

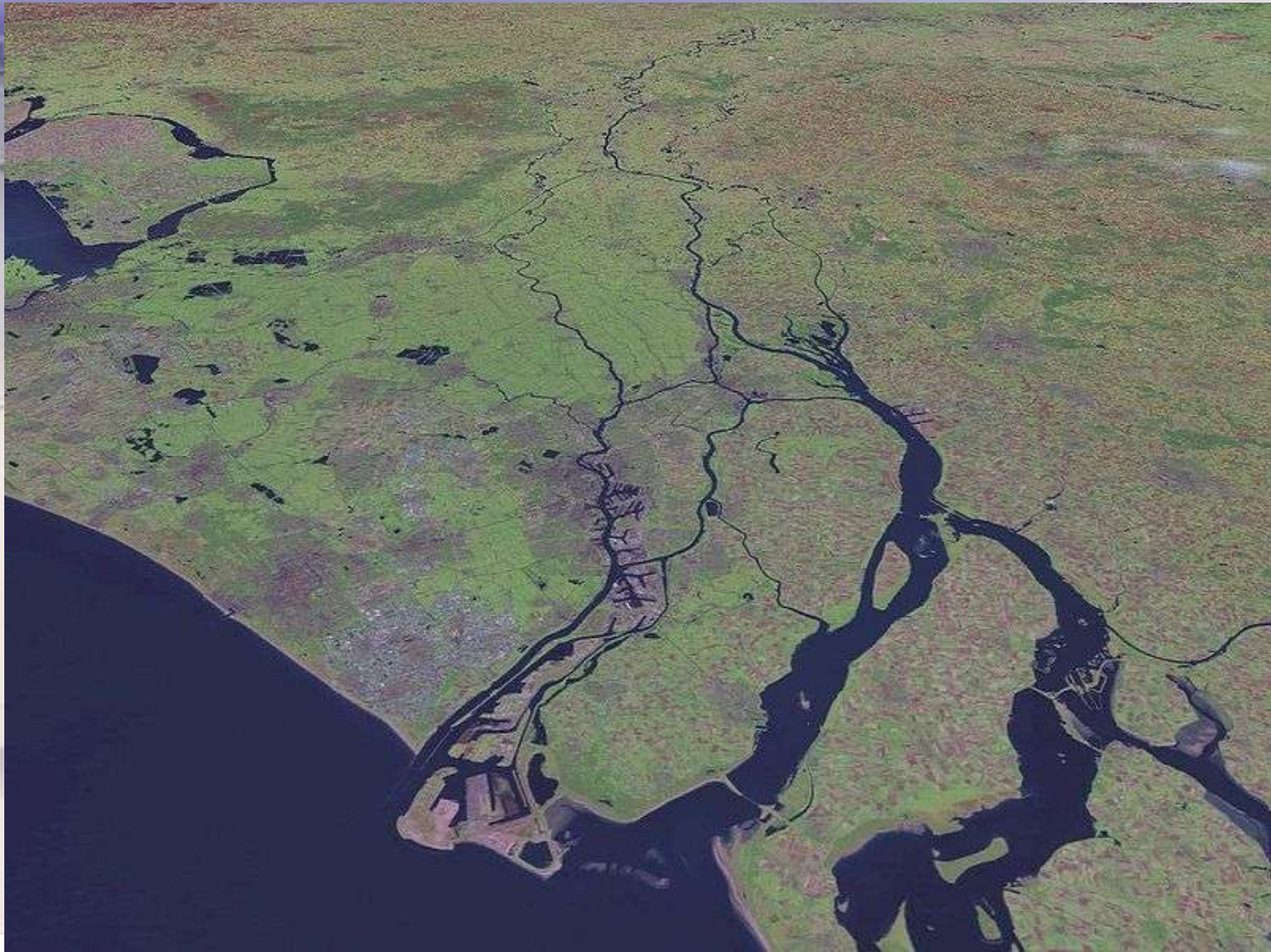


Mysteries van het Rijnland

Gilles Erkens e.a.

9 november 2010

Inleiding



9 november 2010

Deltares

Onderzoekspartners



Universiteit Utrecht



Koster



Hoek



Berendsen



Cohen



Universiteit Utrecht



Middelkoop



Stouthamer



Hoffmann



Kennis voor zaken



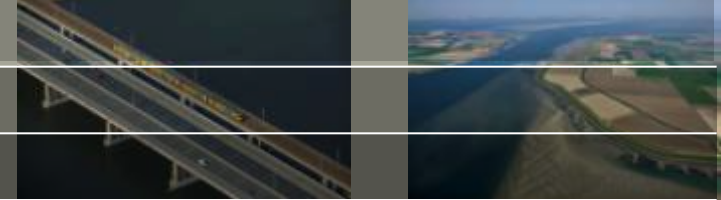
Van der Meulen



Dambeck



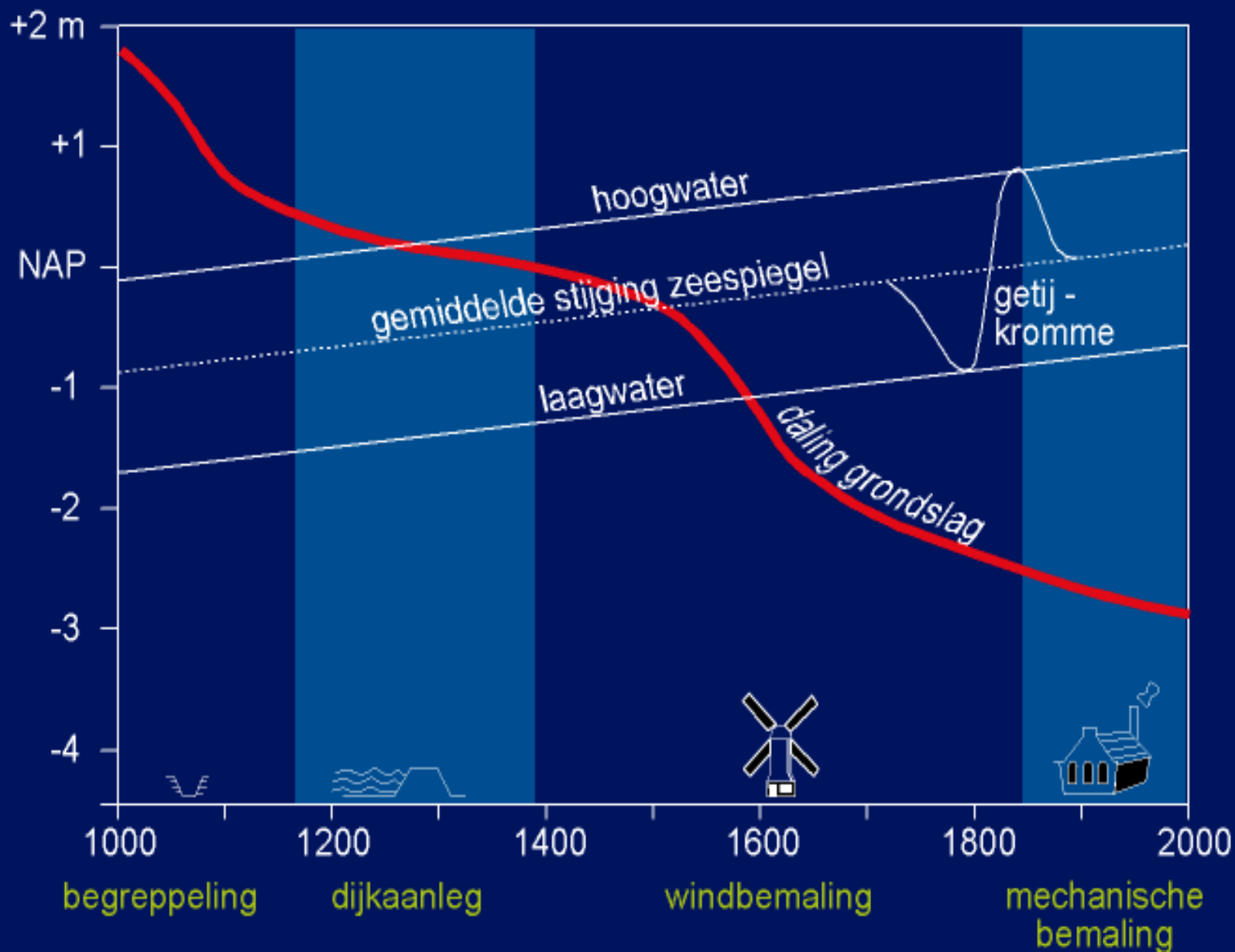
Inleiding – de Rijn-Maas delta



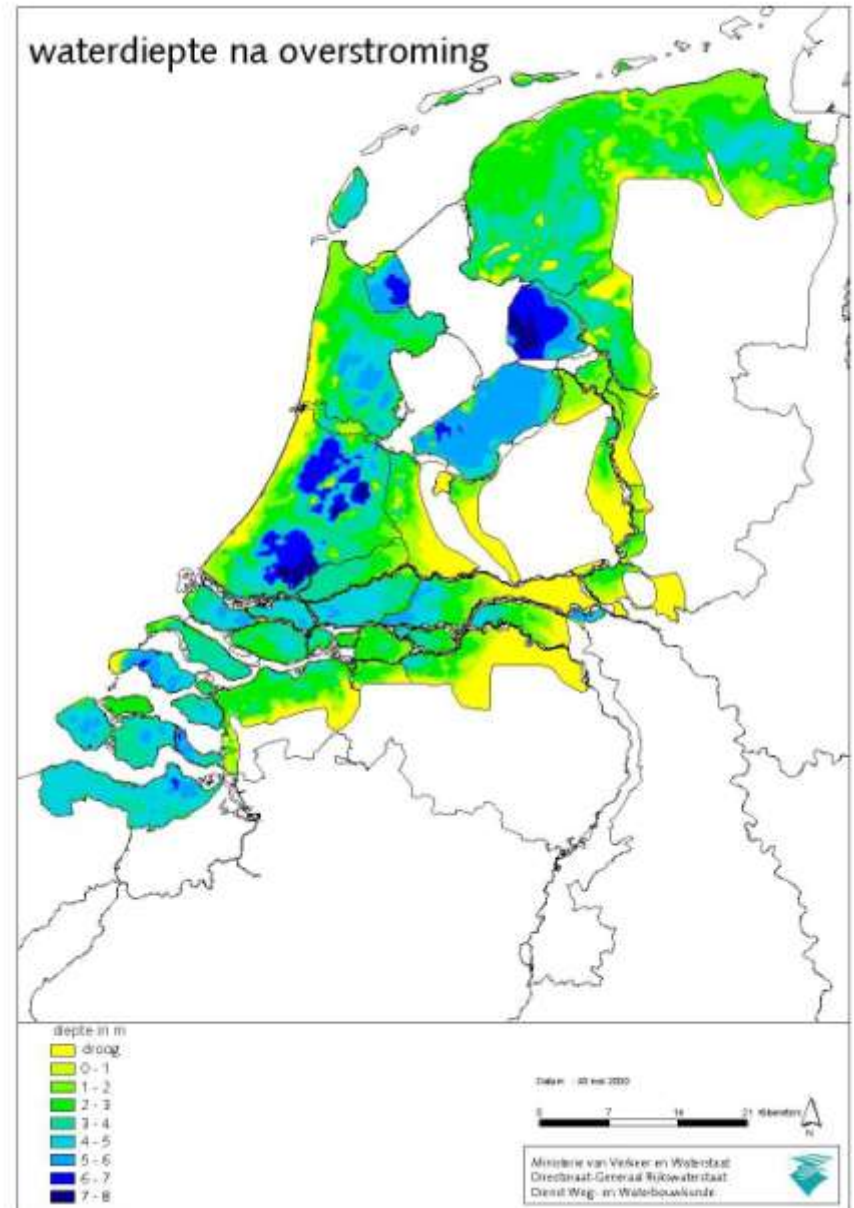
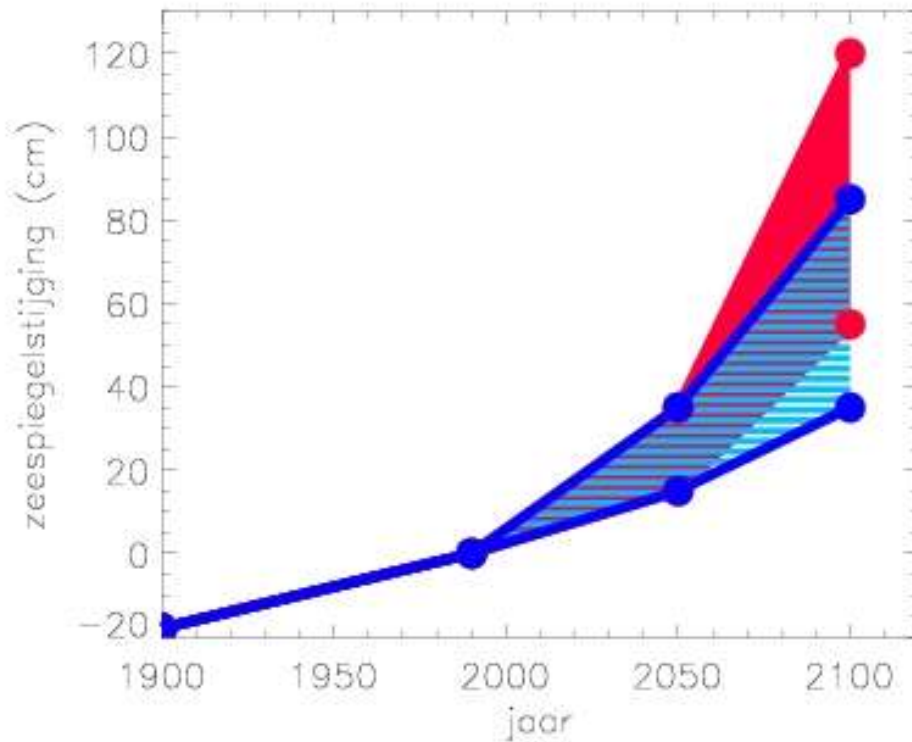
Problemen in de Rijndelta



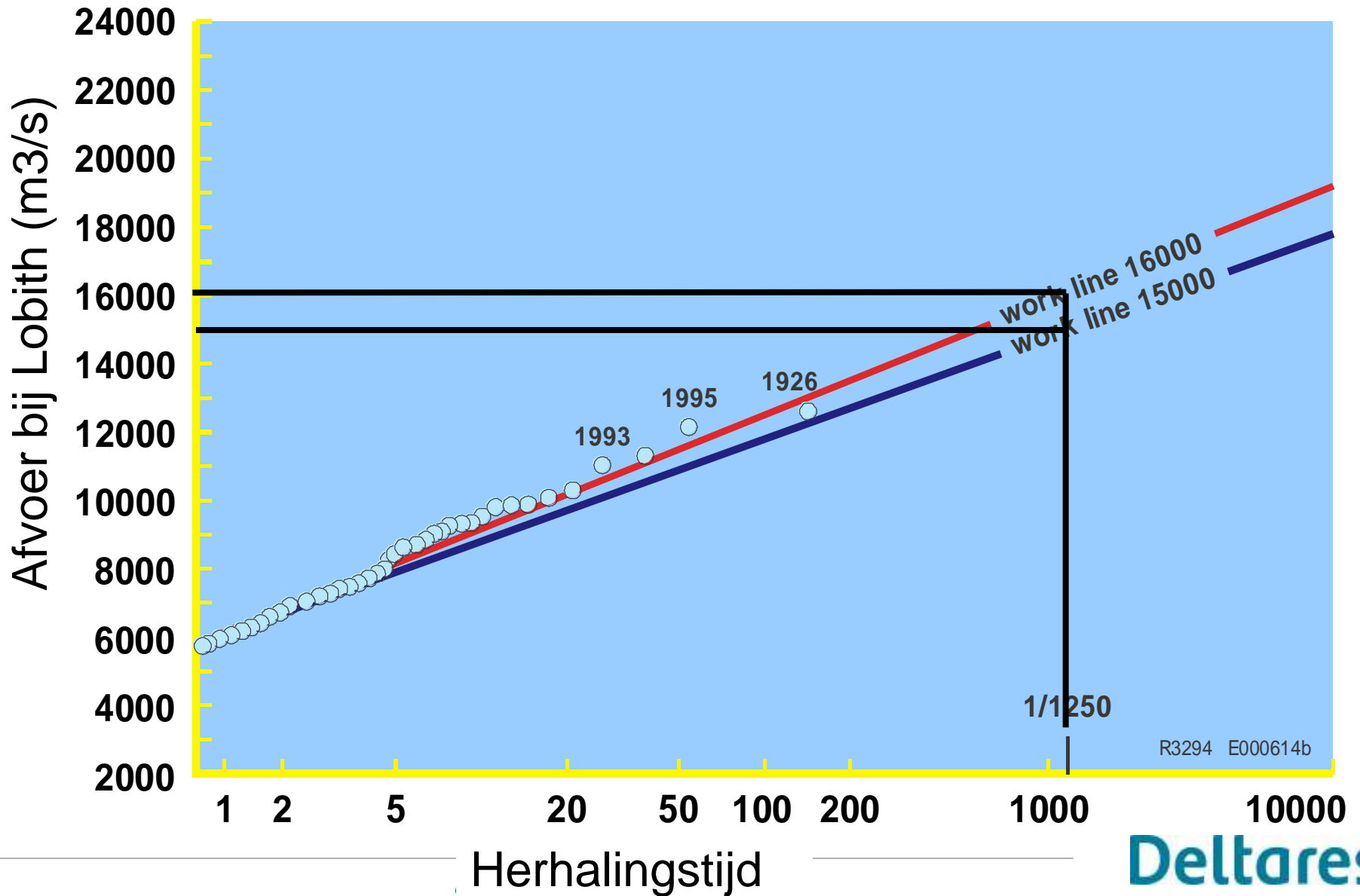
Bodemdaling



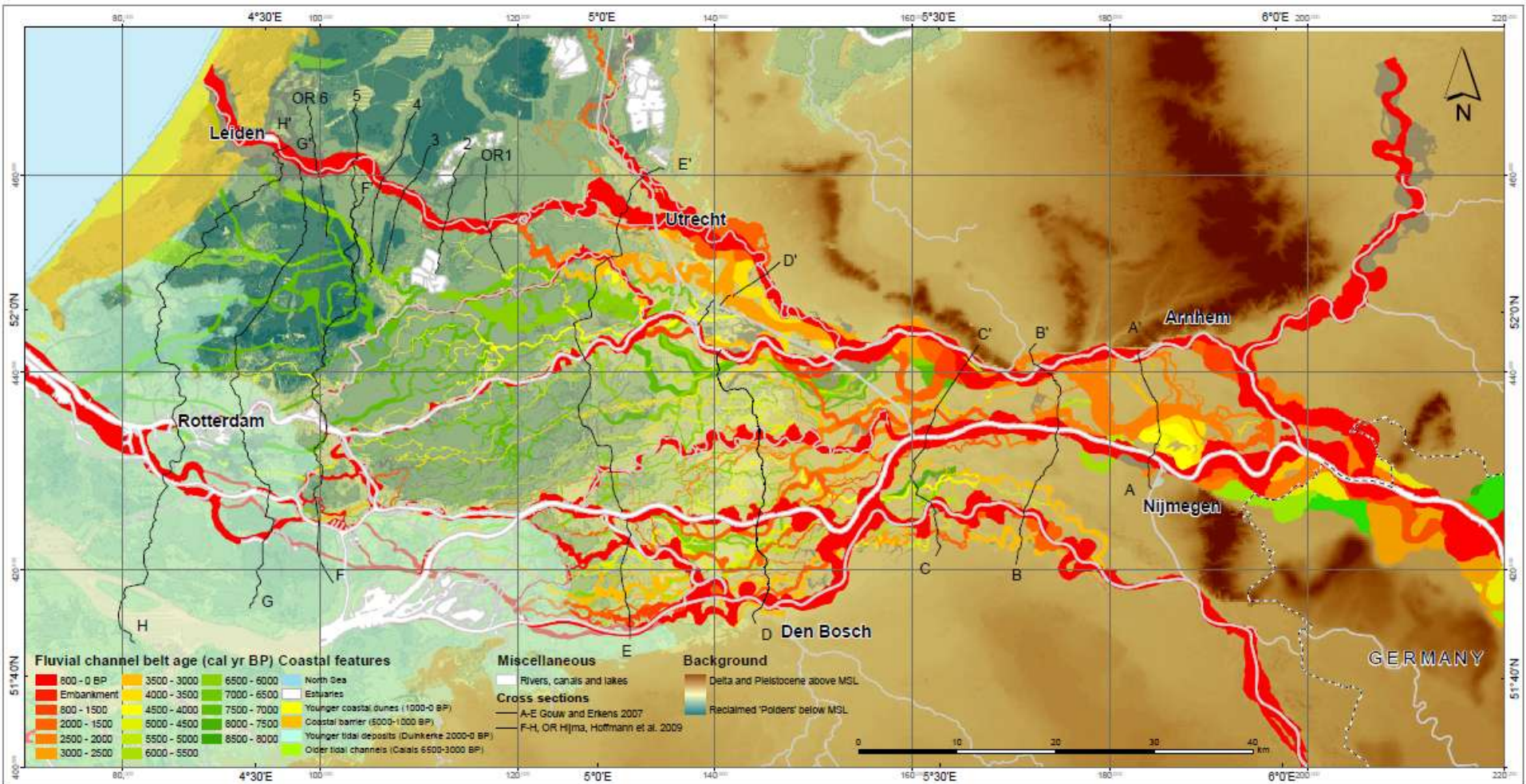
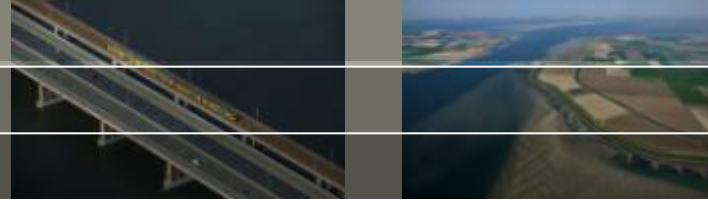
Zeespiegelstijging



