Advances and prospects in deltaic palaeoflood hydrology

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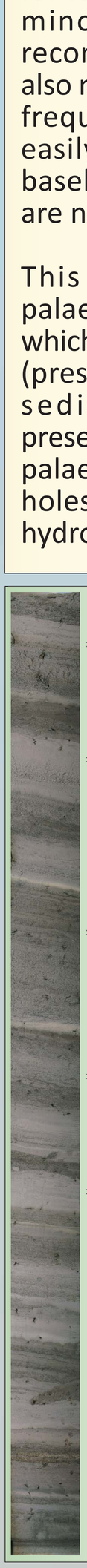
Deltares
Enabling Delta Life

INTRODUCTION

Traditional palaeostage indicators for palaeoflood magnitudes are less suitable for low-lying river valleys and deltas with minor flood amplitude. Palaeoflood reconstructions in upstream reaches are also not very suitable for downstream flood frequency analysis: flood pulses die out easily. Hence, independent palaeoflood baseline studies for downstream reaches are needed.

This calls for new approaches and palaeoflood proxies to be developed, for which recent methodological advances exist (presented on this poster). Especially the sedimentological properties and preservation potential of deltaic deposits in palaeochannel fills and dike breach scour holes are key in this type of palaeoflood hydrology.



SEDIMENTOLOGY

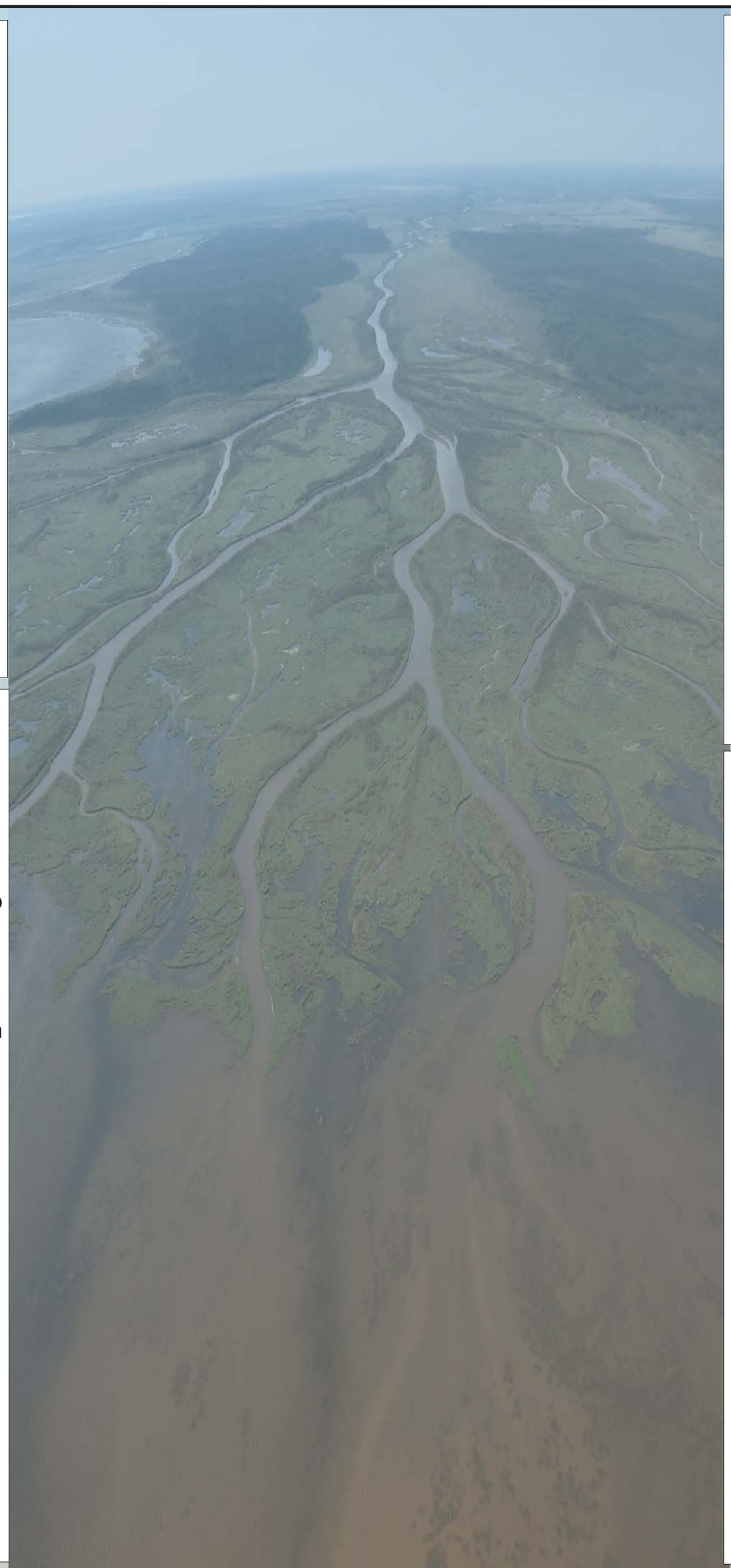
* Understanding of deltaic depostional environment (e.g., channel fills; Toonen et al., 2011)

