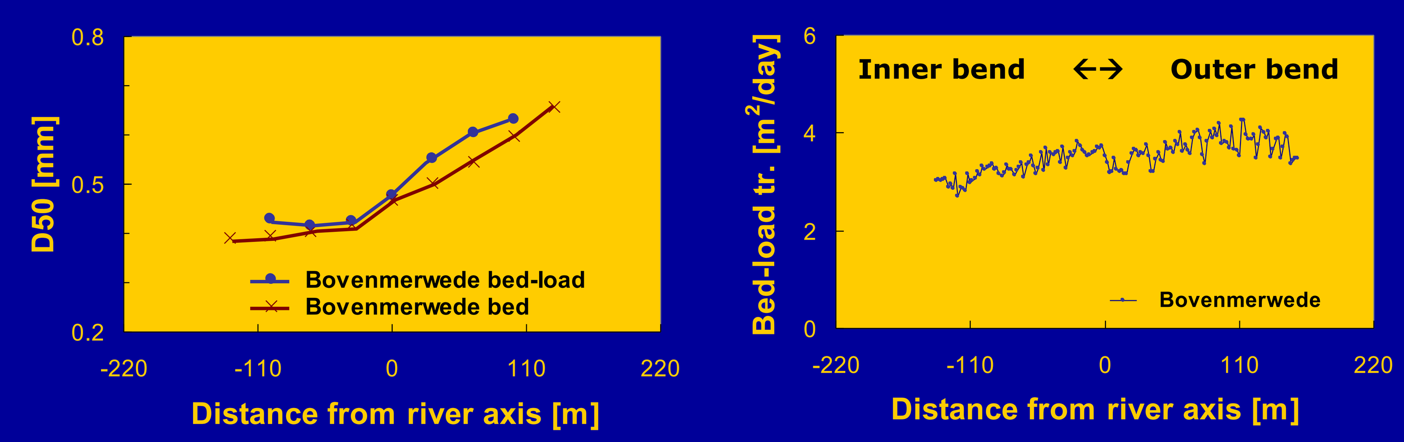
Sediment mobility

The bed samples show a distinct bend sorting upstream of the bifurcation, but both the fine and the coarse sediments are mobile:

A) Shields stress >> critical value (θ' ~ 4θ$_c$, over the entire river width. θ',θ$_c$ = resp. the actual and critical Shields stress, calculated using the measured water levels, velocities and grain sizes)

B) Bed-load transport in outer bend ~ bed-load transport in inner bend

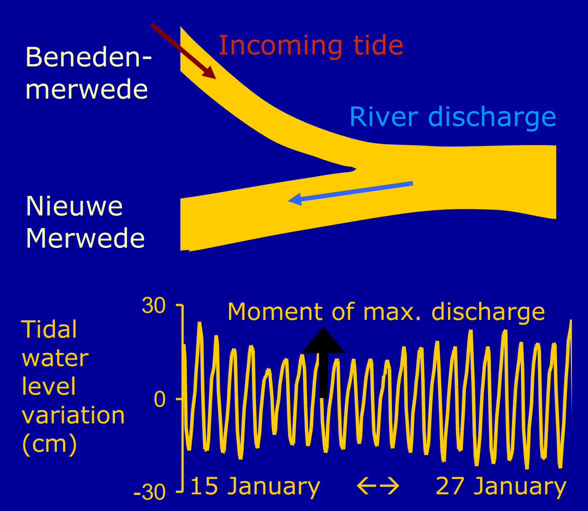
C) Bed-load grain size = bed grain size (if the bed-load grain size were finer, then the coarsest part of the bed sediment would have been immobile)