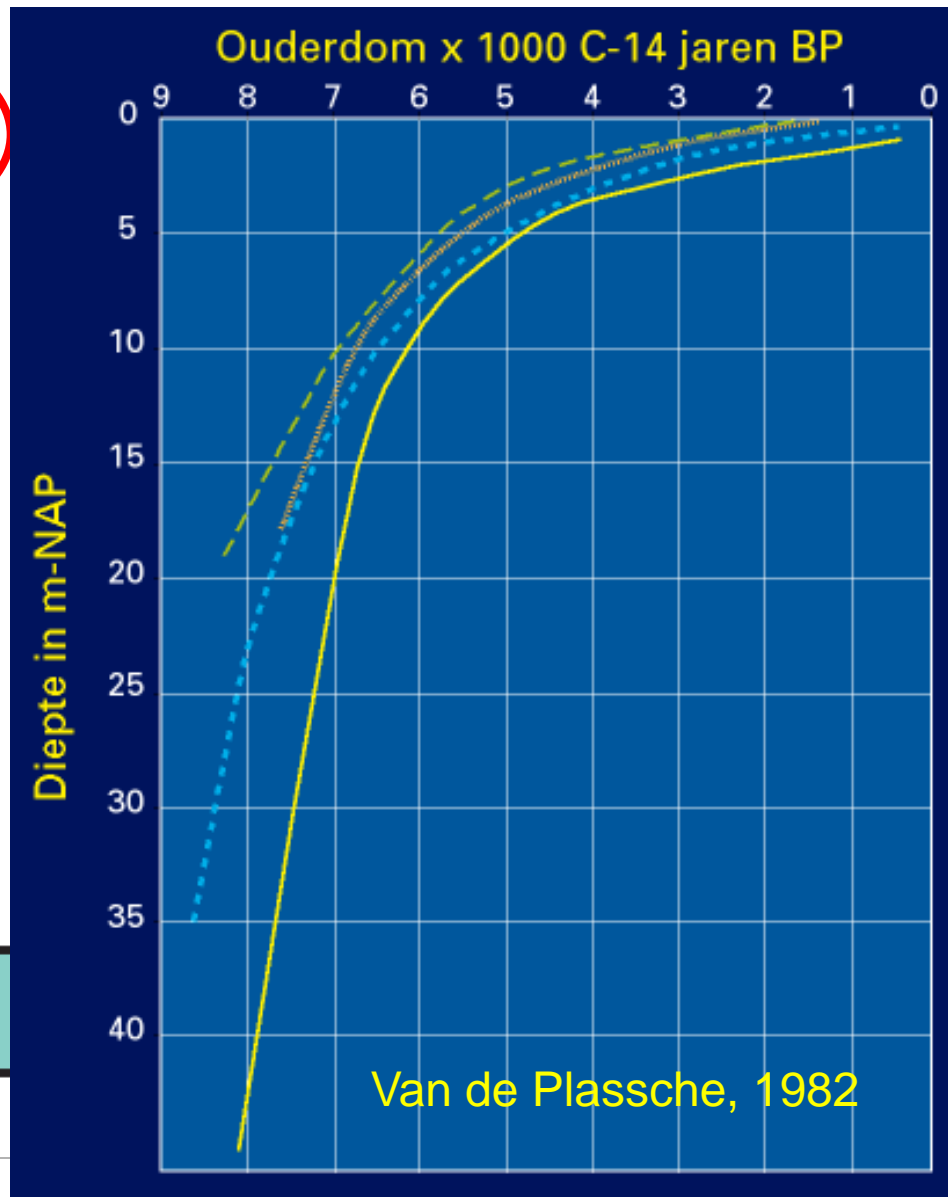
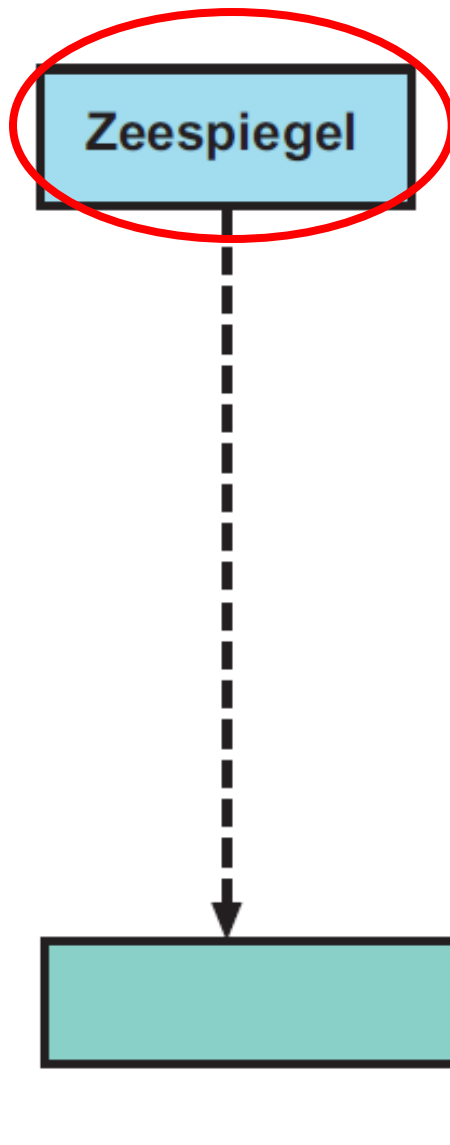
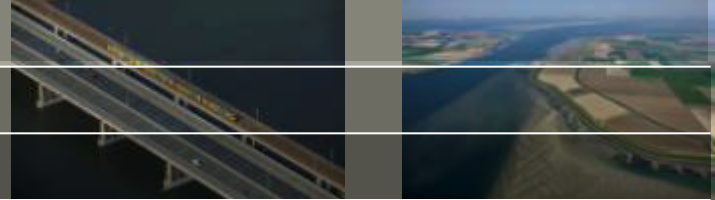
De kans op hoge afvoer



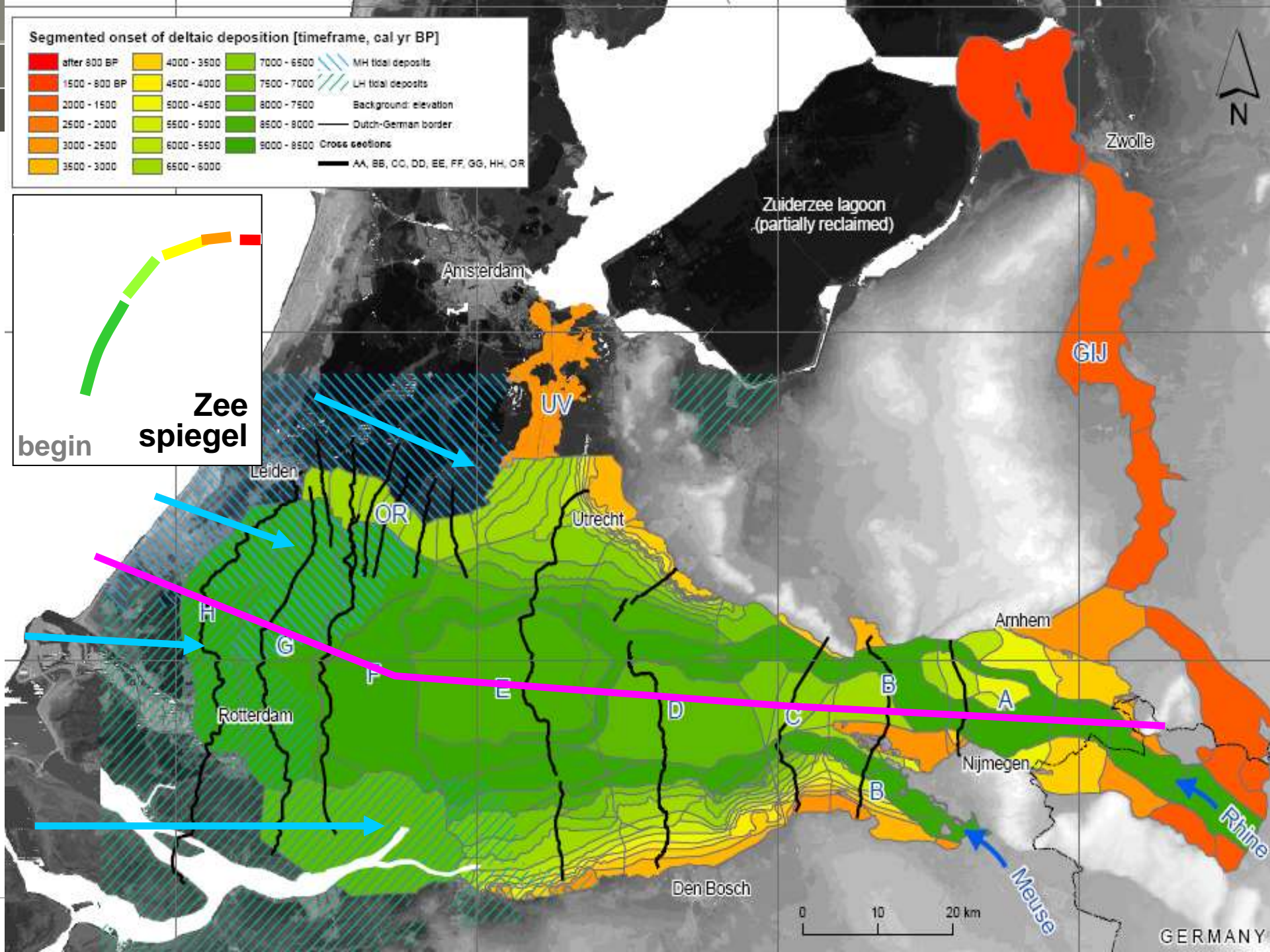
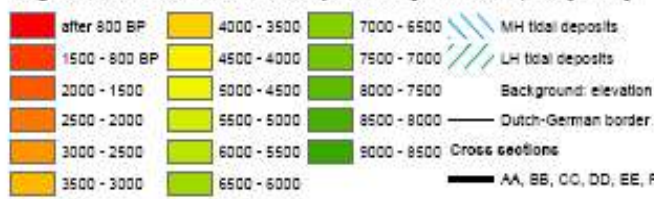
Factoren van invloed - tektoniek



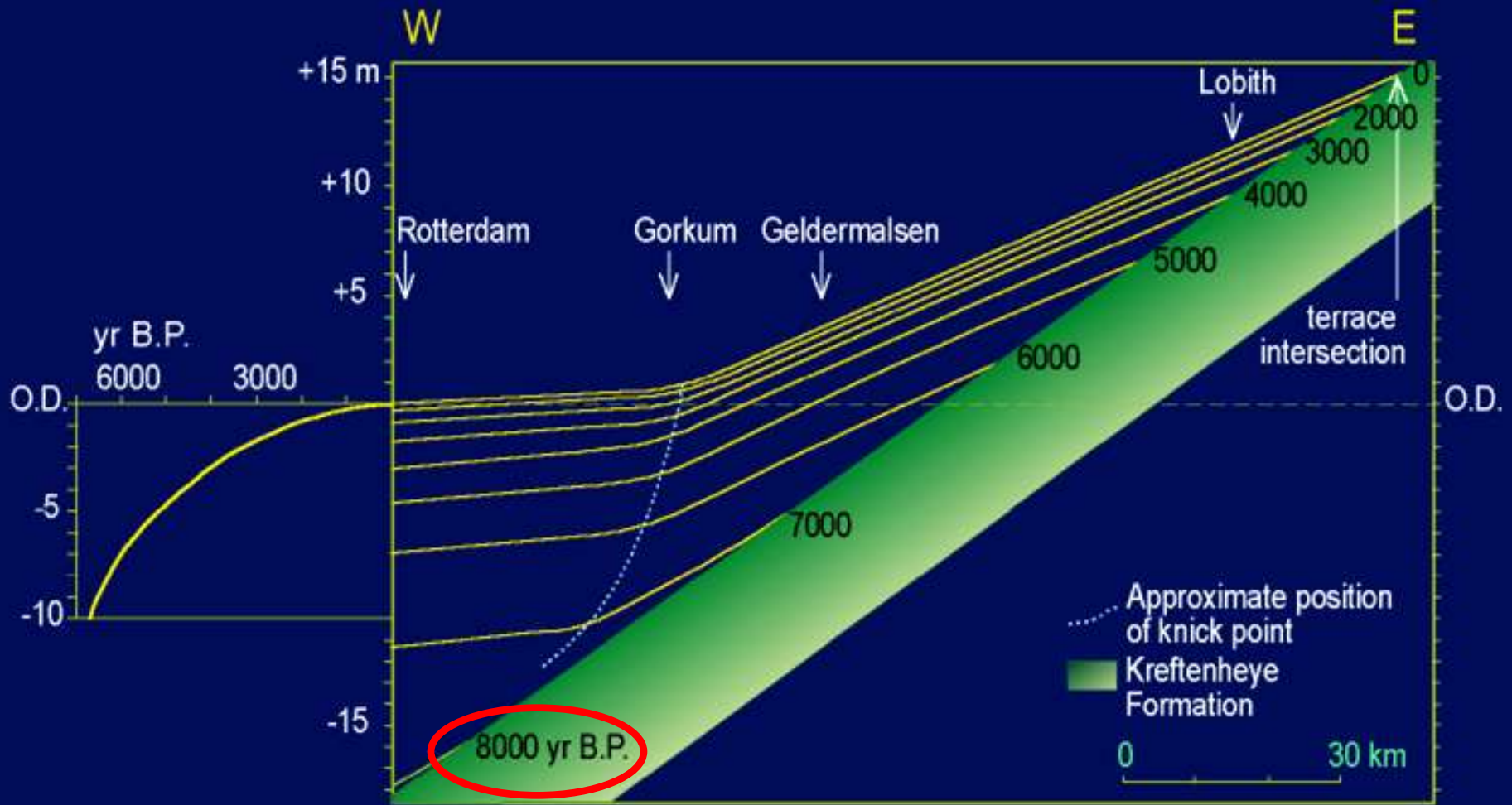
Factoren van invloed - zeespiegel



Segmented onset of deltaic deposition [timeframe, cal yr BP]



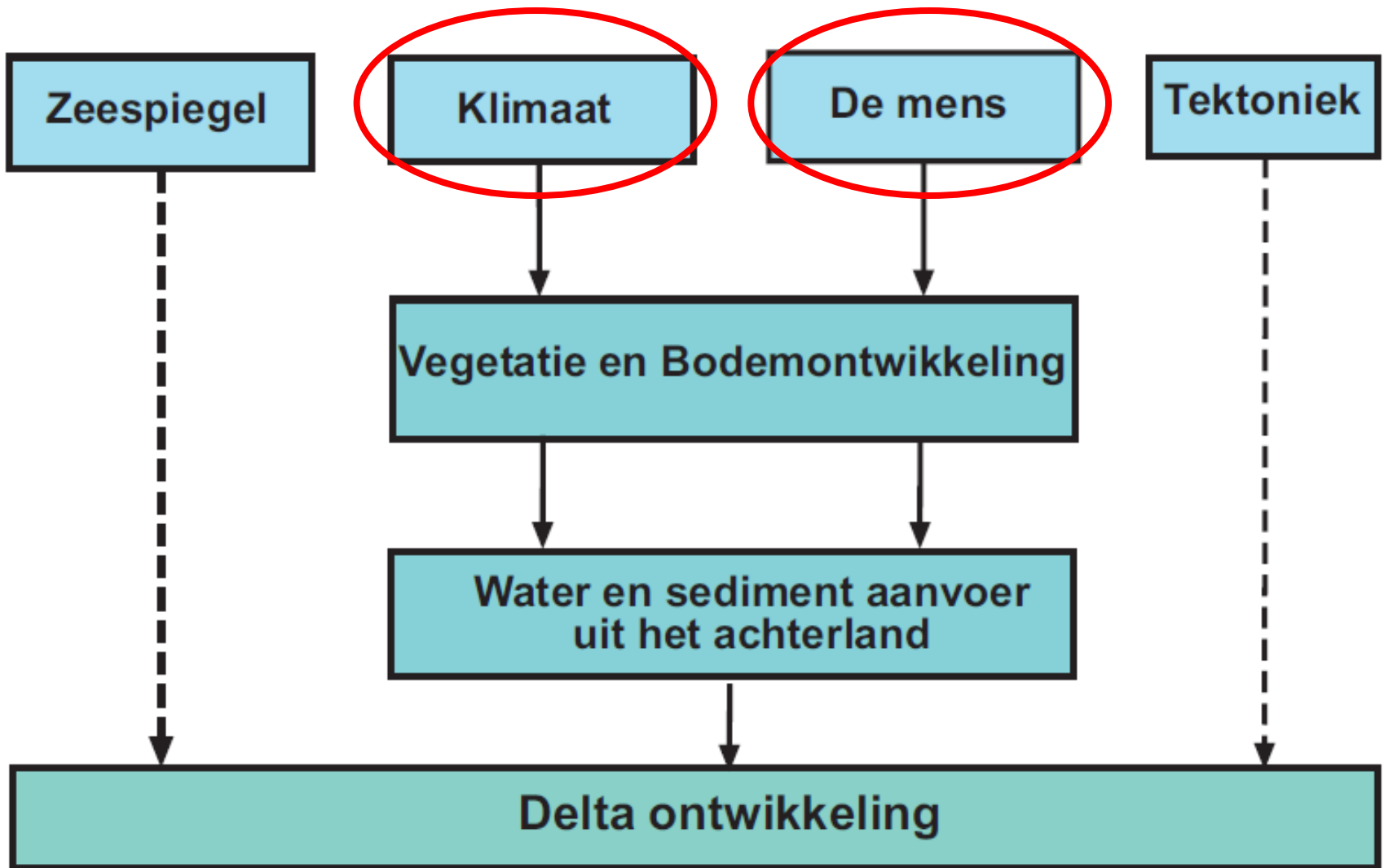
Het creëren van ruimte



Zeespiegelstijging en grondwatergradienten

Naar Van Dijk et al. 1991; Törnqvist 1993

Hypothesen



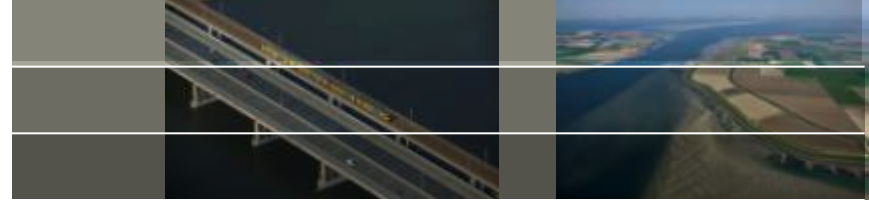
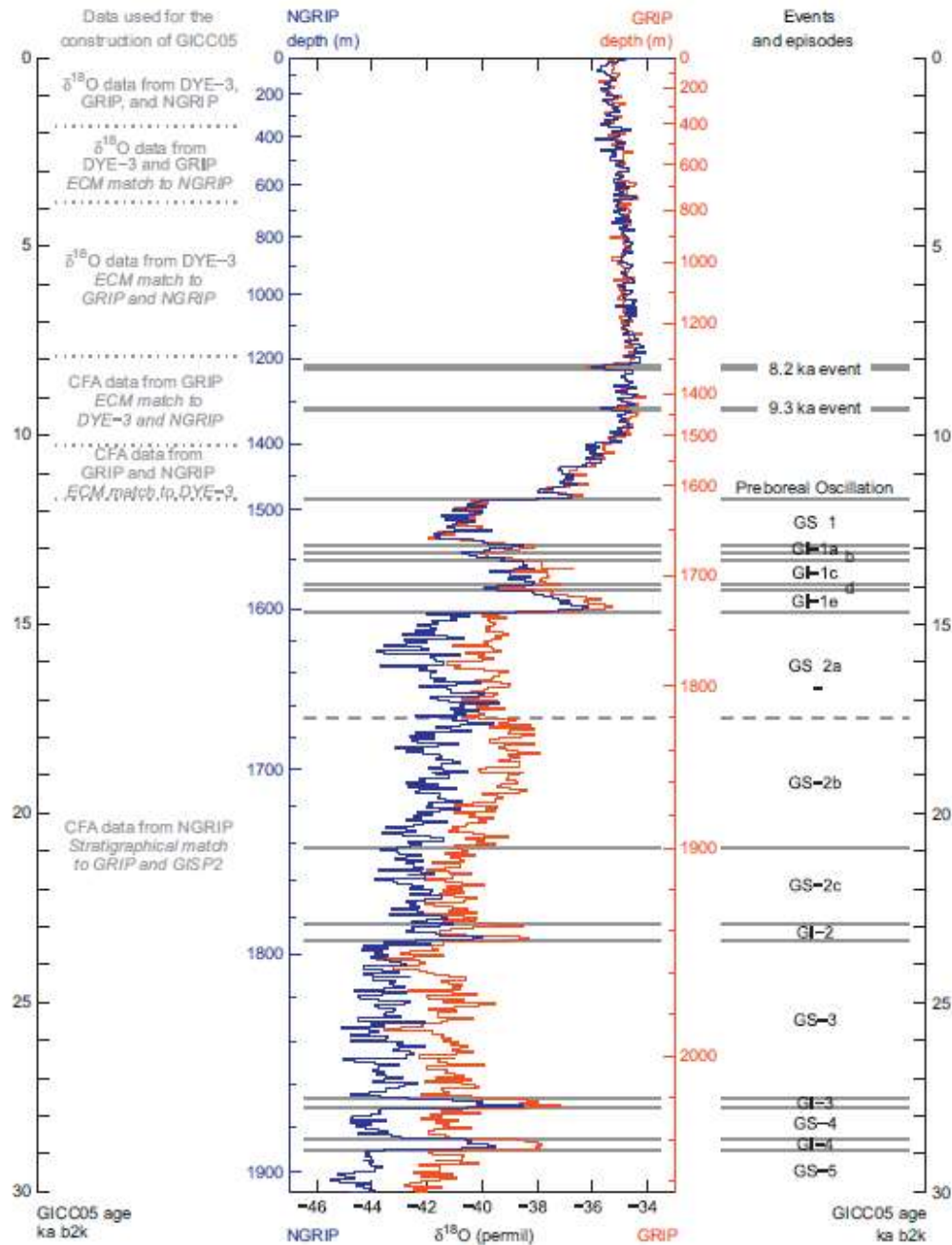


Fig. 1. Comparison of the $\delta^{18}\text{O}$ records for the NGRIP and GRIP ice core records for the last 30,000 years at a 50-year resolution.

