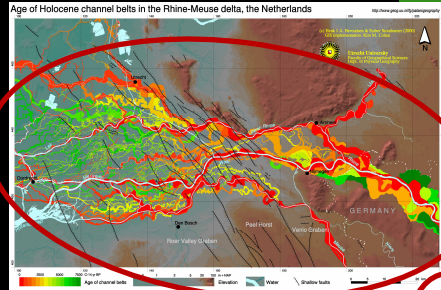


A VIEW FROM A SEDIMENT SINK:

Quantification of Holocene sediment delivery to the floodplains in the Rhine valley and delta



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INTRODUCTION

Two allogenic forcing factors determine vegetation cover in the Rhine drainage basin during the Holocene:

- early Holocene postglacial climatic warming
- increasing human cultivation of land in the second half of the Holocene

This is likely to have influenced erosion and subsequent sediment delivery to the fluvial system. But up till now it was unknown to what extent this caused changes in sedimentation in the floodplains of the Rhine trunk valley and delta downstream.

Therefore we have quantified the amounts of floodplain sedimentation per millennium over the timescale of the Holocene in three main sediment sinks along the Rhine trunk river: the Upper Rhine Graben, the Lower Rhine Embayment and the Rhine-Meuse delta.

New collected field data and borehole data from extensive databases was used to calculate the thicknesses and ages of floodplain sediments. This information allowed to calculate floodplain sediment storage and to estimate sediment delivery on a catchment-scale.

THE SEDIMENT BUDGET APPROACH

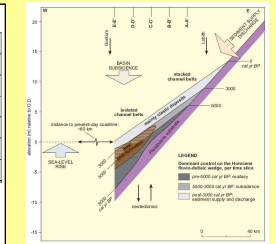
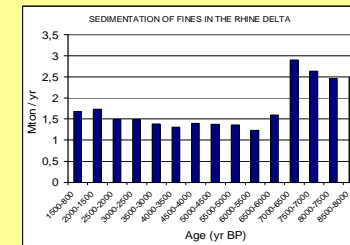


$$\text{VOLUME} = \sum [\text{THICKNESS} \times \text{AREA}] \text{ segment, timeslice, facies}$$



RESULTS: RHINE-MEUSE DELTA

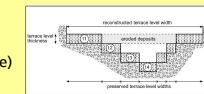
- early Holocene sedimentation was high, due to:
 - high sediment delivery **and/or**
 - high trapping efficiency (eustatic sea level rise)
- middle Holocene sedimentation was low, due to:
 - low sediment delivery, **but**
 - high trapping efficiency (lagoon-delta)
- late Holocene sedimentation was increasing (after ~2000 BP), due to:
 - high sediment delivery, **even though**
 - relatively low trapping efficiency (large tidal inlets)



RESULTS: LOWER RHINE EMBAYMENT

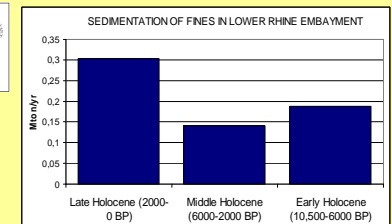
Compared to the Rhine delta:

- **no** downstream allogenic forcing (zero effect of sea level rise)
- only upstream forcing (sediment delivery)
- trapping efficiency is decreasing during the Holocene (due to incision)



Reconstructed sedimentation rates show:

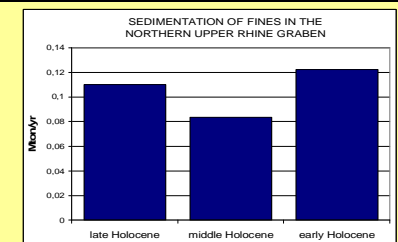
- same trend as in Rhine delta, thus:
- sedimentation trend is result of upstream sediment delivery



RESULTS: northern UPPER RHINE GRABEN

Compared to the Lower Rhine Embayment, this sink shows:

- same general trend in sedimentation during the Holocene
- timing of Late Holocene increase may be a little earlier (Late Holocene starts 3000 BP)
- Late Holocene values is relatively smaller; early Holocene values relatively larger
- In general absolute floodplain sedimentation is 30 – 50 % lower than LRE



Thus: sedimentation in all sinks is similar – this implies that sediment delivery overrules local (site-specific) sedimentation characteristics and that we reconstructed a catchment-wide trend

DISCUSSION/CONCLUSIONS

- High Early Holocene sedimentation - delayed response of the system to the postglacial climatic warming ?
- High Late Holocene sedimentation - shift from a natural controlled to a human modified fluvial system ?
- The results imply that prehistoric human land-use already modified sedimentation patterns on a large spatial scale, such as the Rhine drainage basin.
- The calculated floodplain sedimentation witness the response of the Rhine system to allogenic forcing (climate, human impact) on an interglacial time scale.

FURTHER READING:

Erkens, G., Cohen, K.M., Gouw, M.J.P., Middelkoop, H. & Hoek, W.Z. (2006) Holocene sediment budgets of the Rhine Delta (The Netherlands): a record of changing sediment delivery. In: Rowan, J.S., Duck, R.W., Werritty, A. (Eds.), *Sediment Dynamics and the Hydromorphology of Fluvial Systems*, IAHS Publication 306; 406-415.

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