* High-resolution grain size analysis as a proxy for flow velocities; Statistical transfer of grain size data into flood magnitudes with End Member statistics

* Organic content (LOI) as a quick analysis to detect major trends in sedimentation style and to detect flood peaks (Hoek et al., 2011)

* Chemical element ratios to track down high-magnitude flooding events (Zr/Rb; Jones et al., 2010)

* Chemical fingerprinting of flood laminations to reconstruct source area



HYDROLOGICAL MODELS

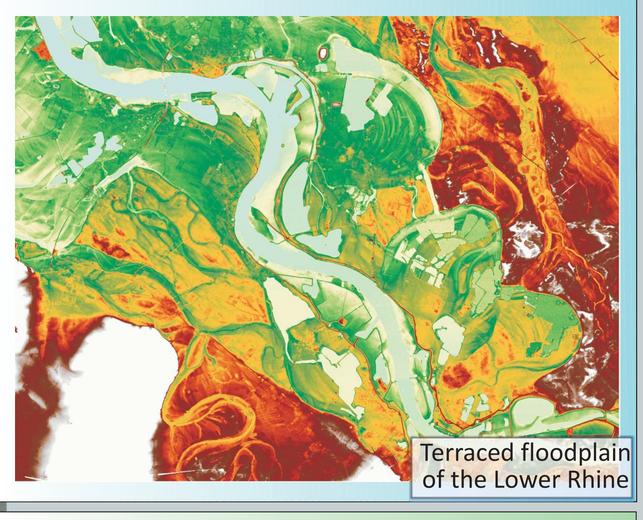
Input data for deltaic palaeodischarge calculations;

* Subtle stage registration of flood amplitudes on different terrace levels

* Accurate timing of floods by dating flood laminations in channel fills

* Preservation of palaeolandscape

* Vegetation roughness, reconstructed from palynology (in channel fills)



GEOCHRONOLOGY

* Abundant organics suit AMS dating

* Organic content (LOI) of deposits as a tool to interpolate between geochronological markers (Hoek et al., 2011)

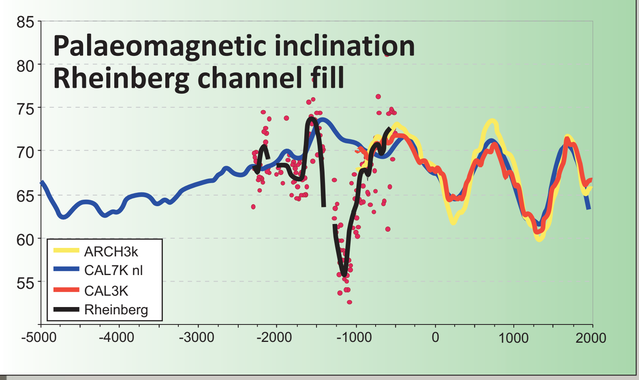
* Chemical markers
  - pollutants (Roman Pb, mining etc.)

* Palynological markers
  - deforestation signals
  - agricultural introductions
  - washed-in exotics