De mens: directe invloed



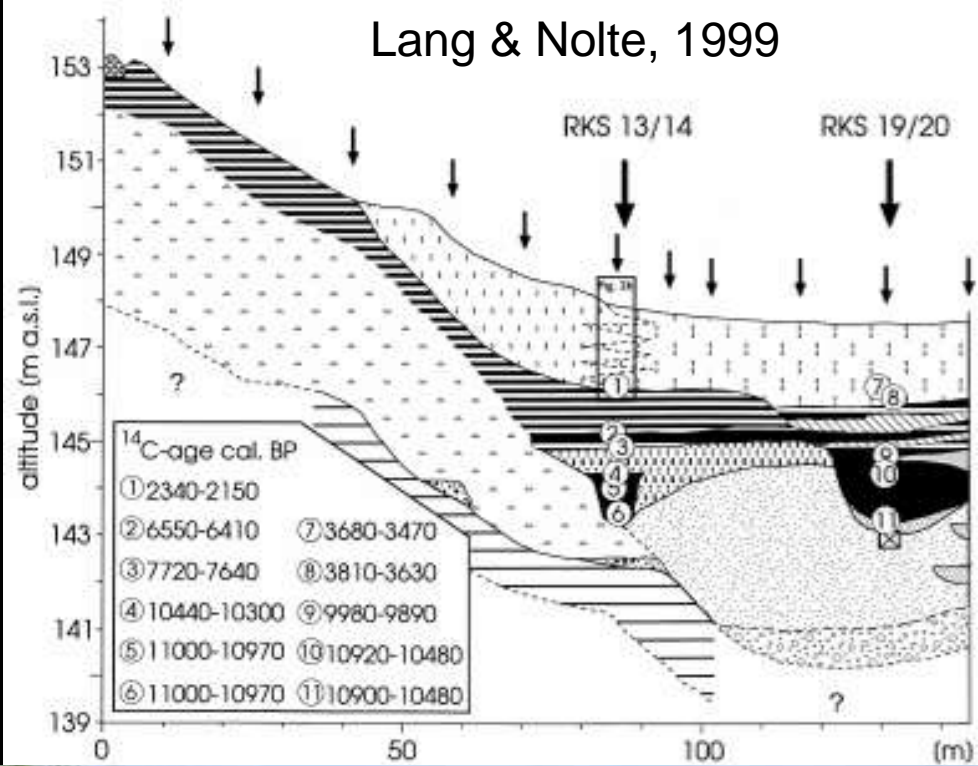
9 november 2010

Deltares

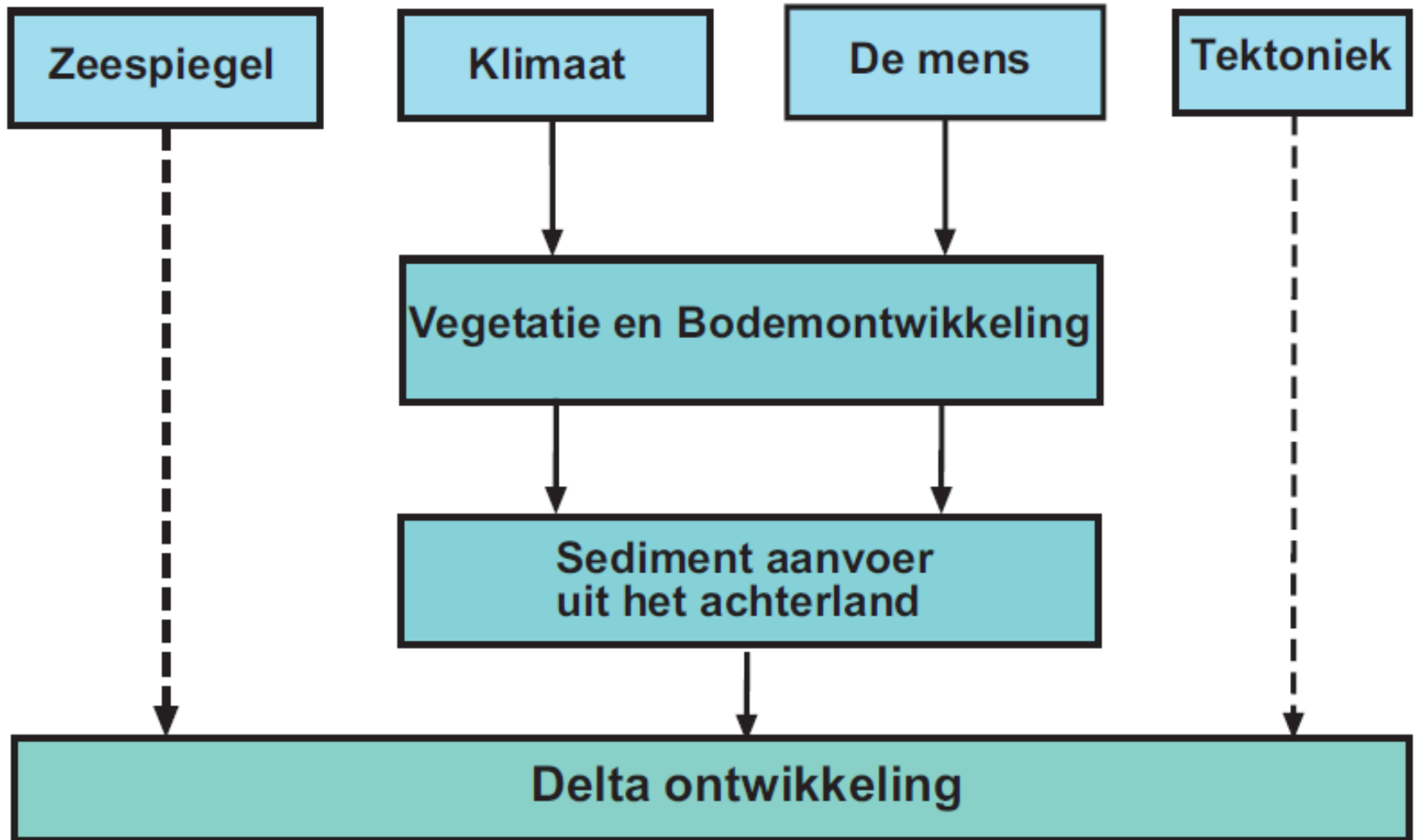
De Mens: landgebruik



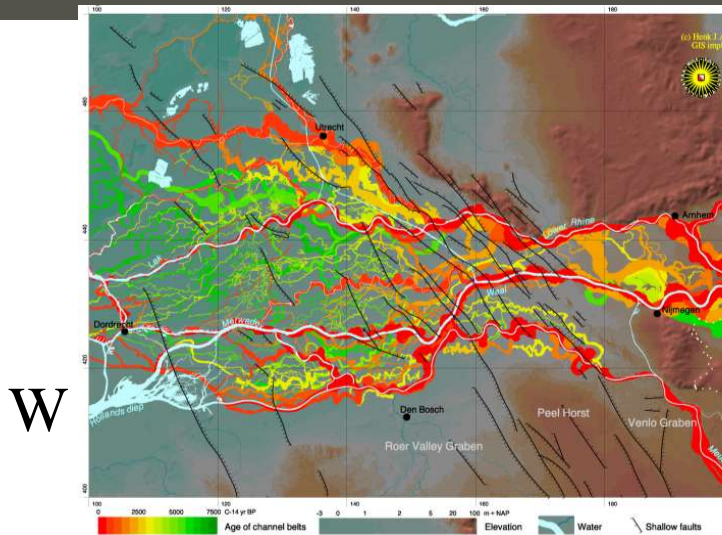
Lang & Nolte, 1999



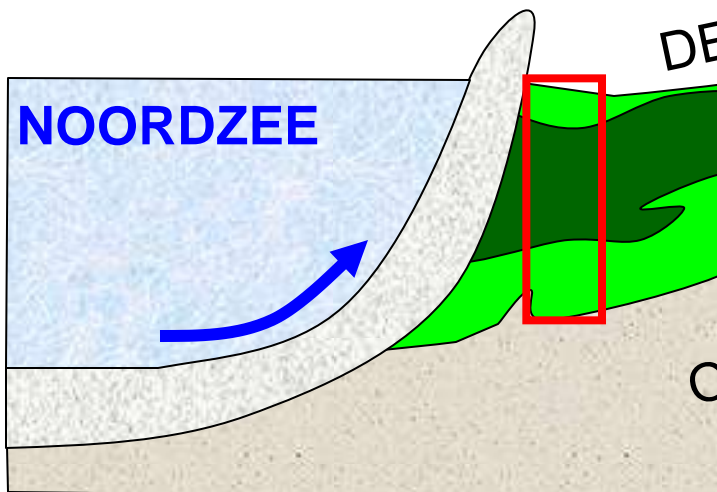
Factoren van invloed



Sedimenten in de R



KUSTLIJN – DUINEN/STRAND



Sediment budget

Wat willen we graag weten?

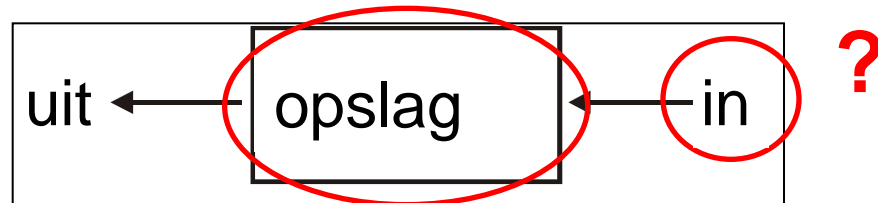
De hoeveelheid sediment die gedurende de afgelopen millennia aangevoerd is naar de Rijn-Maas delta

Wat voor een soort informatie hebben we?

De hoeveelheid sediment die gedurende de afgelopen millennia afgezet is in de Rijn-Maas delta

Als we deze informatie gebruiken moeten we rekening houden met:

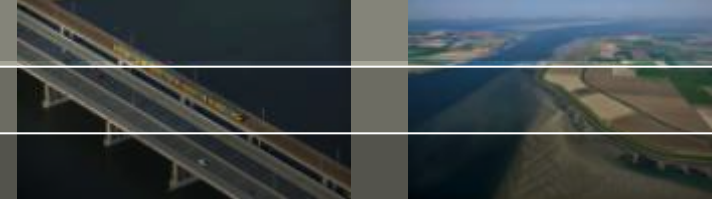
1. De preservatie van sediment
2. De doorvoer van sediment



Rijn-Maas delta

Deltares

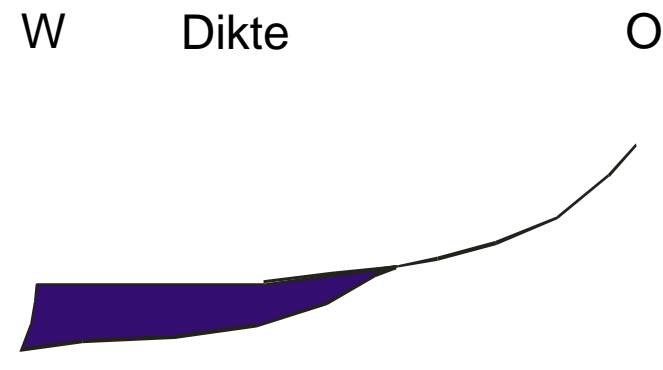
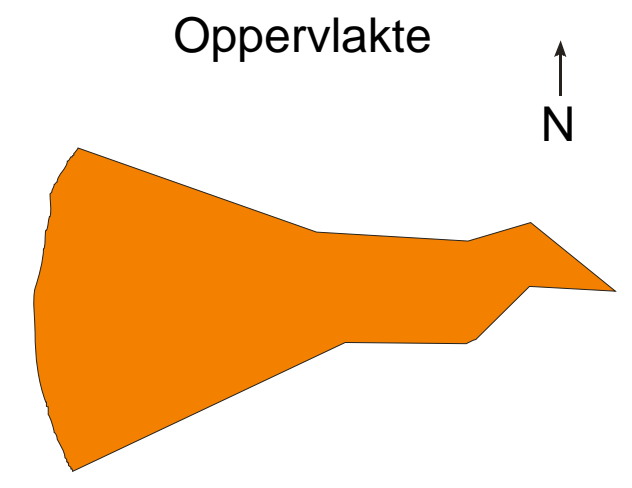
Sediment budgetering



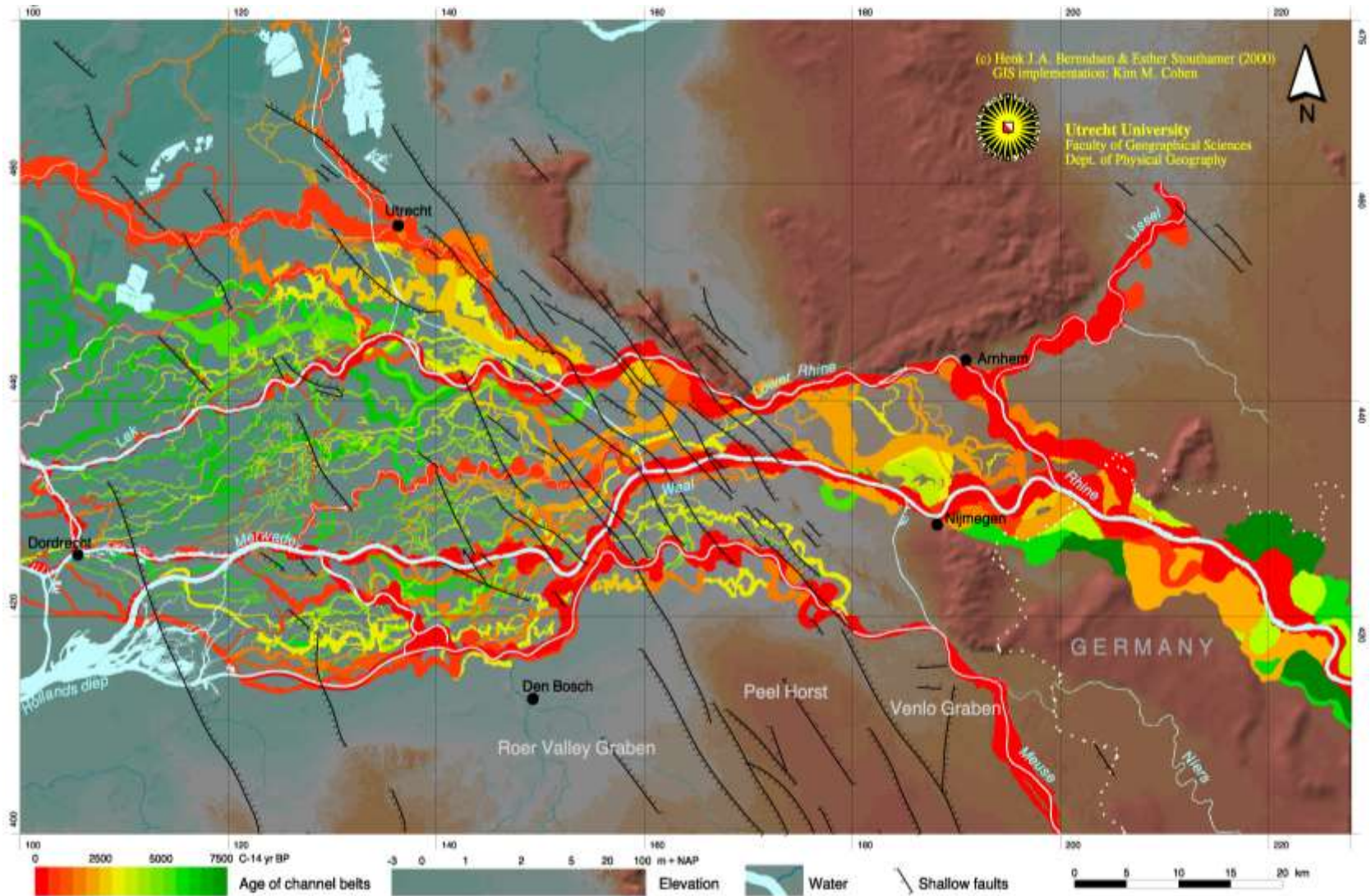
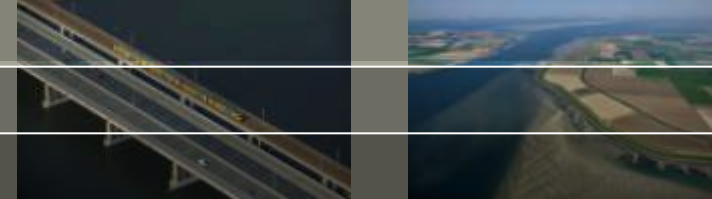
De hoeveelheden sediment in de Rijn-Maas delta vormen een volume.

Om dat volume uit te rekenen hebben we nodig:

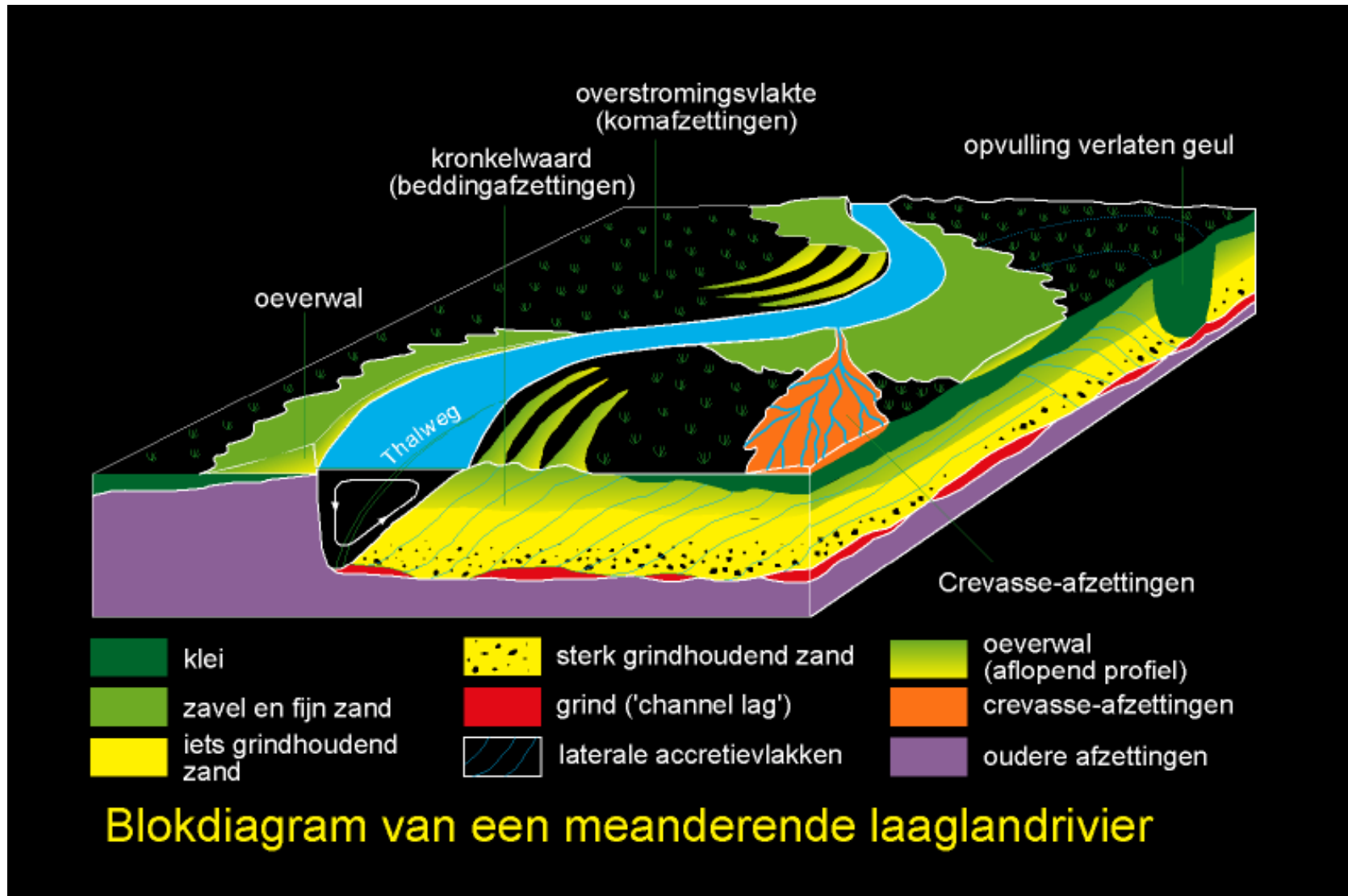
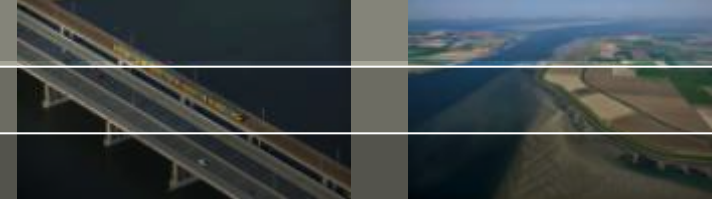
1. Dikte (m)
2. Oppervlak (km²)
3. Ouderdom (jaren)



Stroomruggenkaart



De typische rivier



Grof sediment (zand, grind)