Tidal effects

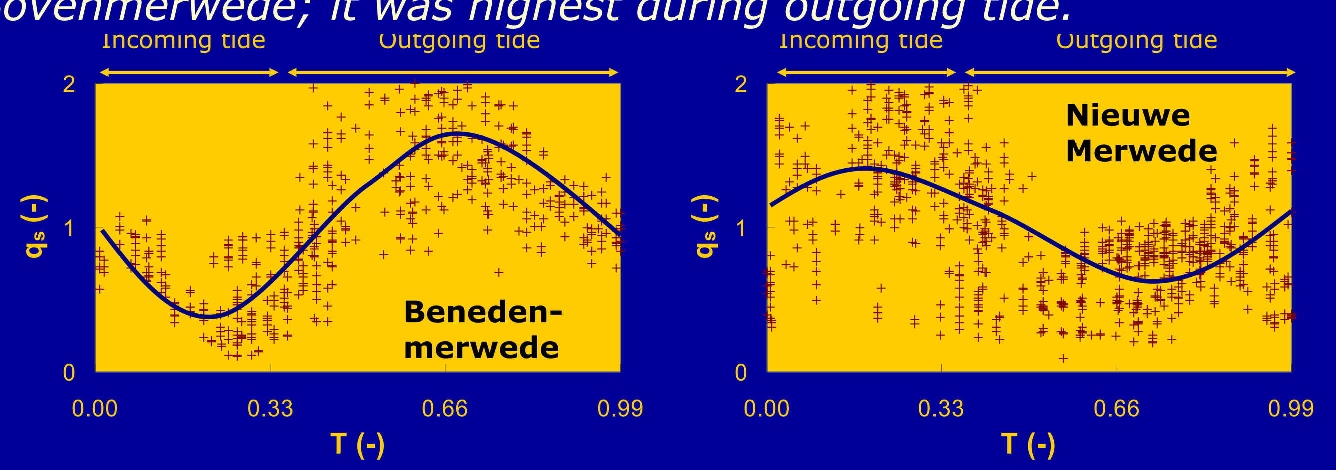
At incoming tide, the water discharge through the Benedenmerwede is hampered.

At outgoing tide the situation is reverse.



→ Incoming tide: bed-load transport highest in Nieuwe Merwede
→ Outgoing tide: bed-load transport highest in Benedenmerwede

N.B. the suspended load transport was only measured in the Bovenmerwede; it was highest during outgoing tide.



q$_s$ = bed-load transport divided by the average transport in a tidal cycle
T = time elapsed since previous low-tide, divided by tidal cycle duration (12.4 hr)

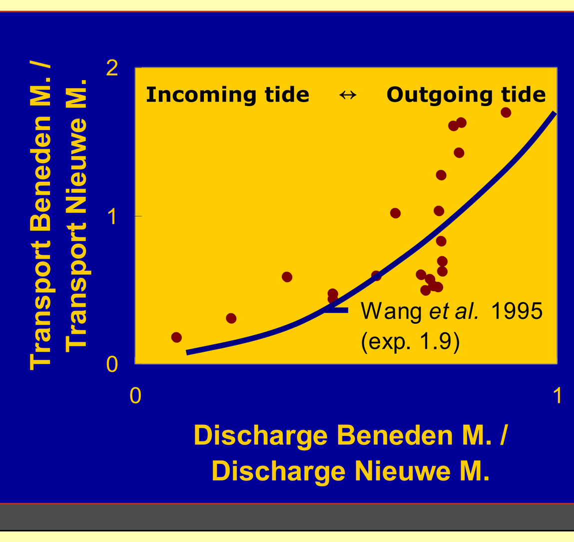
Sediment distribution

→ The coarse grains in the outer bend of the Bovenmerwede do not cause a low bed-load supply towards the Benedenmerwede, for the coarse grains are fully mobile
(Averaged over the discharge wave, the Benedenmerwede received 38% of the water and 41% of the bed-load that was supplied by the Bovenmerwede)

→ The tidal flow pattern causes the bed-load to flow mainly into the Nieuwe Merwede at incoming tide, and into the Benedenmerwede at outgoing tide.
(The amount of bed-load that entered the Benedenmerwede varied from 20 to 60% at incoming tide and outgoing tide respectively. The water supply to the Benedenmerwede was 8-32% at incoming tide and 44-48% at outgoing tide.)

Data ↔ theory

The tidal variation in bed-load distribution can moderately well be described with the theoretical func-tion of Wang *et al.* (1995).



To do...

- Harmonic analysis of tidal influence
- Determining yearly sediment distribution
- Constructing sediment balance per grain size
- Study of bifurcation-related sand-waves
- Study of dune superposition and hysteresis

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For more information: Frings, R.M. (2005): Sediment transport at the Merwedekop bifurcation during the high flow period of 2004 (in Dutch). ICG 05/03. Department of Physical Geography, Universiteit Utrecht, Utrecht.

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