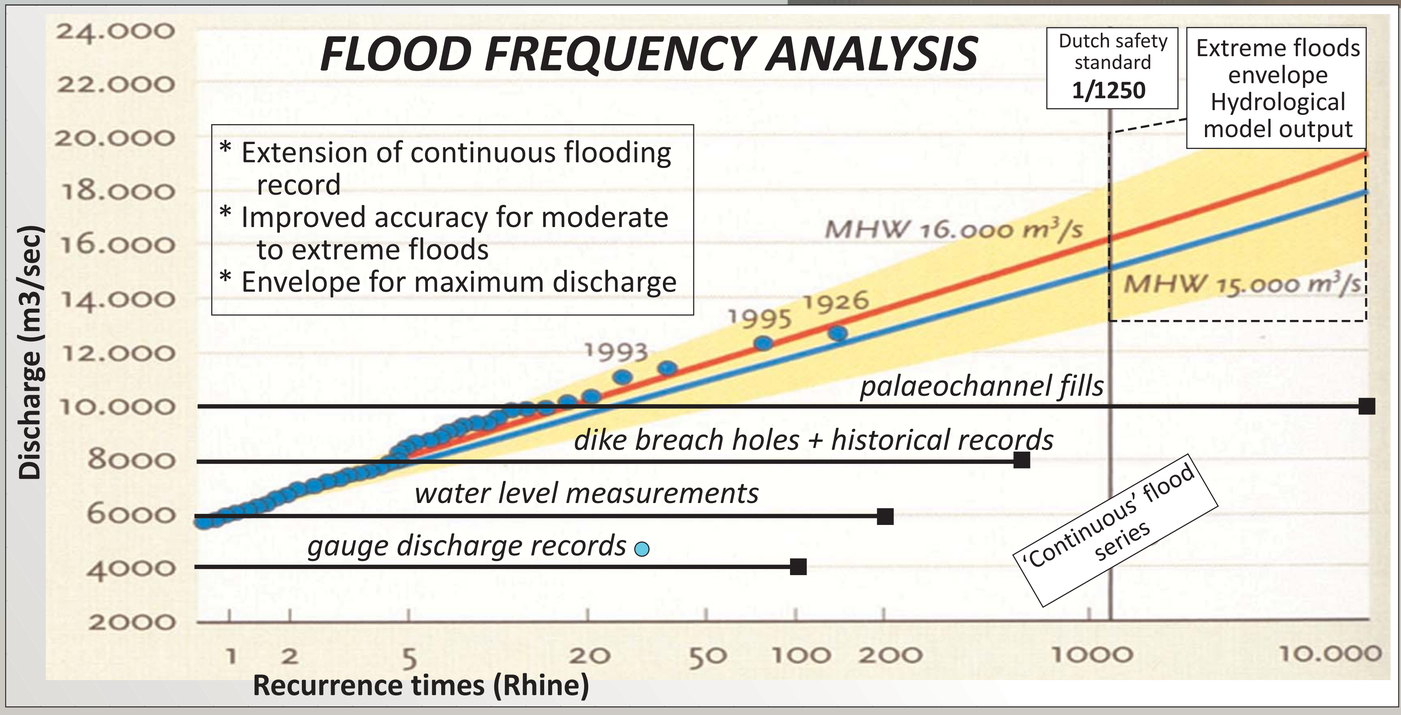
* Historical flood records
  - many deltas have long occupation

* Tephrachronology

* Palaeomagnetism in clayey channel fills



FLOOD FREQUENCY ANALYSIS



PROSPECTS

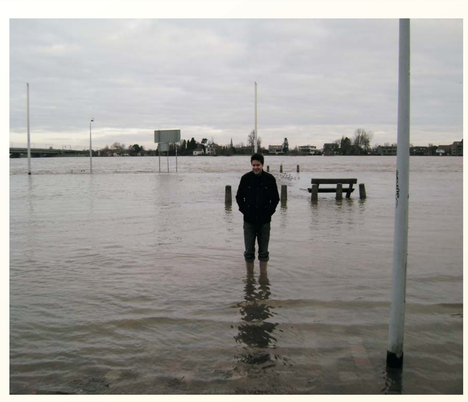
Continuous series of Holocene palaeofloods can be deduced from deltas by adressing;

* Non-stationarity of recurrence times

* Climatic influence on mode of flooding

* Human influence on flooding variations

This will result in improved palaeoflood histories, and better flood mitigation and river management



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Age modelling	W. Hoek, P. Minderhoud
End member statistics	M. Prins[2]
Fingerprinting	M. Macklin[3], M. van der Perk

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1) TNO Geological Survey of the Netherlands, 2) VU Amsterdam, 3) University of Aberystwyth; all other co-workers are from Utrecht University

References

Hoek, W.Z., Minderhoud, P.S.J., Cohen, K.M., Erkens, G., Toonen, W.H.J., 2011. Towards a decadal flood record of the river Rhine over the past 7000 years. Abstract INQUA 2011 Bern.

Jones, A.F., Lewin, J., Macklin, M.G., 2010. Flood series data for the later Holocene: Available approaches, potential and limitations from UK alluvial sediments. The Holocene 20:7, p 1123-1135.

Toonen, W.H.J., Kleinhans, M.G., Cohen, K.M., 2011. Sedimentary architecture of abandoned channel fills. Submitted to ESPL.

Photographs

Middle	Mossy delta of the Saskatchewan River, Cumberland Marshes (Canada). Van Asselen, Bos, Toonen.
Left	Oxbow lake of the abandoned Old Channel of the Saskatchewan River (Canada). Van Asselen, Bos, Toonen.
Right	High water (winter 2011) of the river Waal near the city of Nijmegen. Toonen.

Figures & graphs

Hydrology	DEM of the terraced floodplain of the Lower Rhine between Xanten and Rees (Germany).
Geochronology	Measurements of the inclination signal in palaeochannel fill deposits (Rheinberg, Germany).
Flood freqency analysis	Extrapolation of the size of the '1/1250' flood, based on modern gauge measurements (RWS).