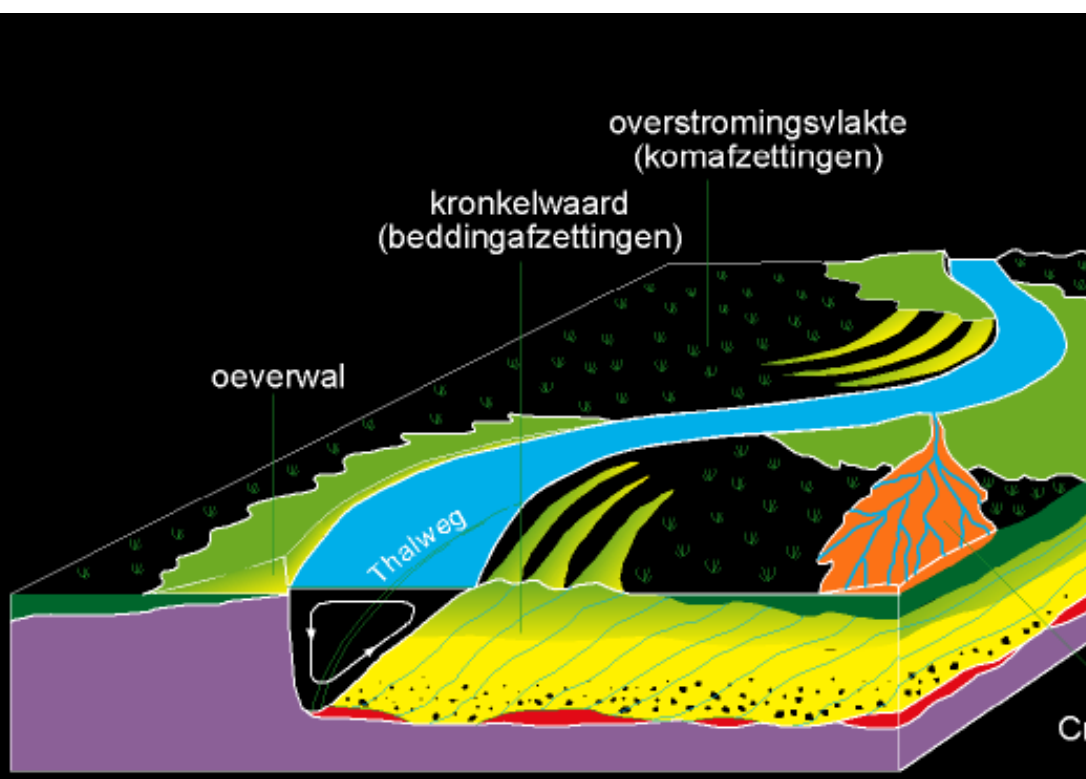
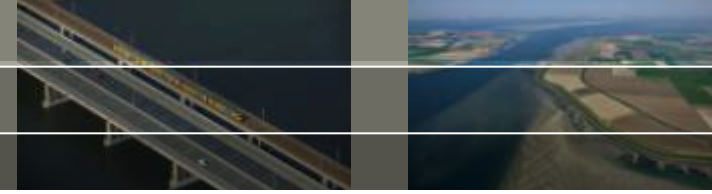


Fijn sediment (klei, silt)

Veen

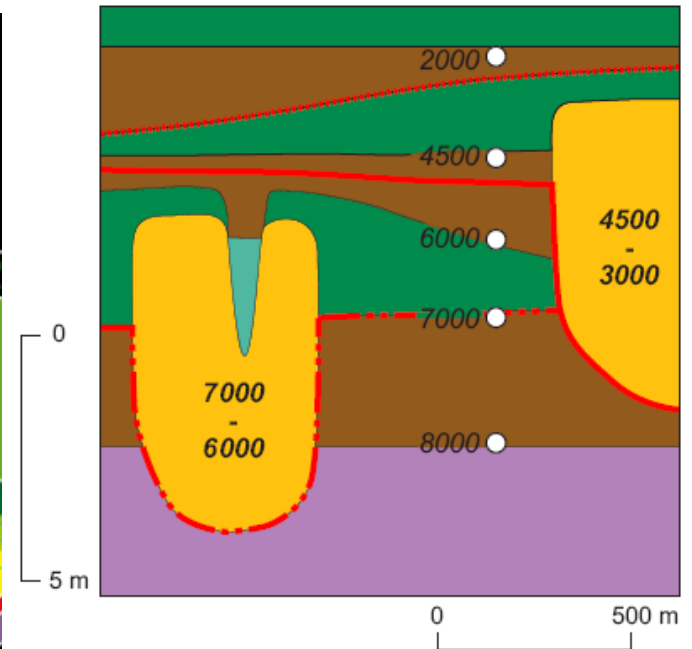


De typische rivier



- | | | | | |
|--|------------------------|--|--------------------------|--|
| | klei | | sterk grindhoudend zand | |
| | zavel en fijn zand | | grind ('channel lag') | |
| | iets grindhoudend zand | | laterale accretievlakken | |

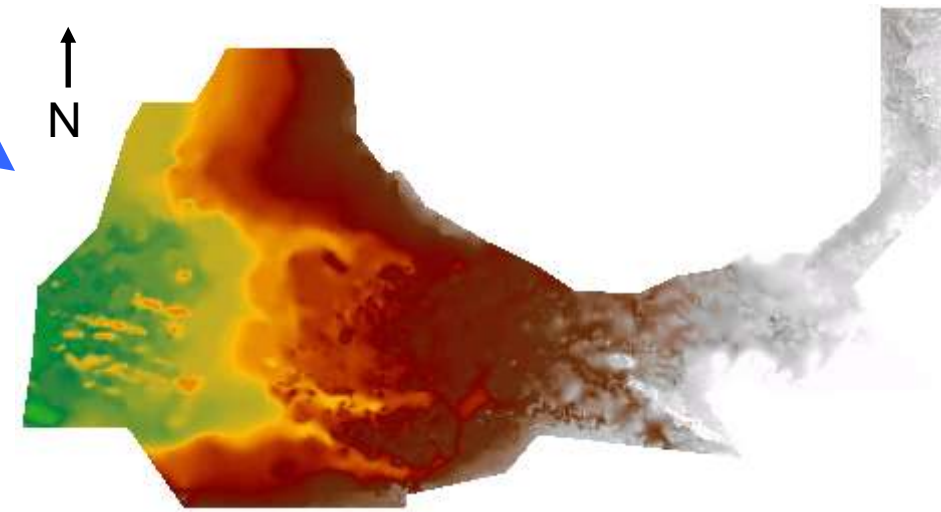
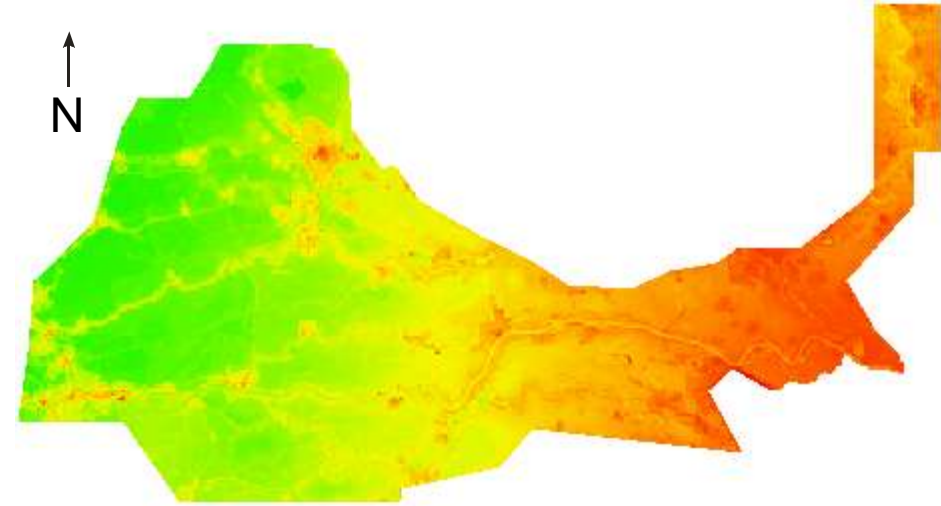
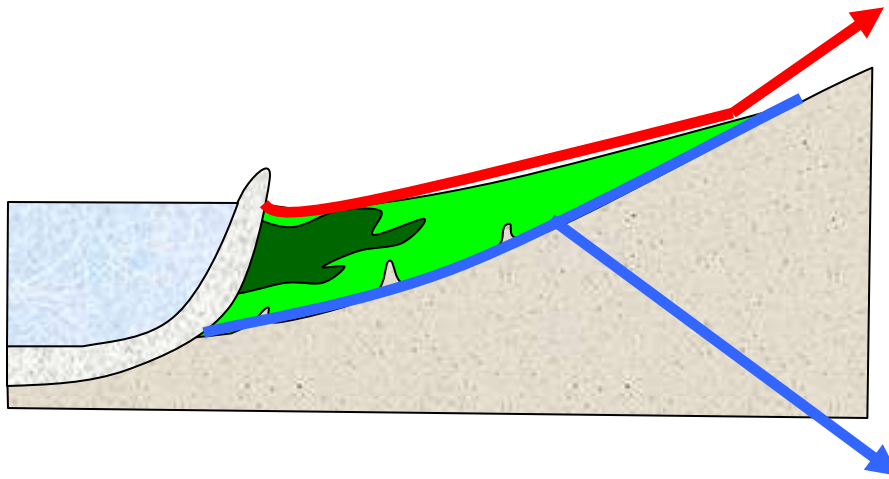
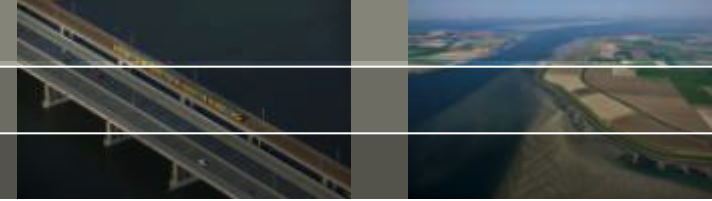
Blokdiagram van een meanderende laag



- LEGEND**
- channel-belt deposits
 - overbank deposits
 - channel-fill deposits
 - peat
 - Pleistocene substrate
 - ¹⁴C-sample, age in cal yr BP
 - period of activity of channel belt (cal yr BP)

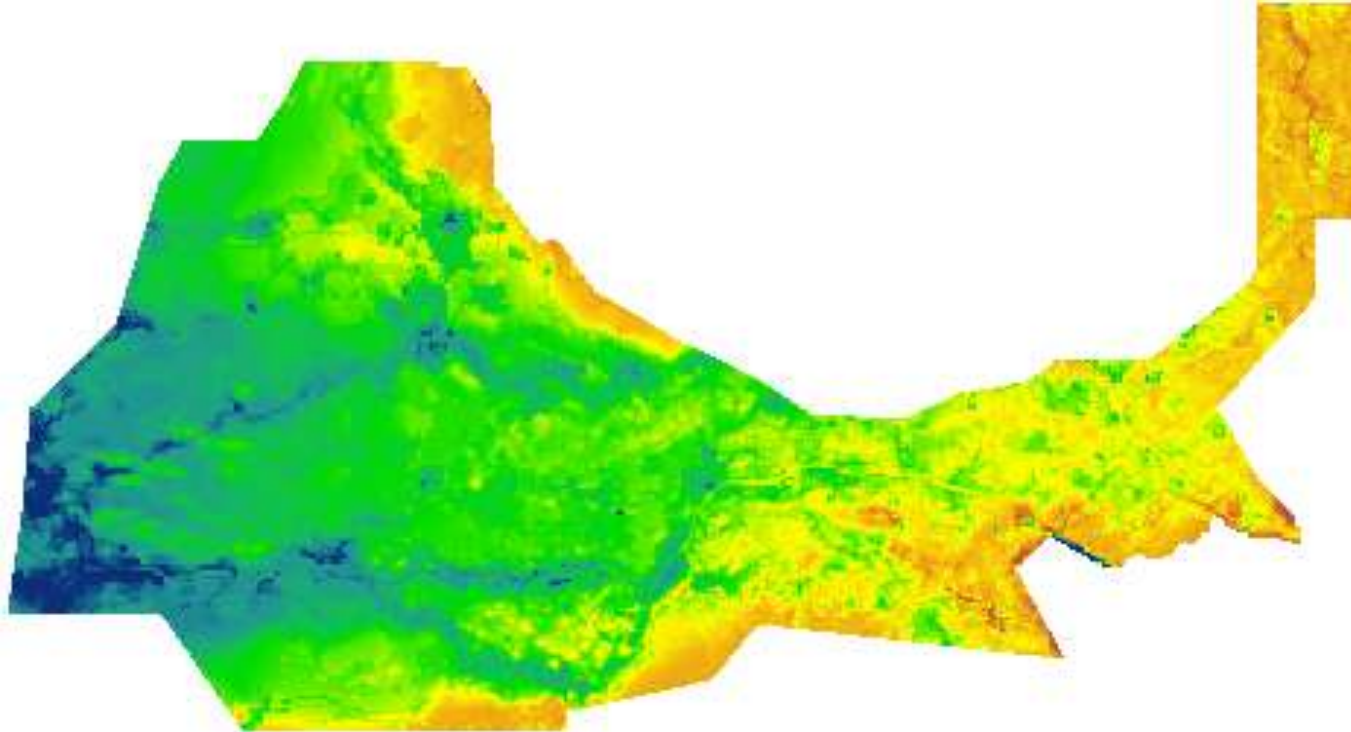
- Time lines**
- 3000 cal yr BP
 - 5000 cal yr BP
 - 7000 cal yr BP

Eerste kwantificering.....



**DIKTE = OPPERVLAK
BOVEN MINUS
OPPERVLAK ONDER**

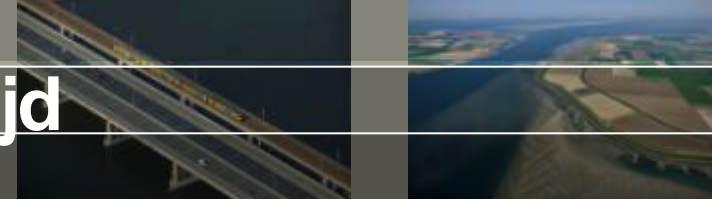
Volume en gewicht



Totale volume Rijn sedimenten in de delta:
~12 km³

Totale gewicht van Holocene Rijn sedimenten:
~16,3 Gton

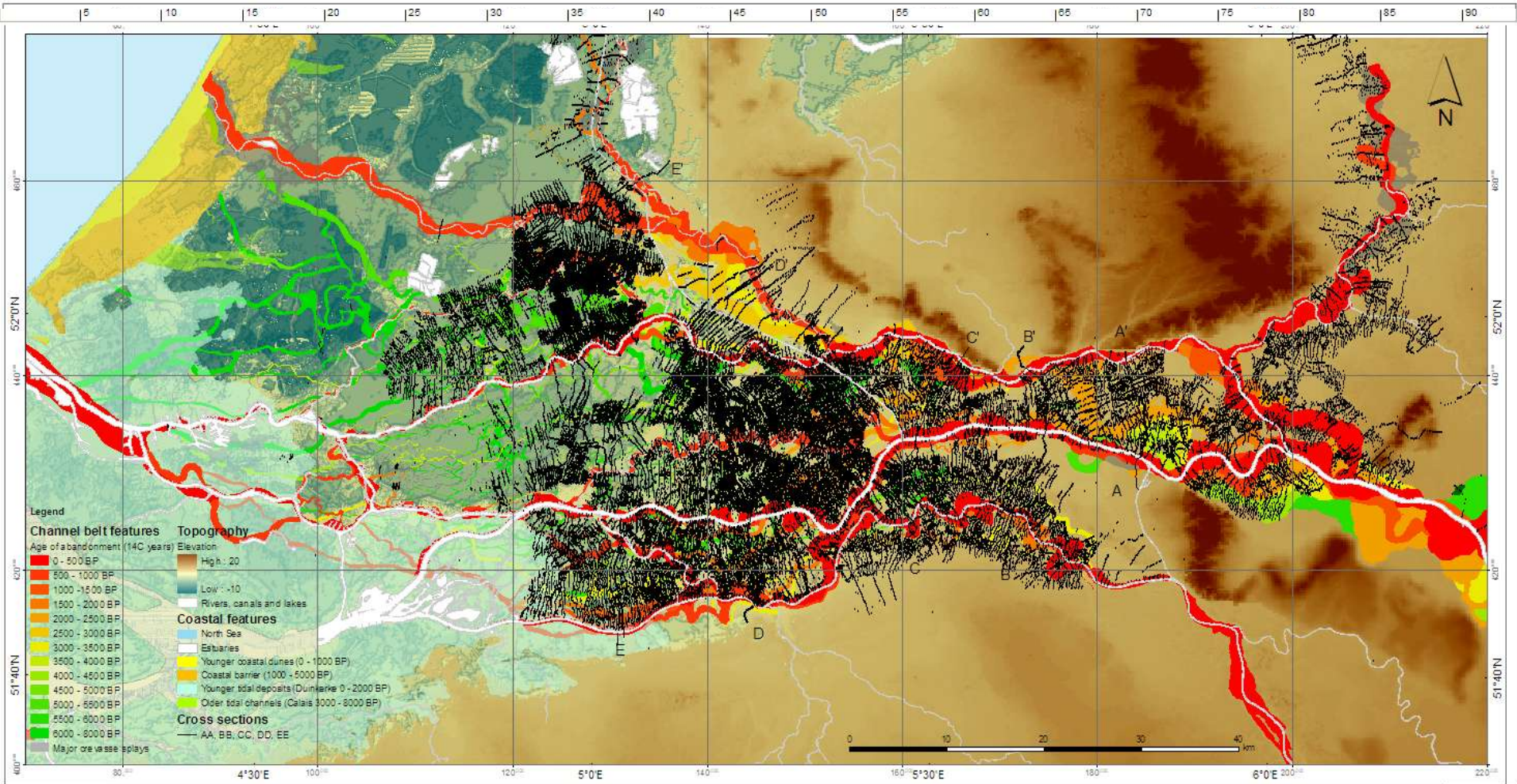
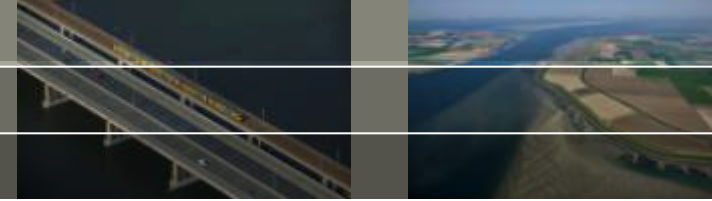
Aanvoer van sediment door de tijd



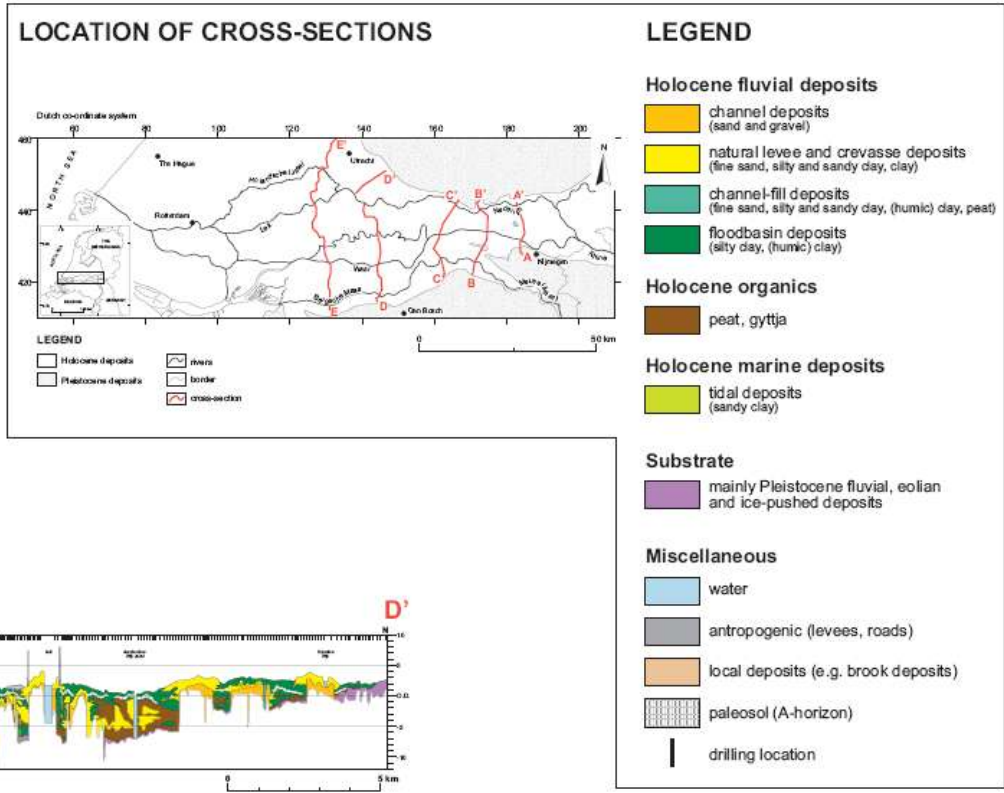
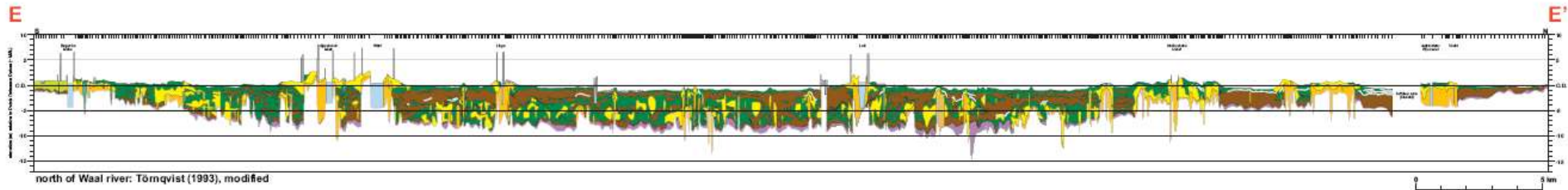
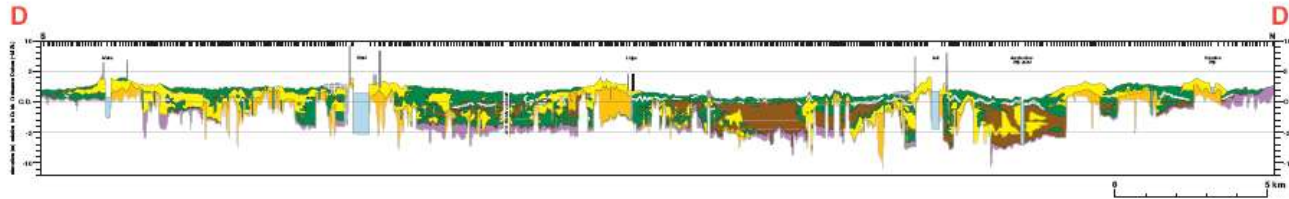
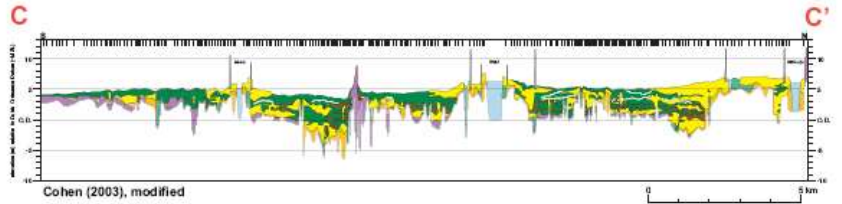
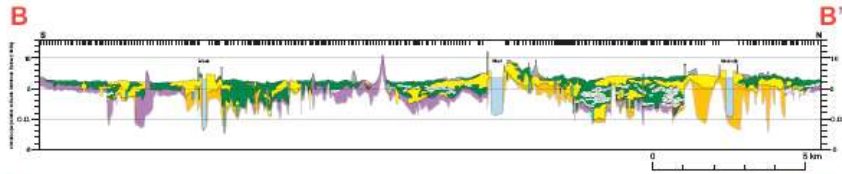
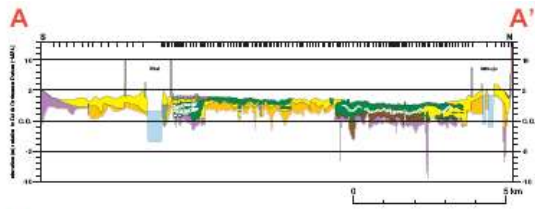
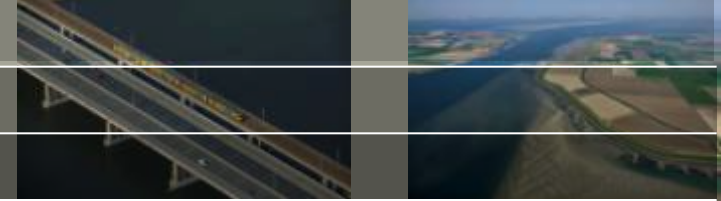
<i>Sediment aanvoer per jaar (Mton = 10⁹ kg)</i>	Zand & Grind	Fijn sediment
Huidig	0,85 Mton	3,1 Mton
Laatste 9000 jaar	~0,80 Mton	~1,00 Mton



