The impact of human activity on the flux of bed load and suspended load is different

GILLES ERKENS

PROBLEM STATEMENT

- The hinterland of many fluvial systems has been deforested by humans to create arable land, resulting in increased erosion and sediment loads in the fluvial system.
- Once in the fluvial system, the human-induced sediment is sorted according to its grain size and transported either in suspension or over the bed.
- Both types of sediment (suspended load and bed load) differ in transport-speed, -capacity, –timing, and depositional environment.
- Therefore, the contribution of both sediment types to the sedimentary record is different, which is important information when studying a fluvial record, or when modelling sediment fluxes as a result of land use changes.

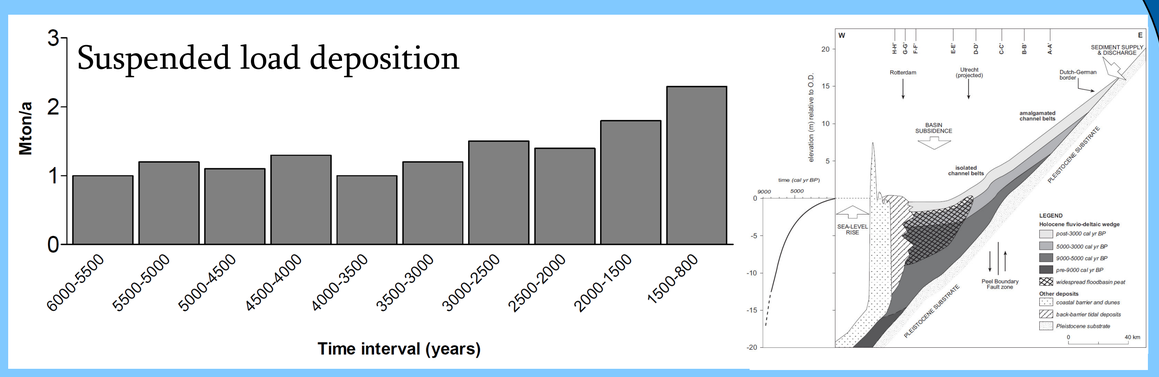
This study compares the response of bed load and suspended load to deforestation of the Rhine catchment

DATA AND STUDY AREA

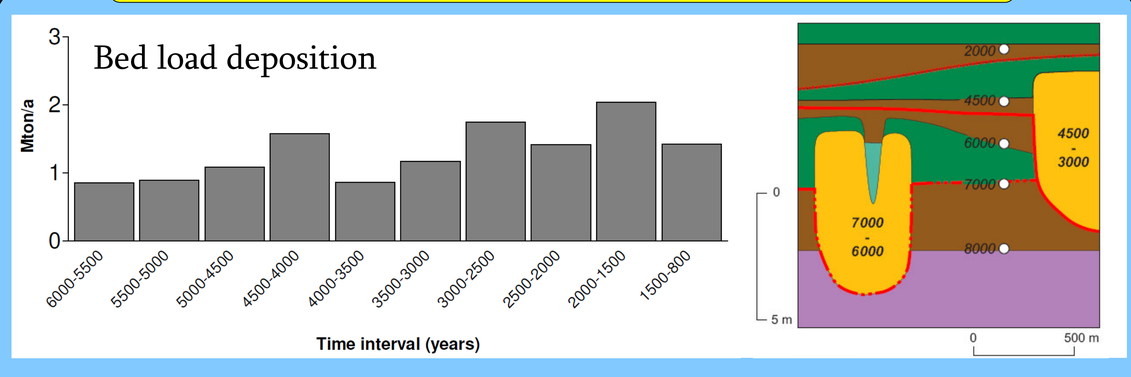
- The deposition of suspended sediment en bed sediment in the Rhine delta was quantified for each 500 years.
- Time interval of study was the last 6000 years, including the pristine (>3 ka) and human-impacted period (<3 ka).
- Input data were 11 palaeogeographic maps, 8 valley wide cross-sections, 1400 OSL/^{14}C dates .
- All values are corrected for preservation, reworking, and internal sediment re-deposition.

Rhine delta

RESULTS: SUSPENDED LOAD



RESULTS: BED LOAD



Suspended load deposition
Shows a smooth trend during the last 6000 years

Preservation
On average 82% of the deposited amount is still present

Internal sources
The potential contribution of reworked sediment is 18%

Accommodation space
Large, and directly coupled to relative sea level rise

Trap efficiency
Constant 70% of the delivered suspended sediment is trapped

Trends in suspended sediment delivery
There is a gradual increase in suspended sediment delivery, related to the deforestation in the hinterland

Bed load deposition
Shows a trend with peaks during the last 6000 years

Preservation
Unknown, probably ca 50 % (see below)

Internal sources
The potential contribution of reworked sediment is 50%

Accommodation space
Depends on the *cumulative* Holocene relative sea level rise

Trap efficiency
Highly variable, depends on number of active channels (1-4)

Trends in bed sediment delivery
The record is obscured by the changes in trap efficiency, yet possibly there is a gradual increase

DISCUSSION POINTS

INVENTORIES OF BED LOAD TRAPPING ARE GOOD RECORDERS OF LOCAL AUTOGENIC DYNAMICS
- The bed sediment record is more related to changes in local trap efficiency (more active channels) than to upstream changes
- A local source: potentially all delivered sediment is coming from net incision and reworking in the 150 km upstream lower valley
- Bed load is transport-limited: discharge is less sensitive to land use change in a sizable catchment such as the Rhine

SUSPENDED LOAD IS A GOOD PROXY TO QUANTIFY UPSTREAM ALLOGENIC CHANGES
- Suspended sediment is derived from the entire catchment, and represents changes in upstream sediment dynamics
- Suspended sediment is supply limited, and in case of ample accommodation space, the amount of deposited sediment is directly related to the delivered amount

Universiteit Utrecht

Geological Survey of The Netherlands

Gilles Erkens (g.erkens@geo.uu.nl) Department of Physical Geography,
Faculty of Geosciences, Utrecht University, P.O. Box 80.115, 3508 TC Utrecht, the Netherlands.
Tel.:+31(0)30 253 2758. Website: www.geo.uu.nl/fg/palaeogeography.

Reference:
Erkens, G. , 2009. Sediment dynamics in the Rhine catchment - quantification of fluvial response to climate change and human impact. Published PhD-thesis Utrecht University. Netherlands Geographical Studies 388, 278 pp.