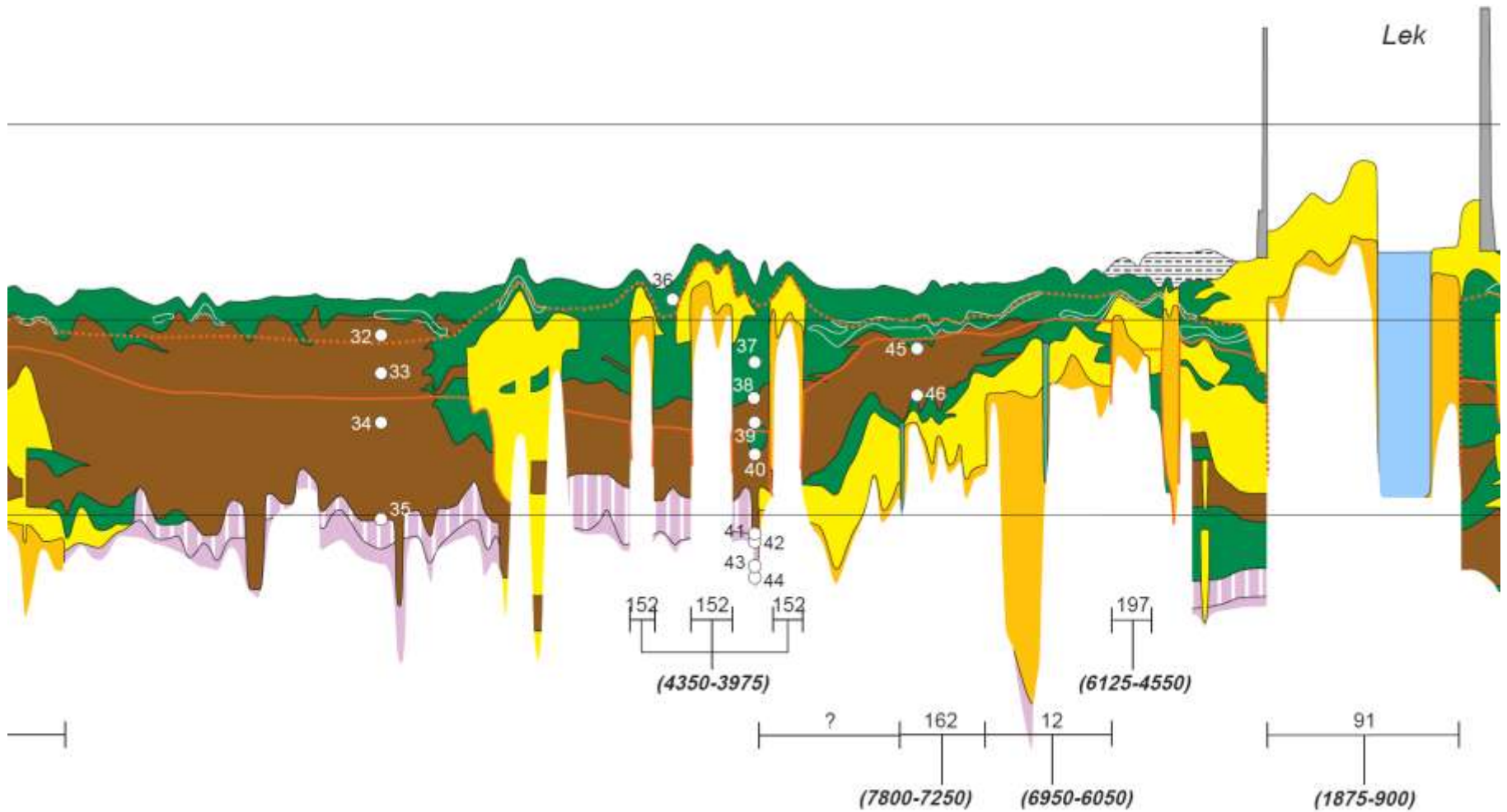
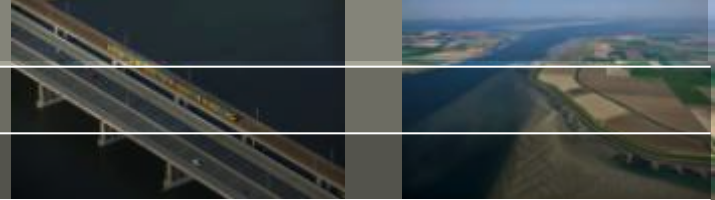
Boorpuntenkaart



Profielen



Profielen in detail



Het dateren van afzettingen

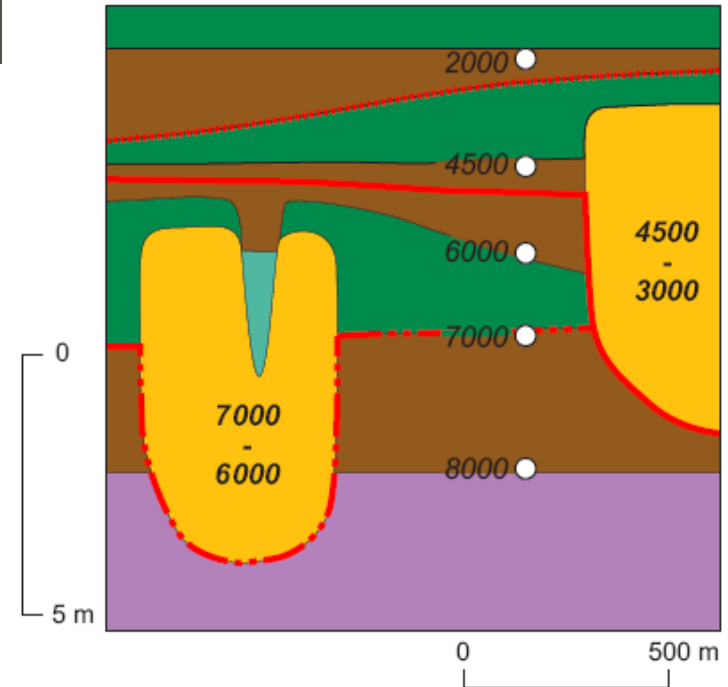
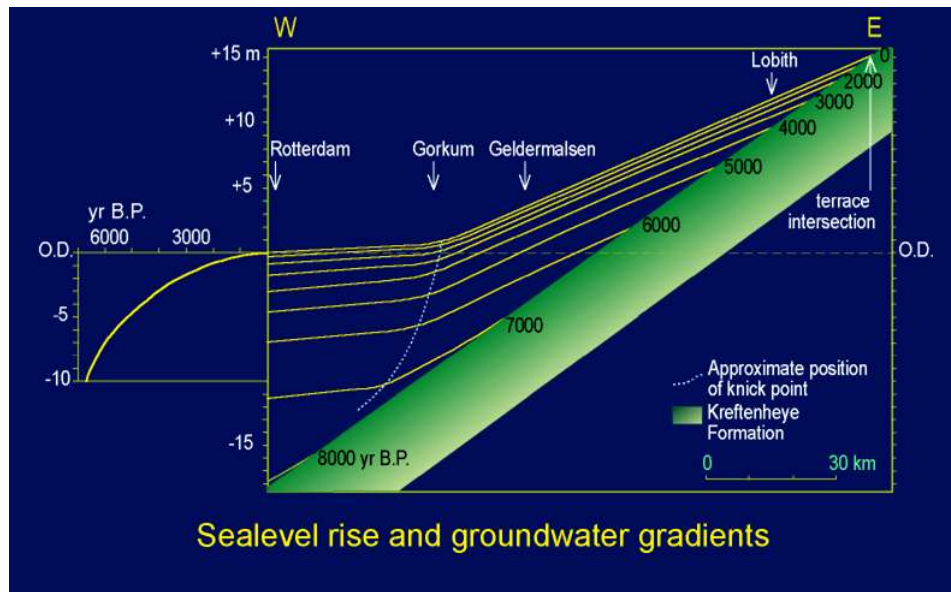
Dateringstechnieken:

^{14}C dateringen – klei en veen

OSL dateringen - zand

Archaeologische vondsten

Afgeleidde grondwatervniveaus



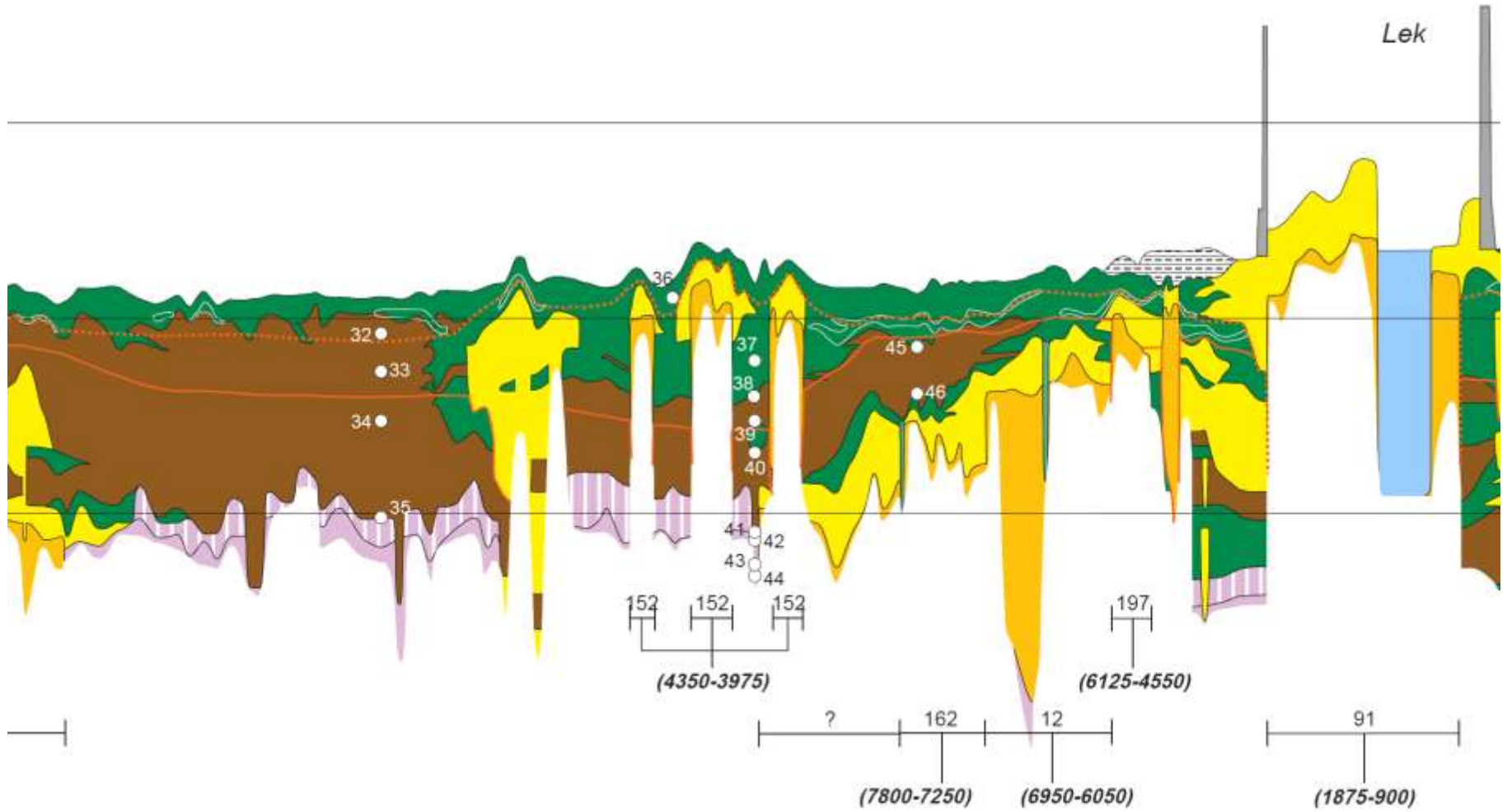
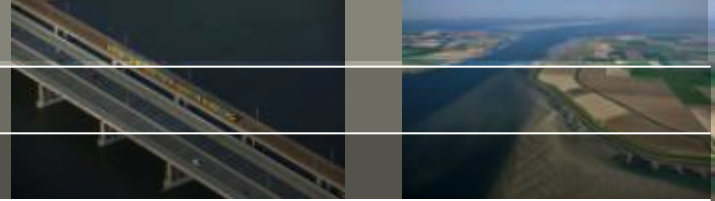
LEGEND

- channel-belt deposits
- overbank deposits
- channel-fill deposits
- peat
- Pleistocene substrate
- 8000 ^{14}C -sample, age in cal yr BP
- 7000 period of activity of channel belt (cal yr BP)
- 6000 period of activity of channel belt (cal yr BP)

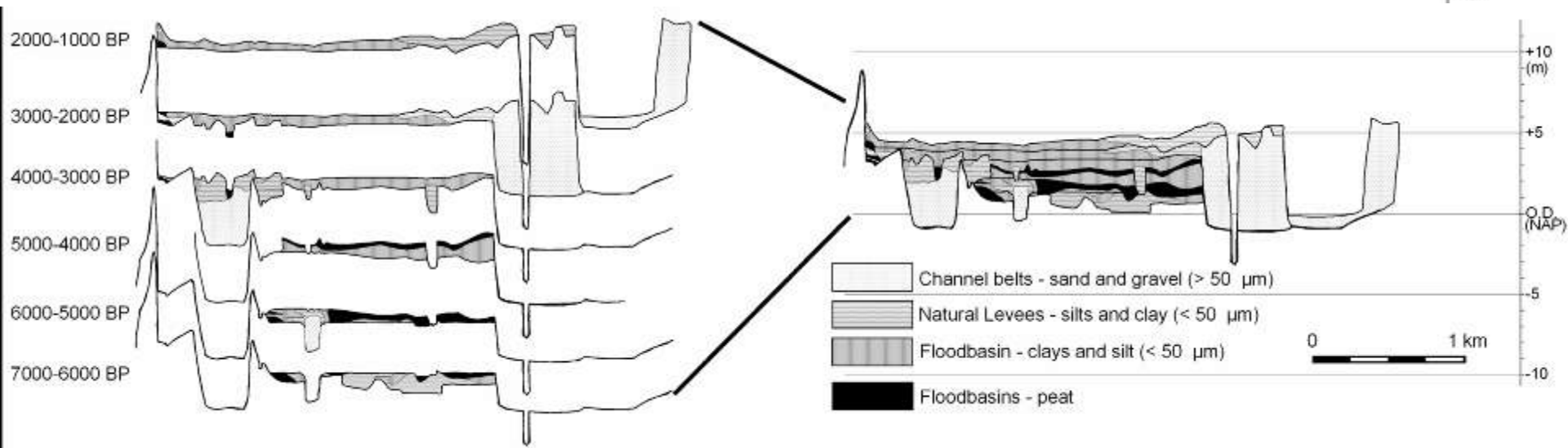
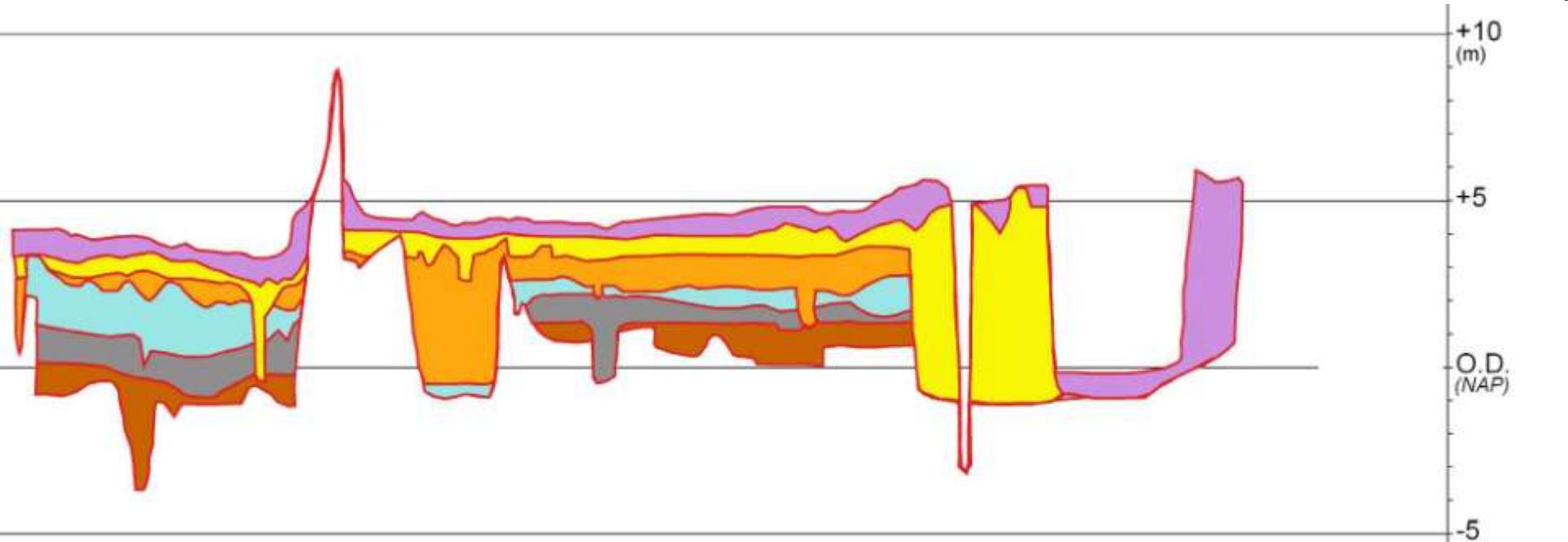
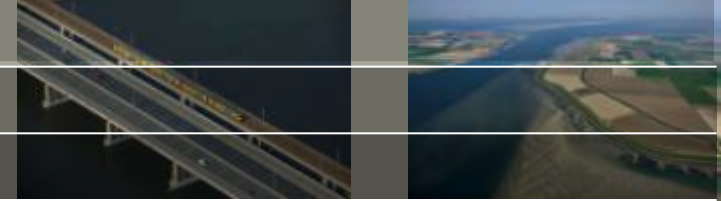
Time lines

- 3000 cal yr BP
- 5000 cal yr BP
- 7000 cal yr BP

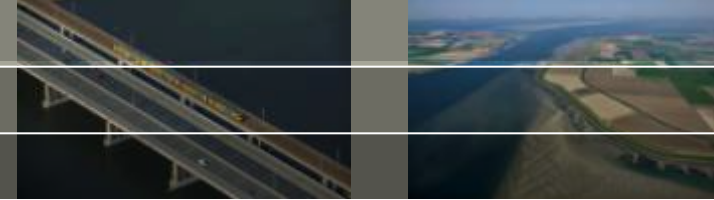
Tijdslijnen



Tijdslijnen en preservatie



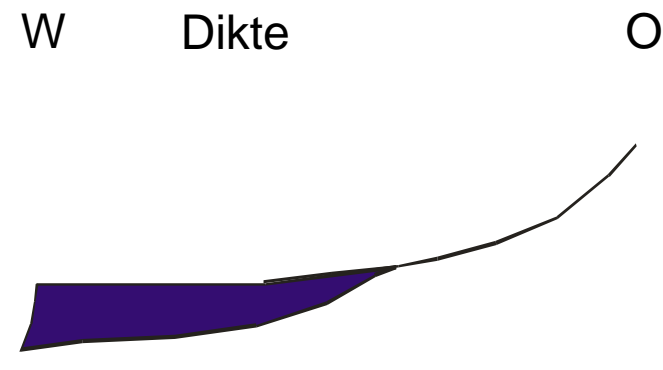
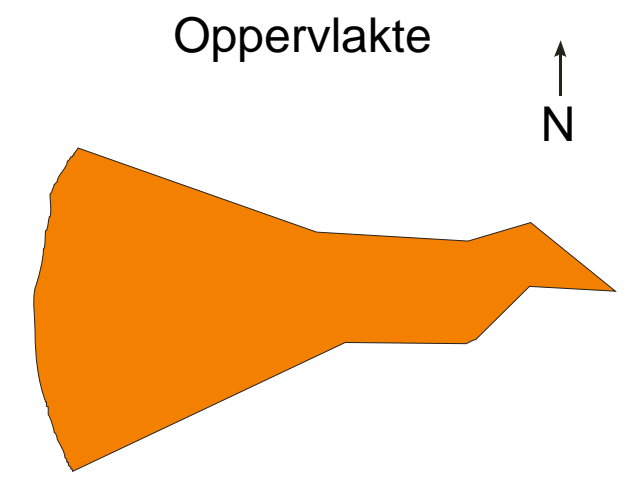
Sediment budgetering



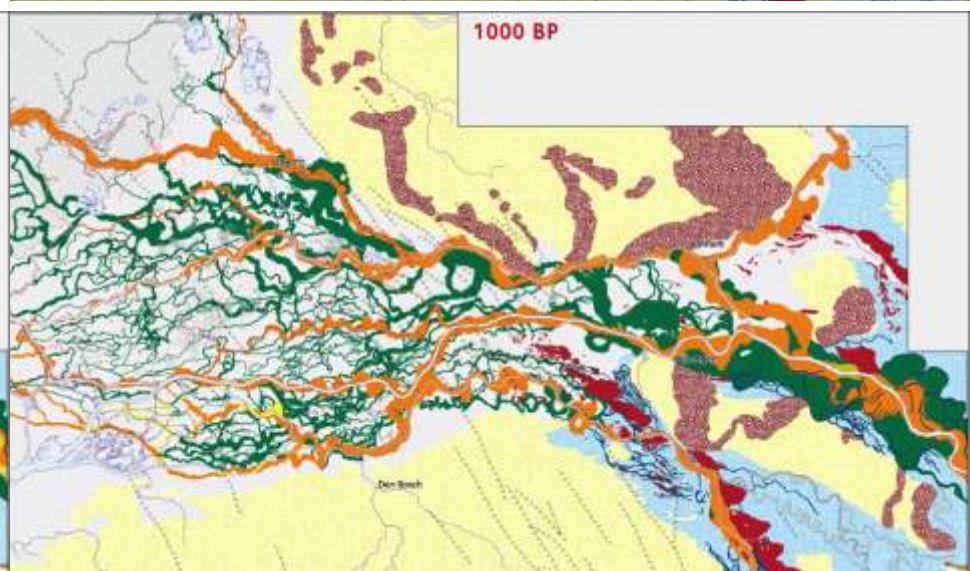
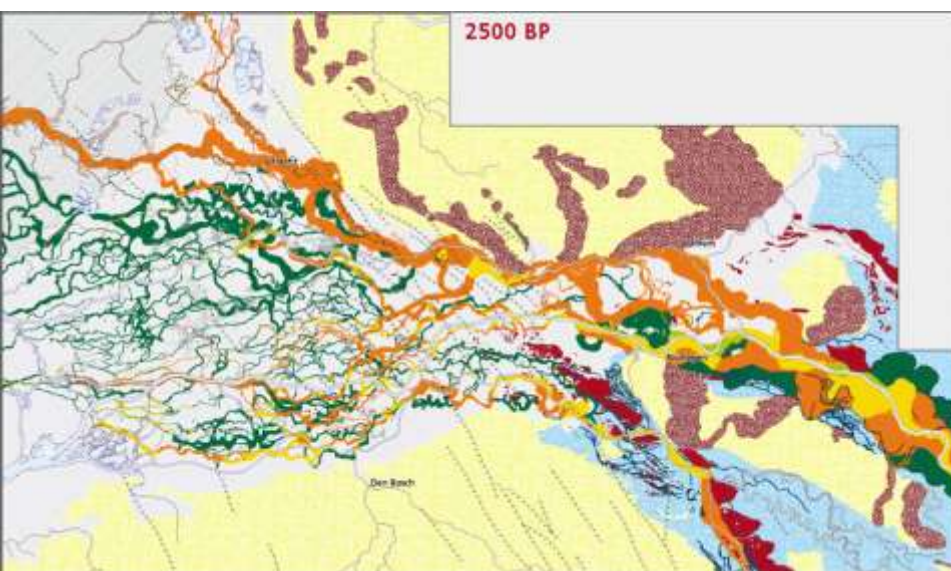
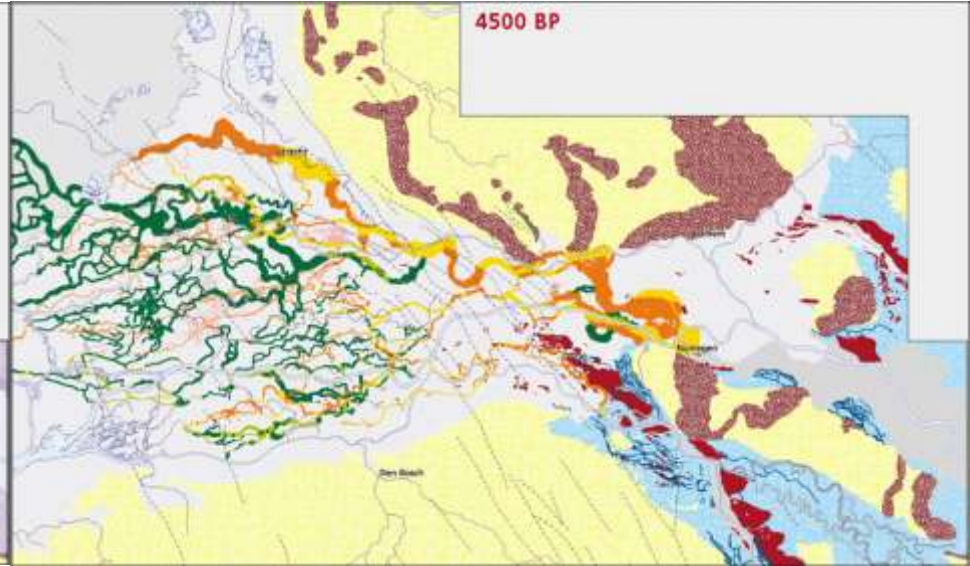
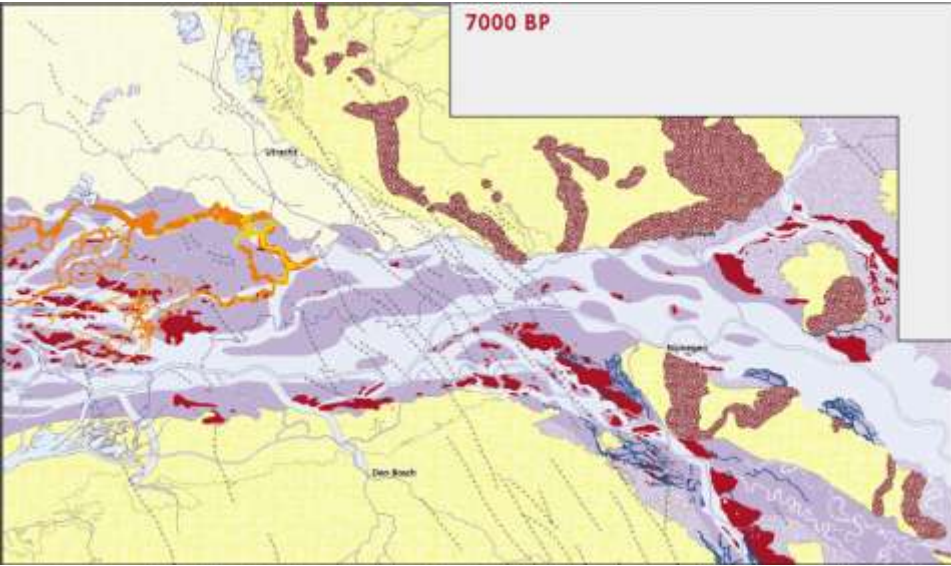
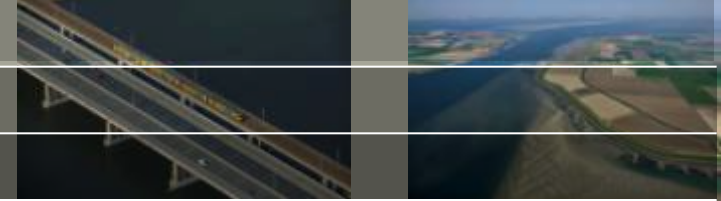
De hoeveelheden sediment in de Rijn-Maas delta vormen een volume.

Om dat volume uit te rekenen hebben we nodig:

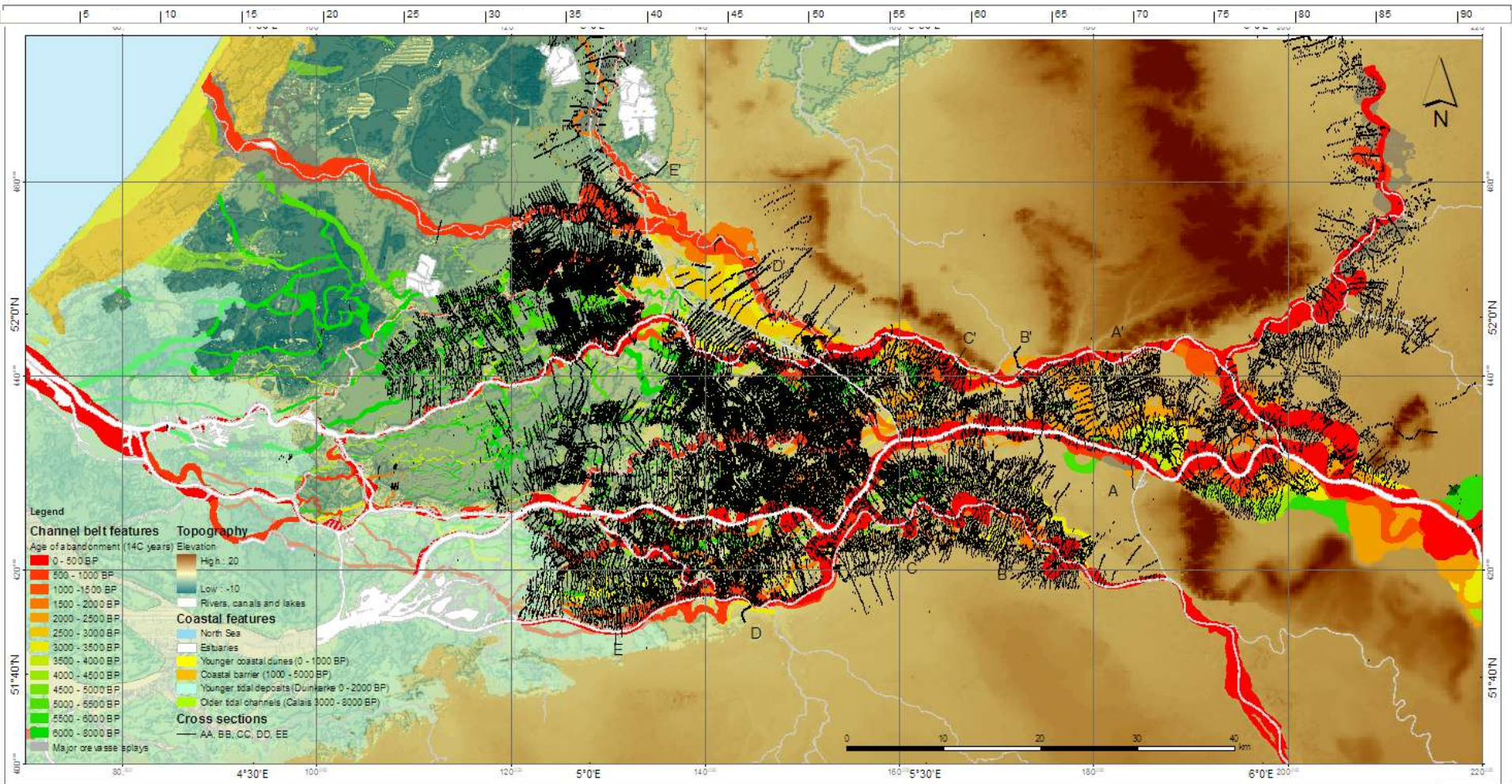
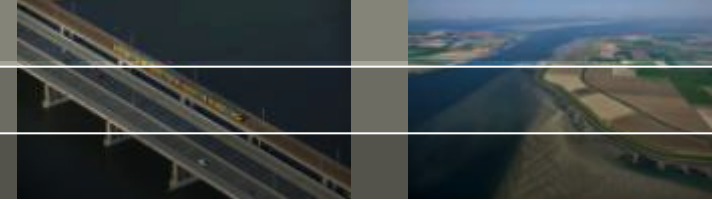
1. Dikte (m)
2. Oppervlak (km²)
3. Ouderdom (jaren)



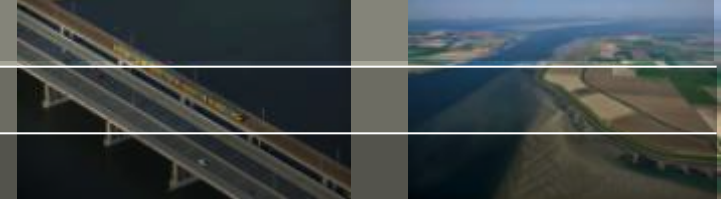
Palaeogeografische ontwikkeling



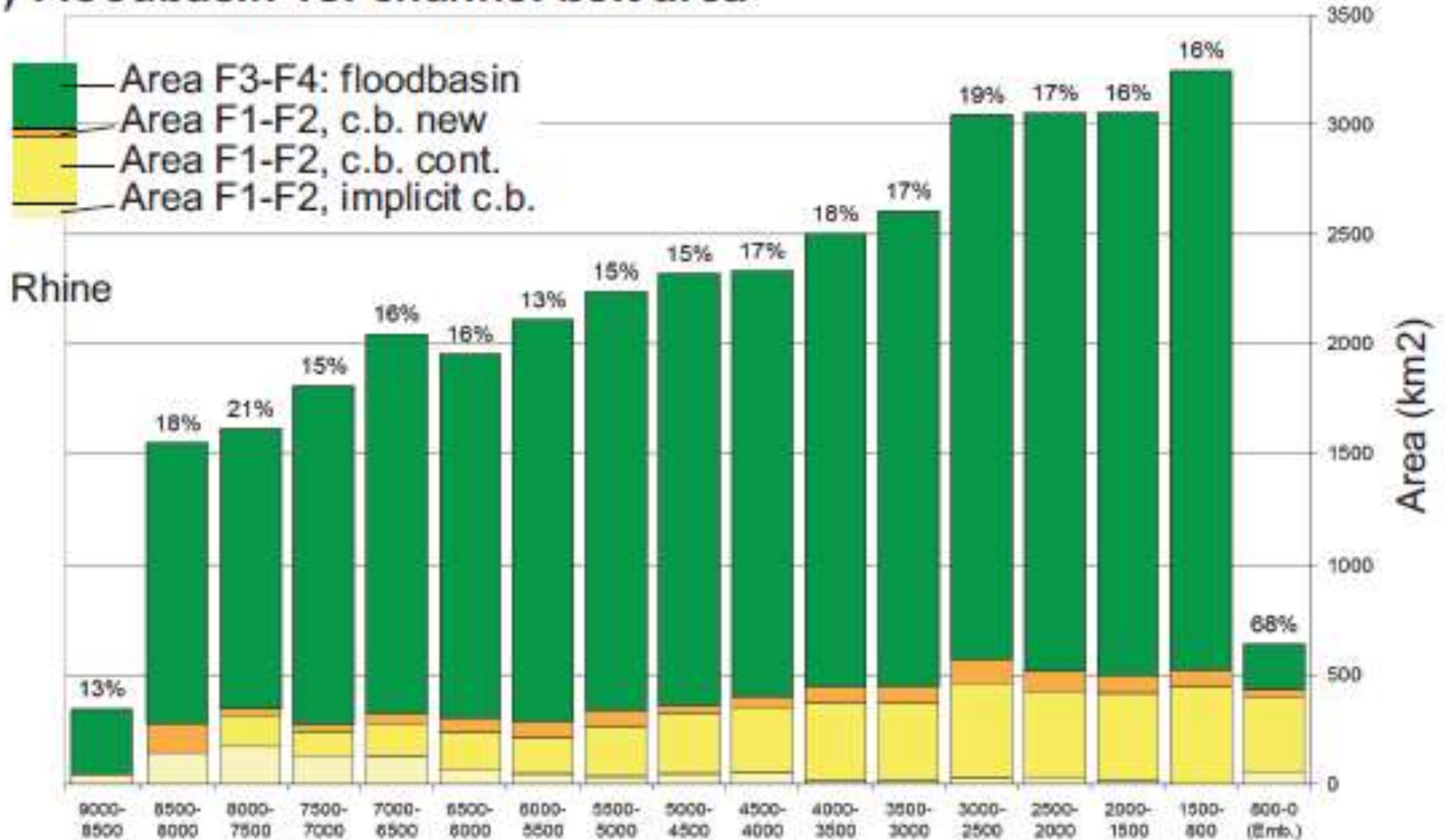
Segmenten



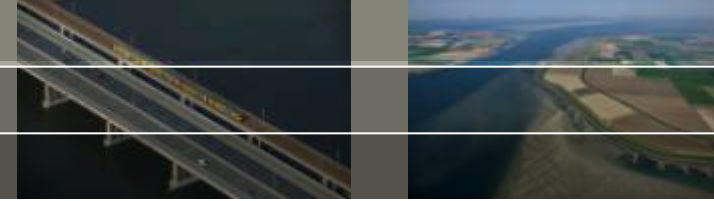
Delta oppervlak door de tijd



f) Floodbasin vs. channel belt area



Sediment budgetering



De hoeveelheden sediment in de Rijn-Maas delta vormen een volume.

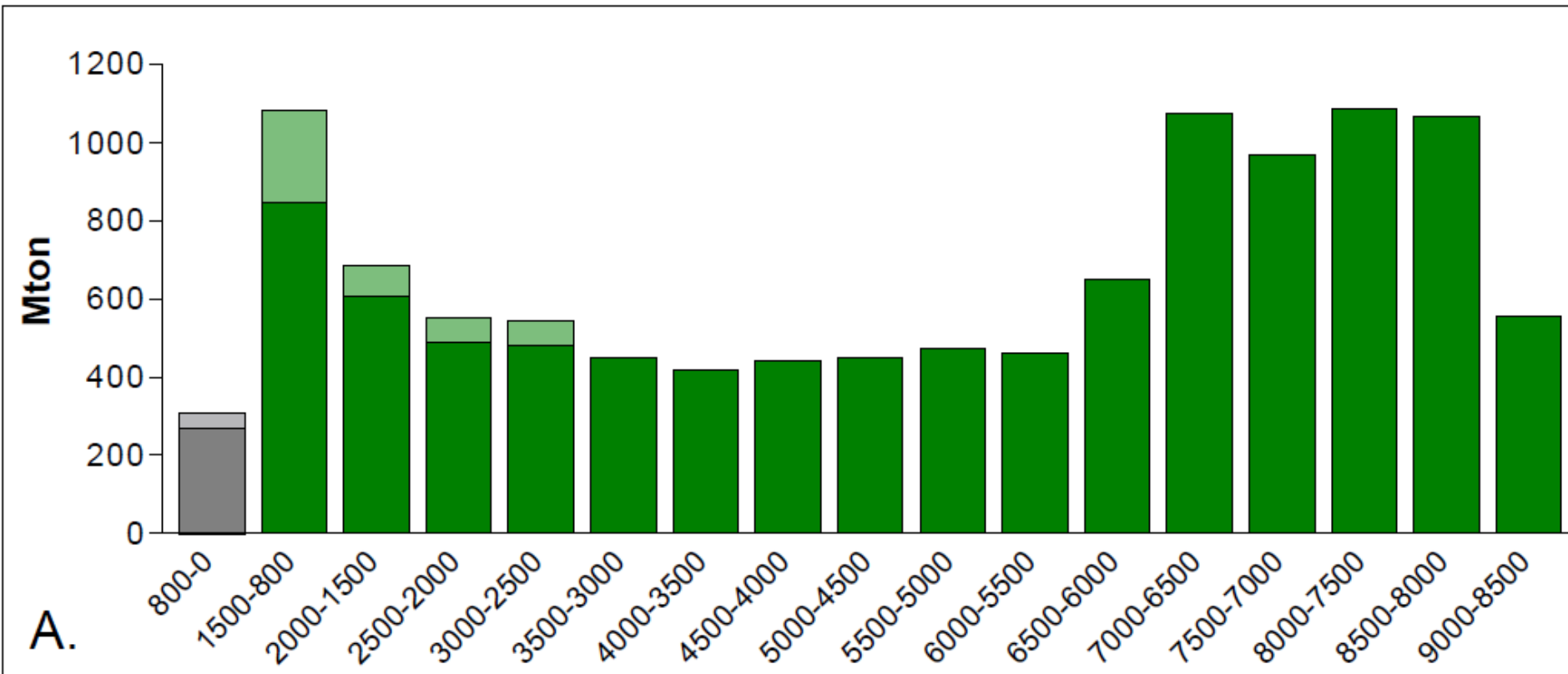
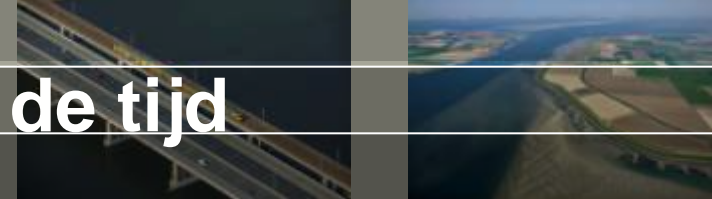
Om dat volume uit te rekenen hebben we nodig:

1. Dikte (m) **uit de profielen**
2. Oppervlak (km²) **uit de palaeogeografische kaarten**
3. Ouderdom (jaren) **doormiddel van dateringen**

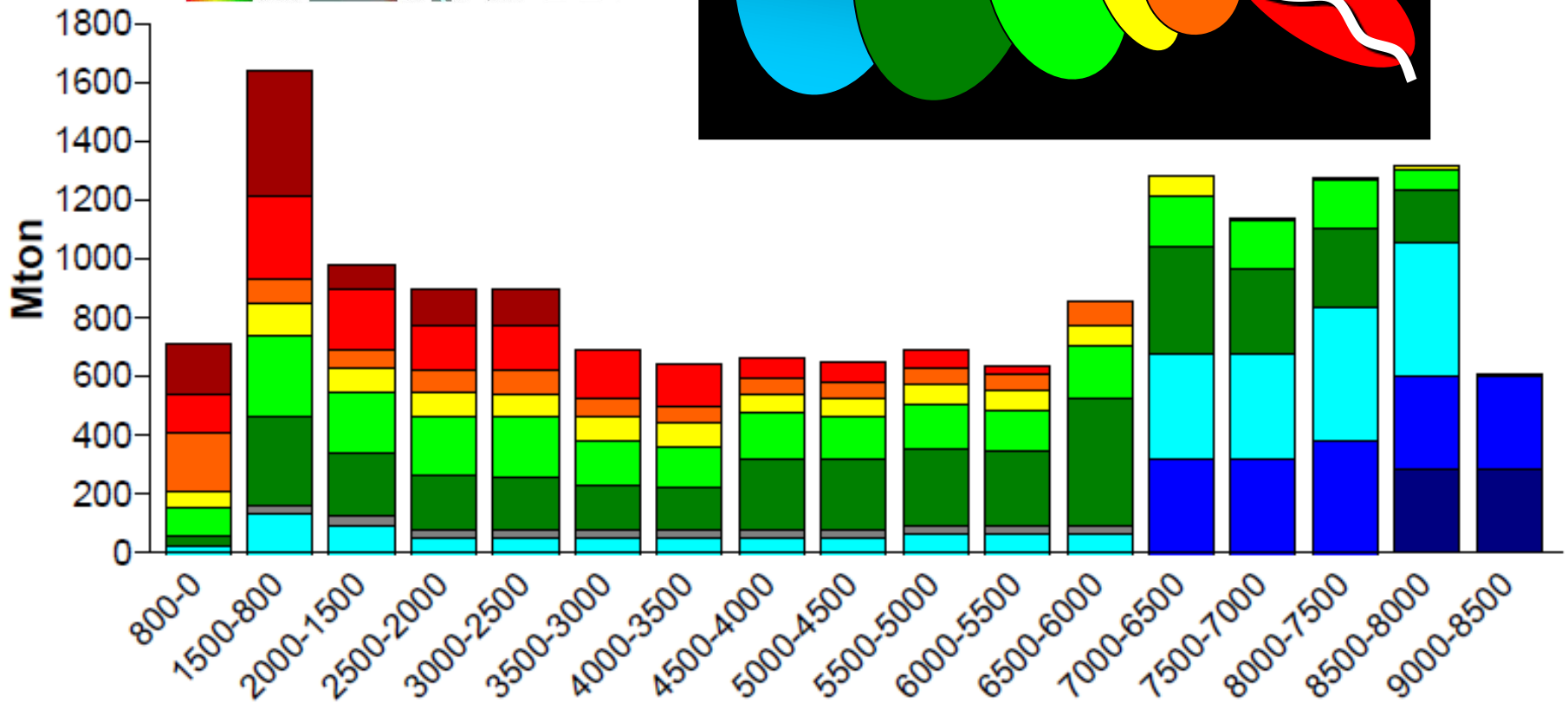
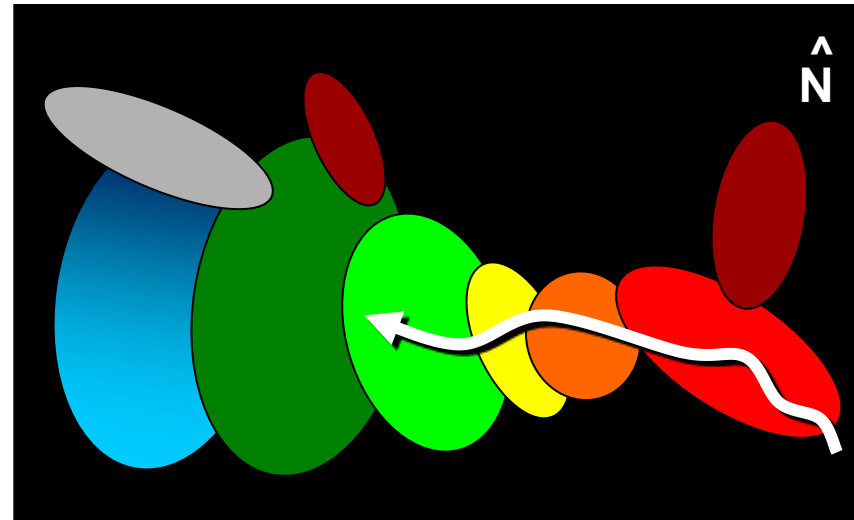
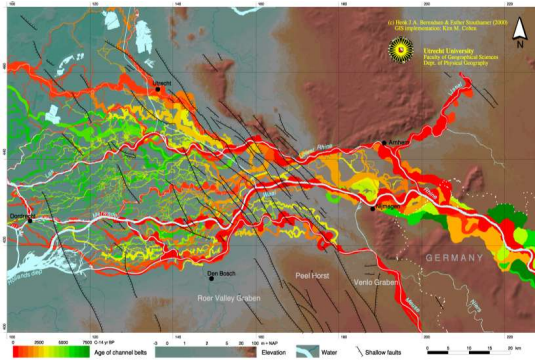
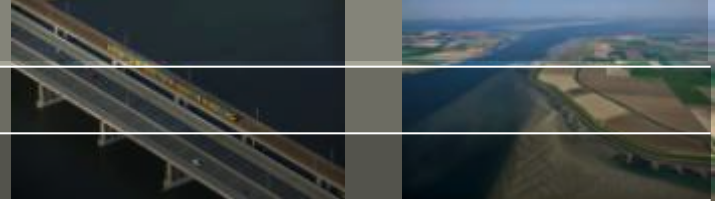
4. De massa van de sedimenten hangt af van:

- De samenstelling van het materiaal
(veen, ca 200 kg/m³ , klei ca 1200 kg/m³, zand ca 1700 kg/m³)
- De begravingdiepte en begravingsgeschiedenis
(is vooral voor veen belangrijk).

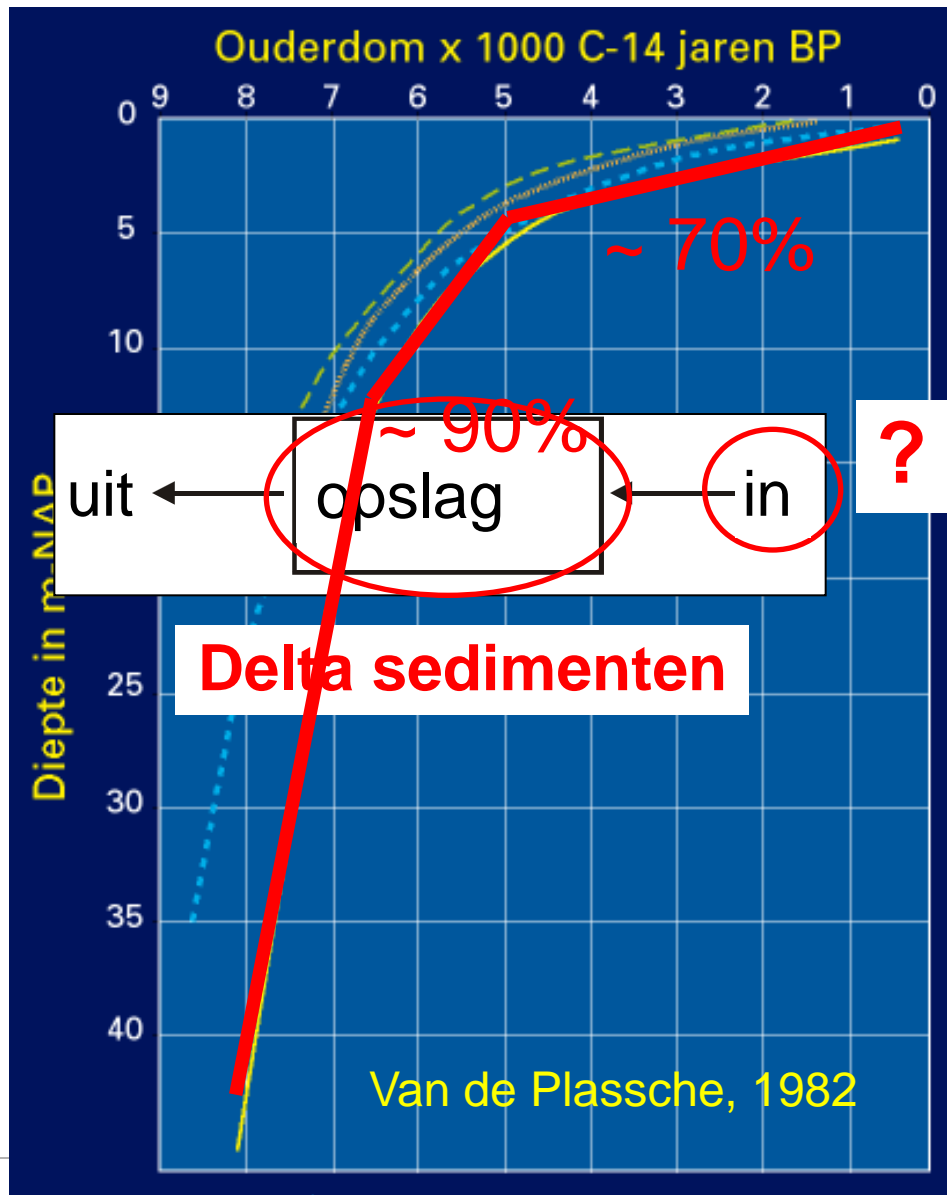
Sedimentatie in de delta door de tijd



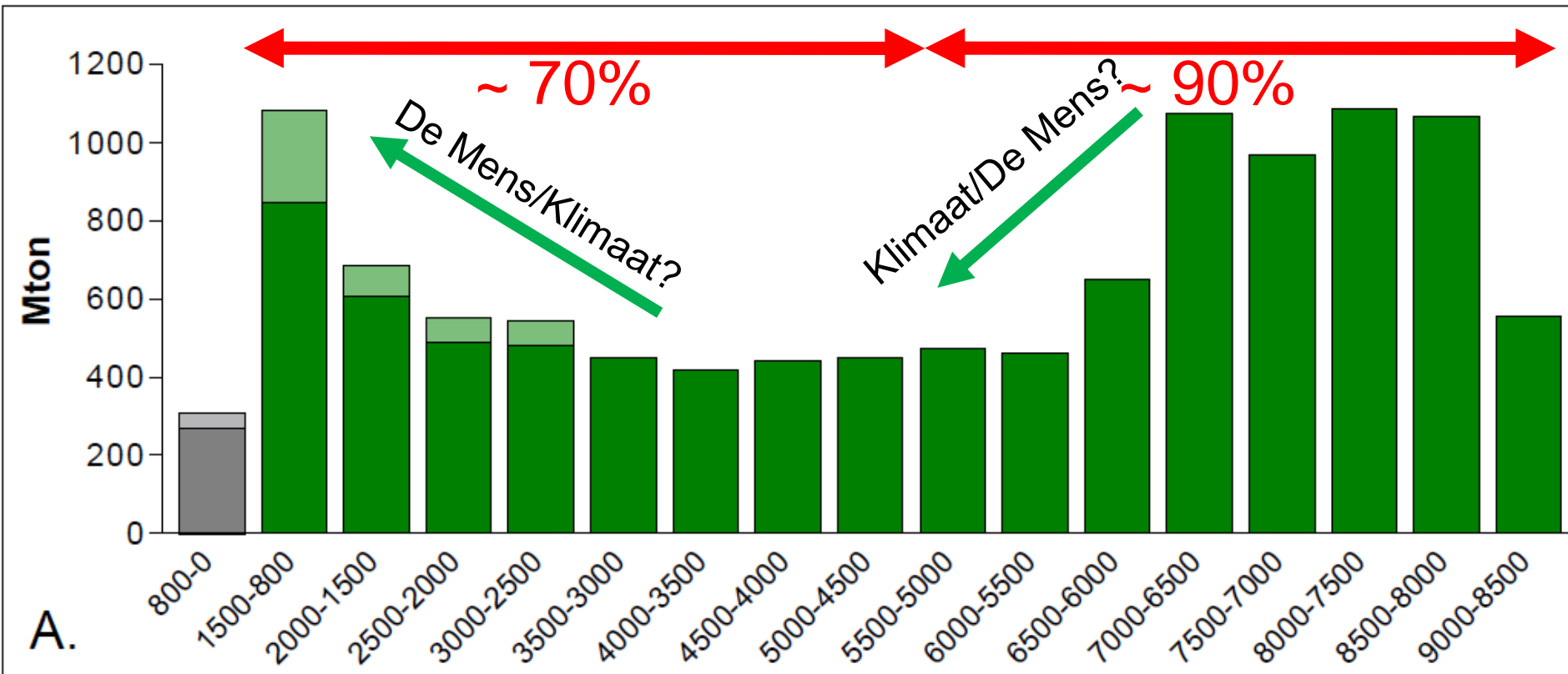
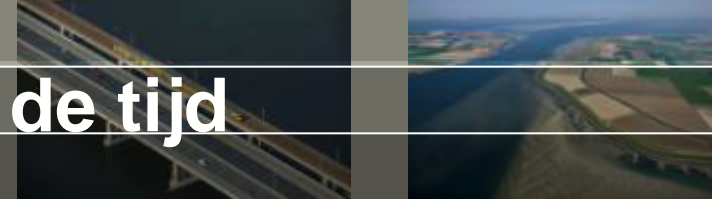
Sedimentatie in de delta



Effectiviteit van de sedimentafvang



Sedimentatie in de delta door de tijd



De eerste sedimentatie piek

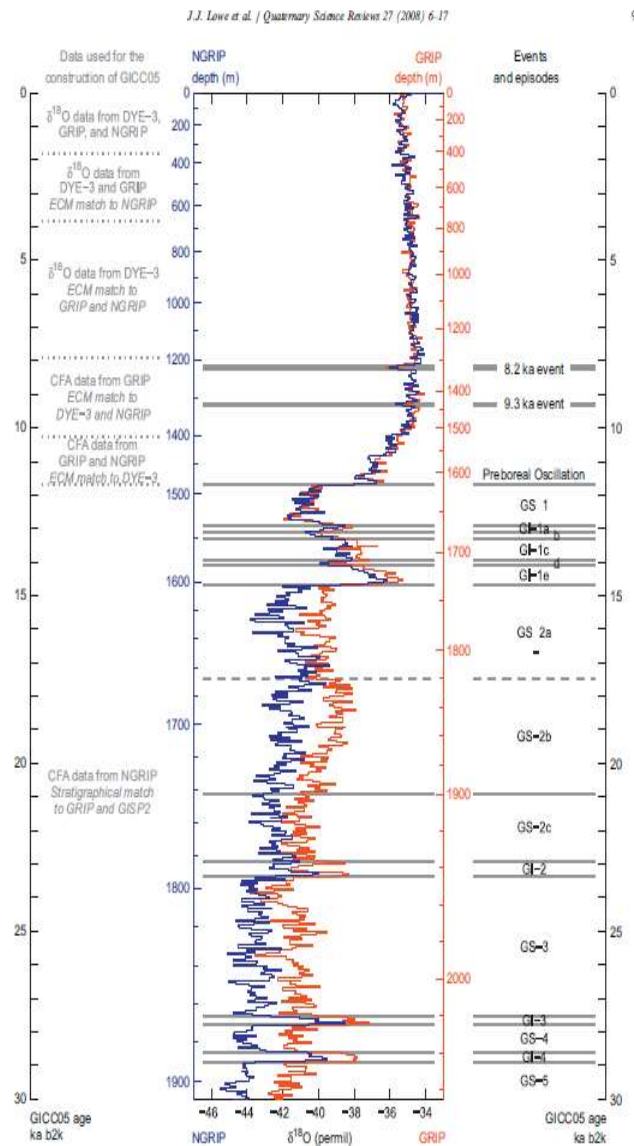
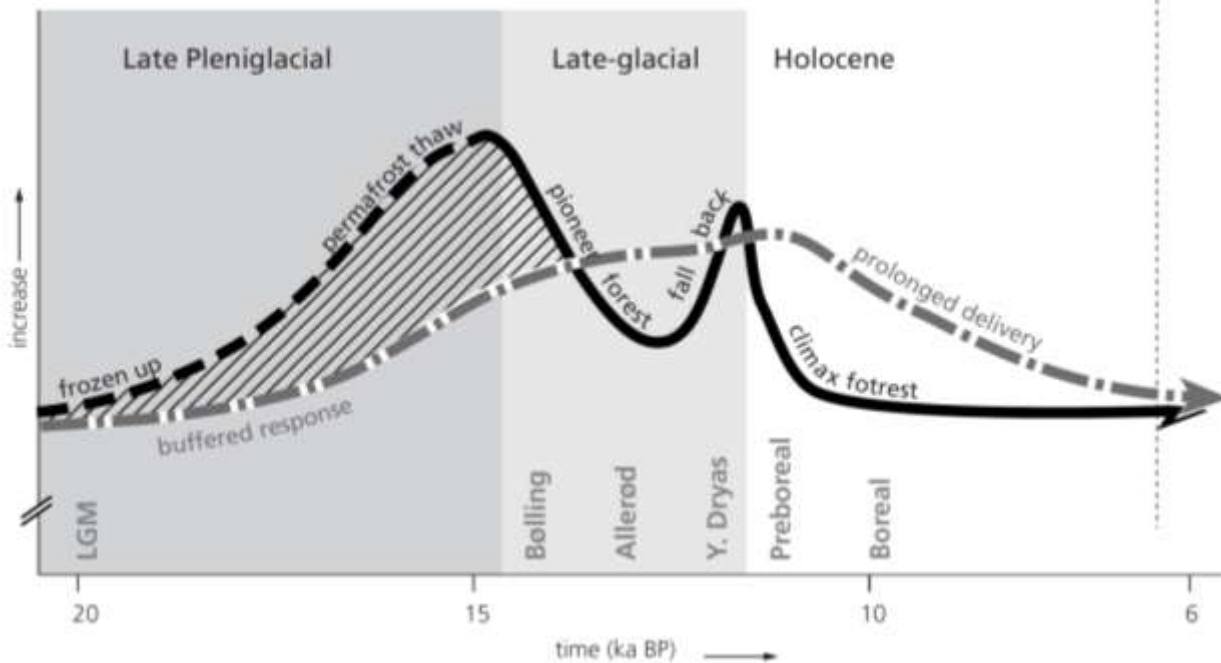
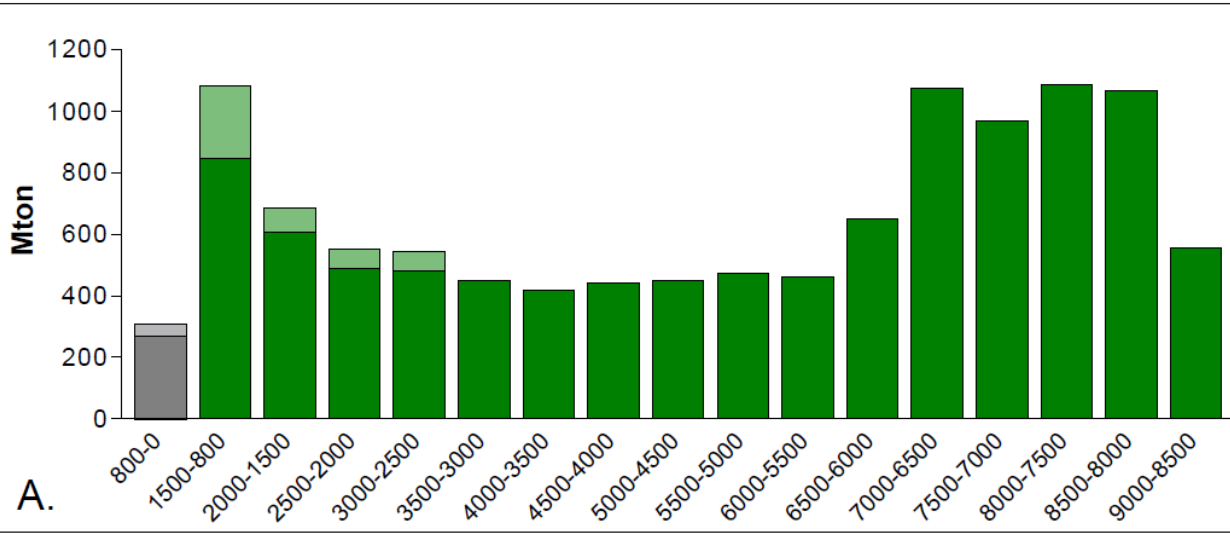
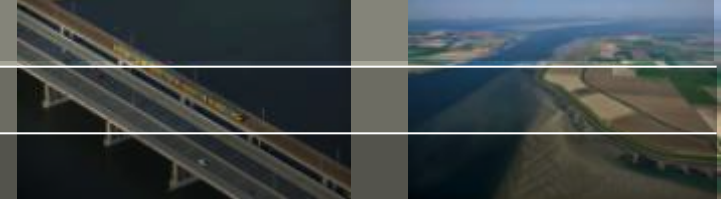
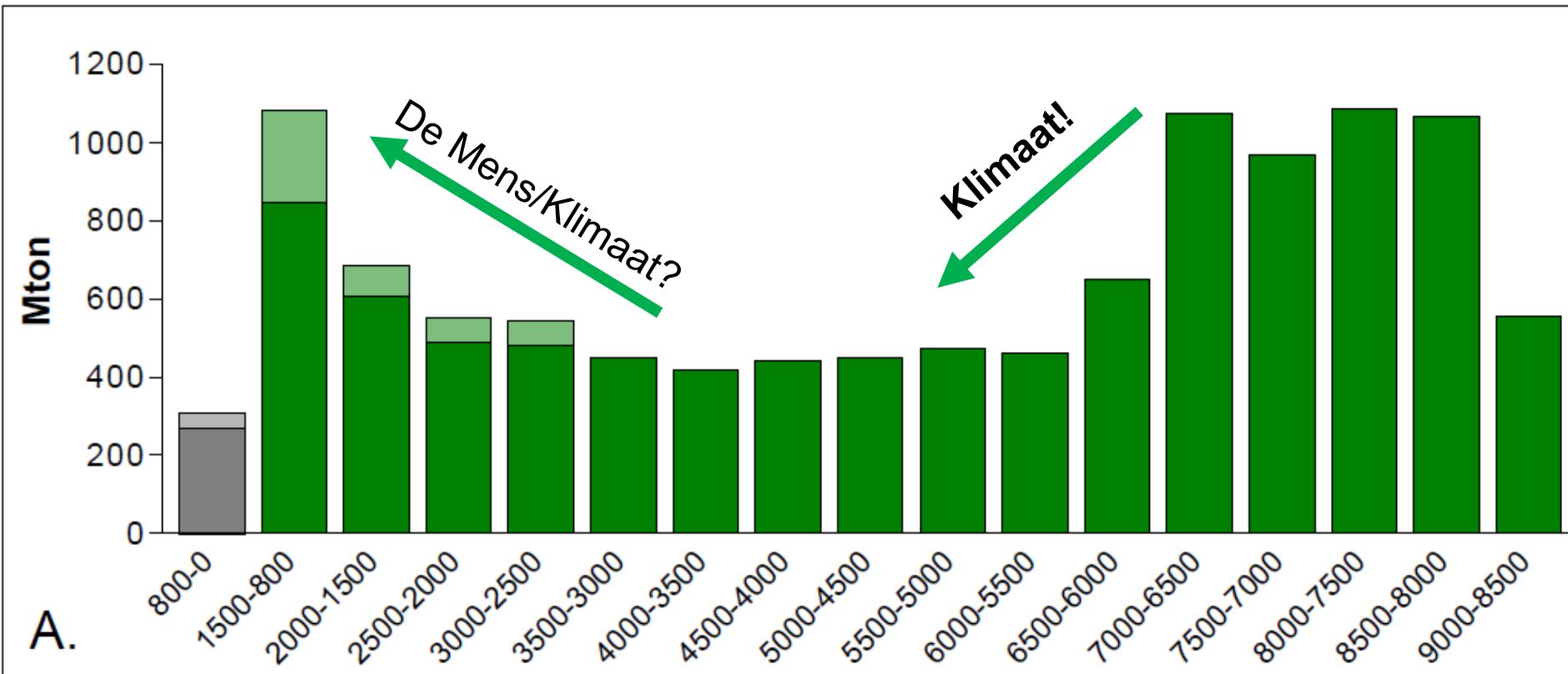
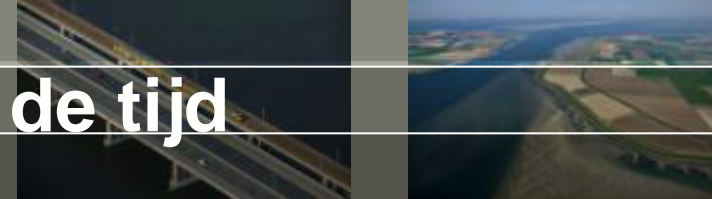
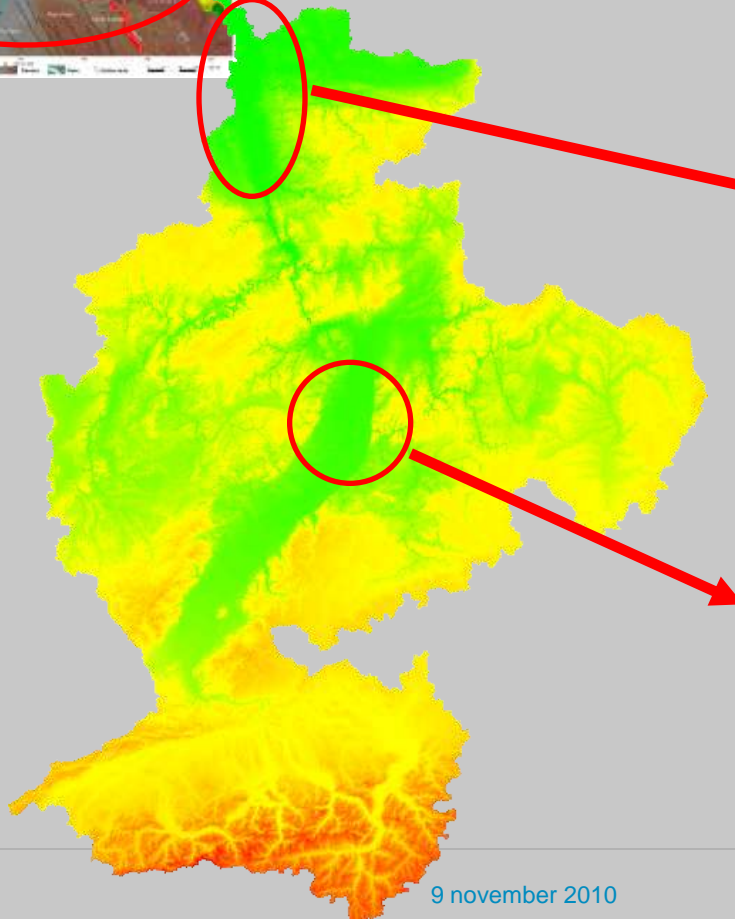
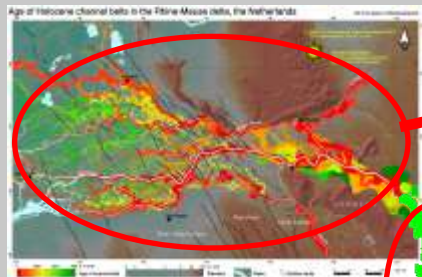
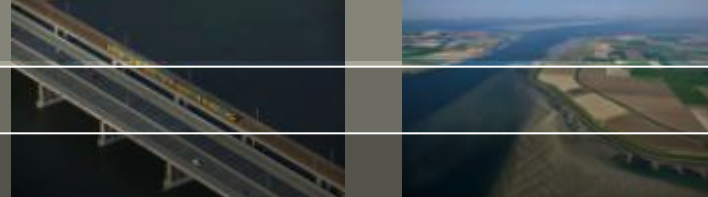


Fig. 1. Comparison of the $\delta^{18}\text{O}$ records for the NGRIP and GRIP ice core records for the last 30,000 years at a 50-year resolution.

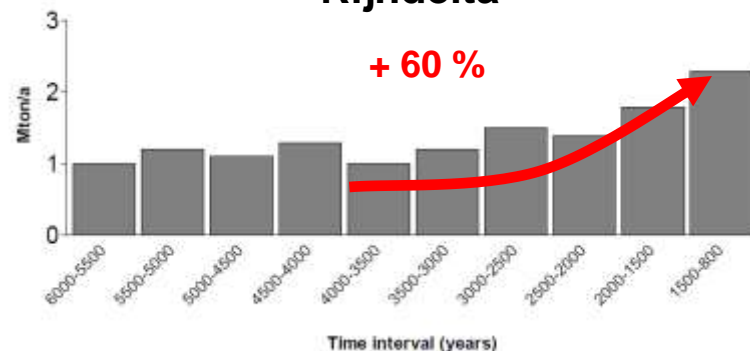
Sedimentatie in de delta door de tijd



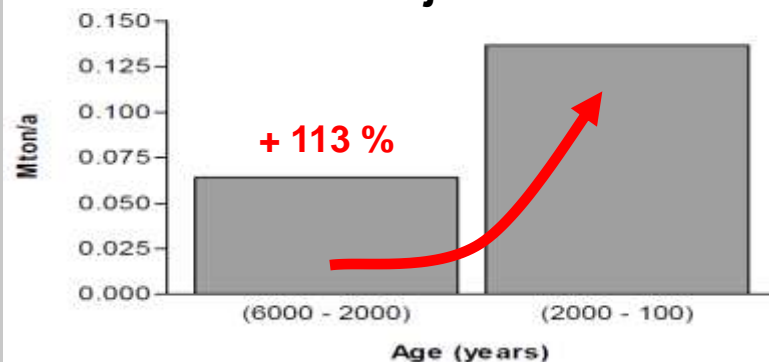
Trends in het stroomgebied



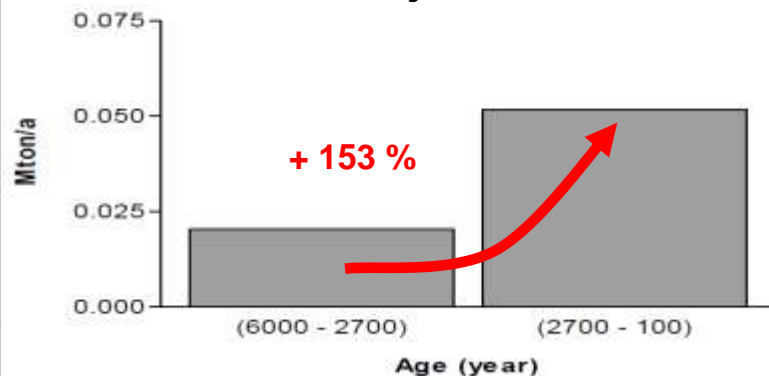
Rijndelta



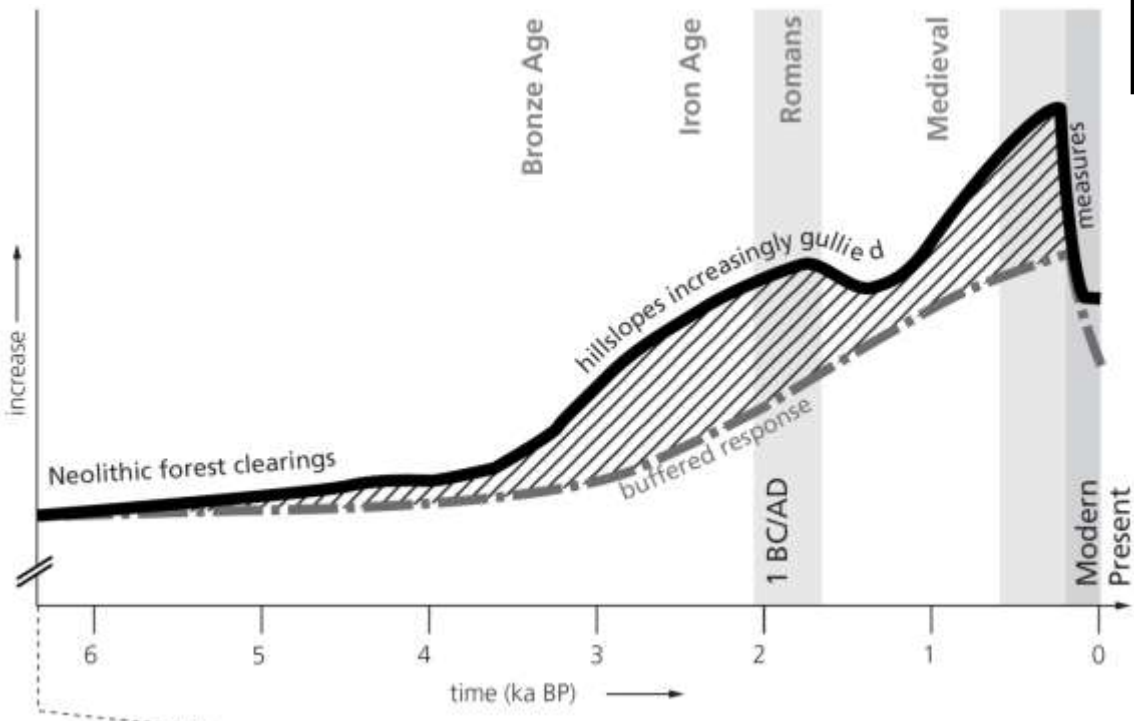
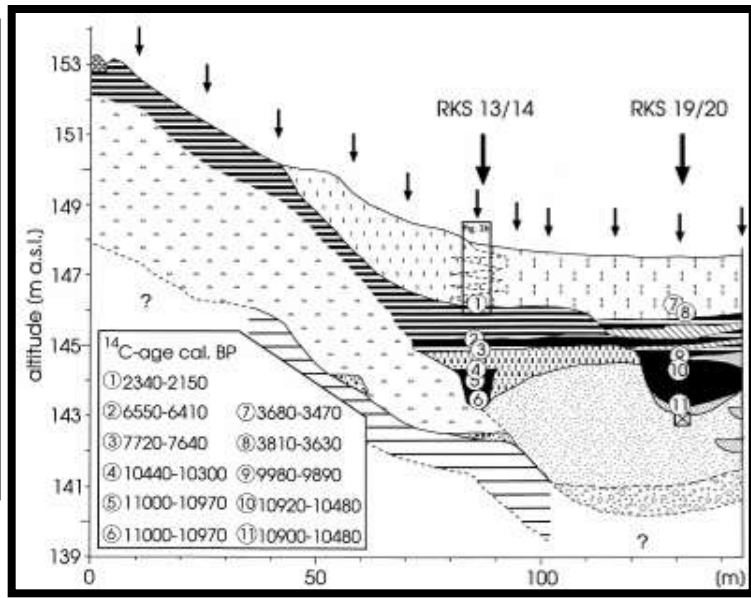
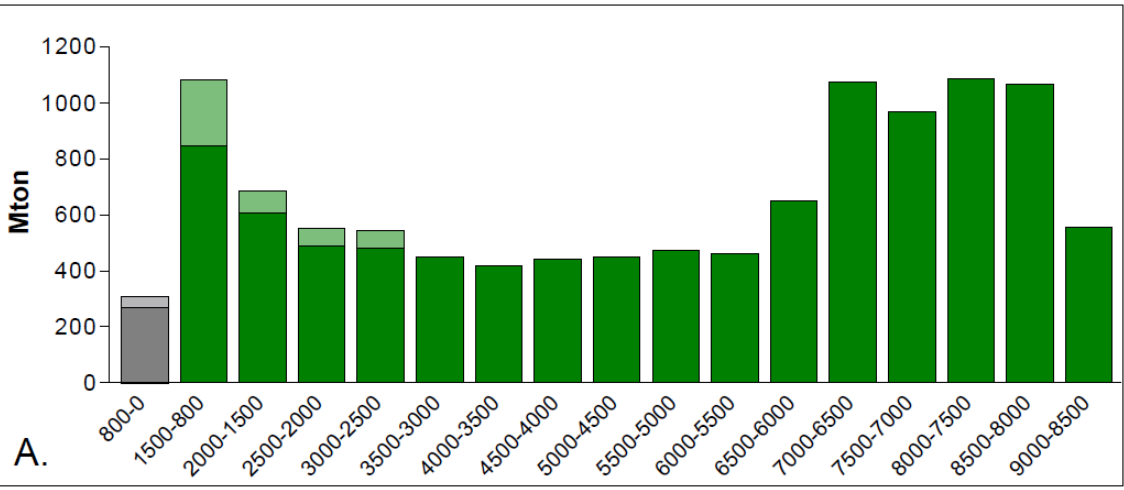
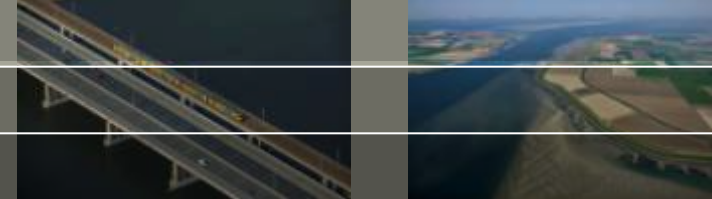
Beneden Rijndalslenk



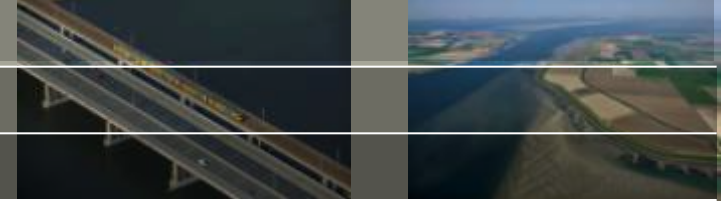
Boven Rijndalslenk



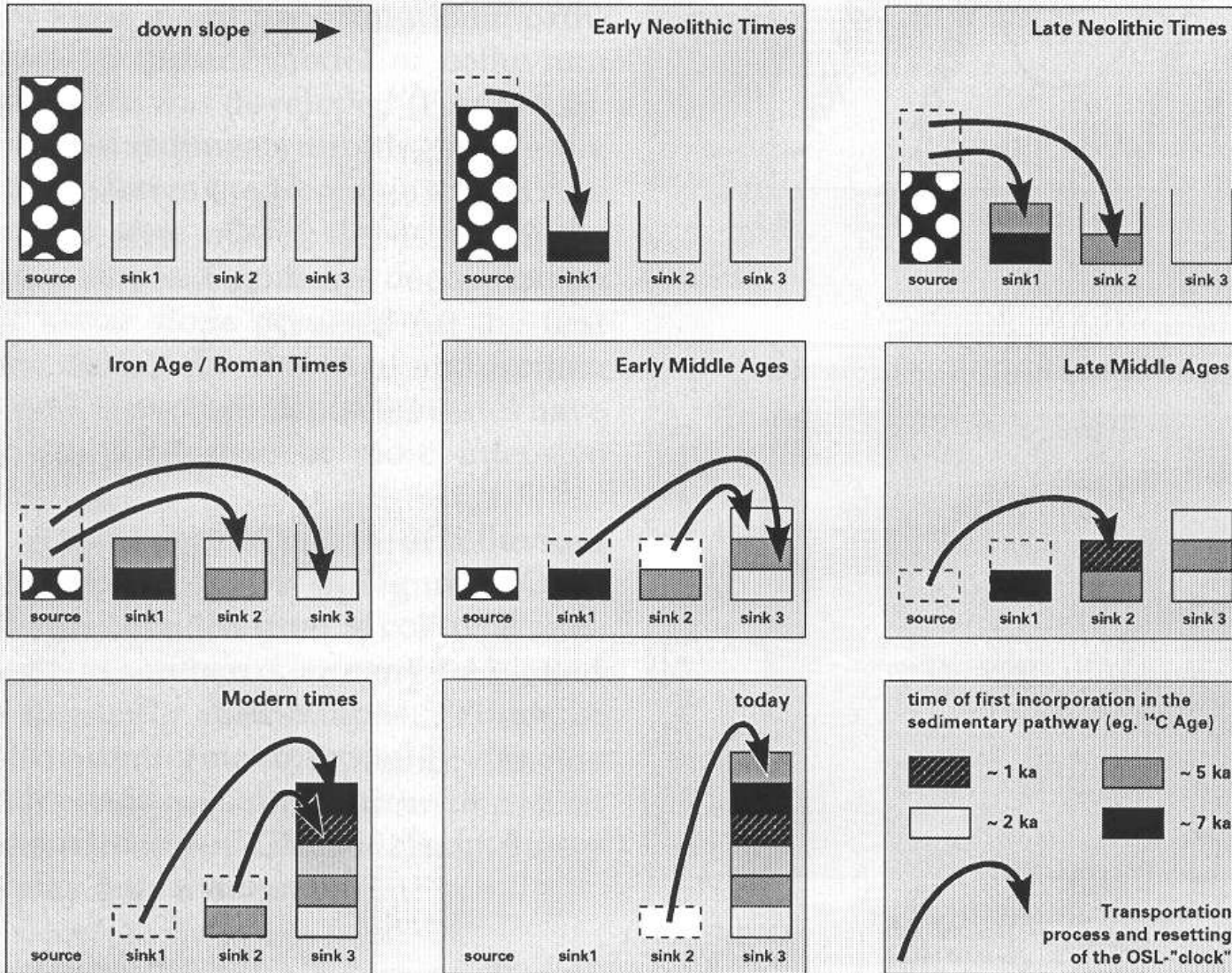
Menselijke invloed



Vertraging in sedimentaanvoer



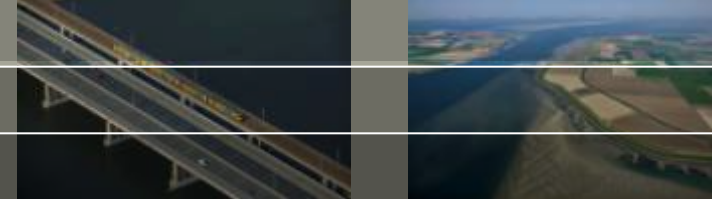
Lang et al (2003)



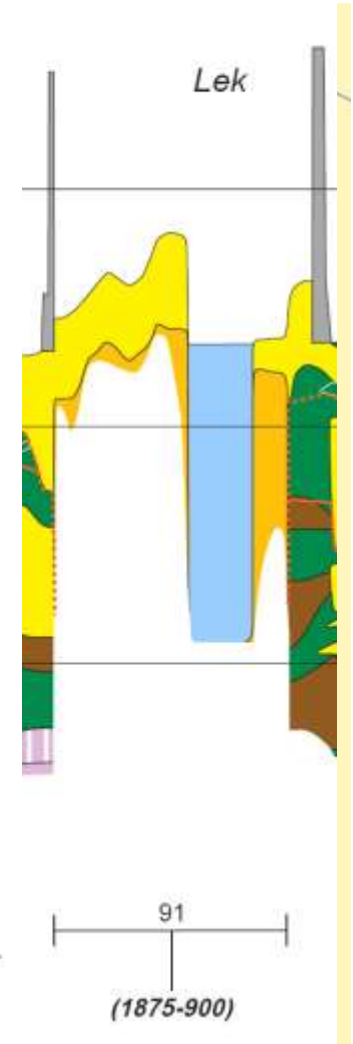
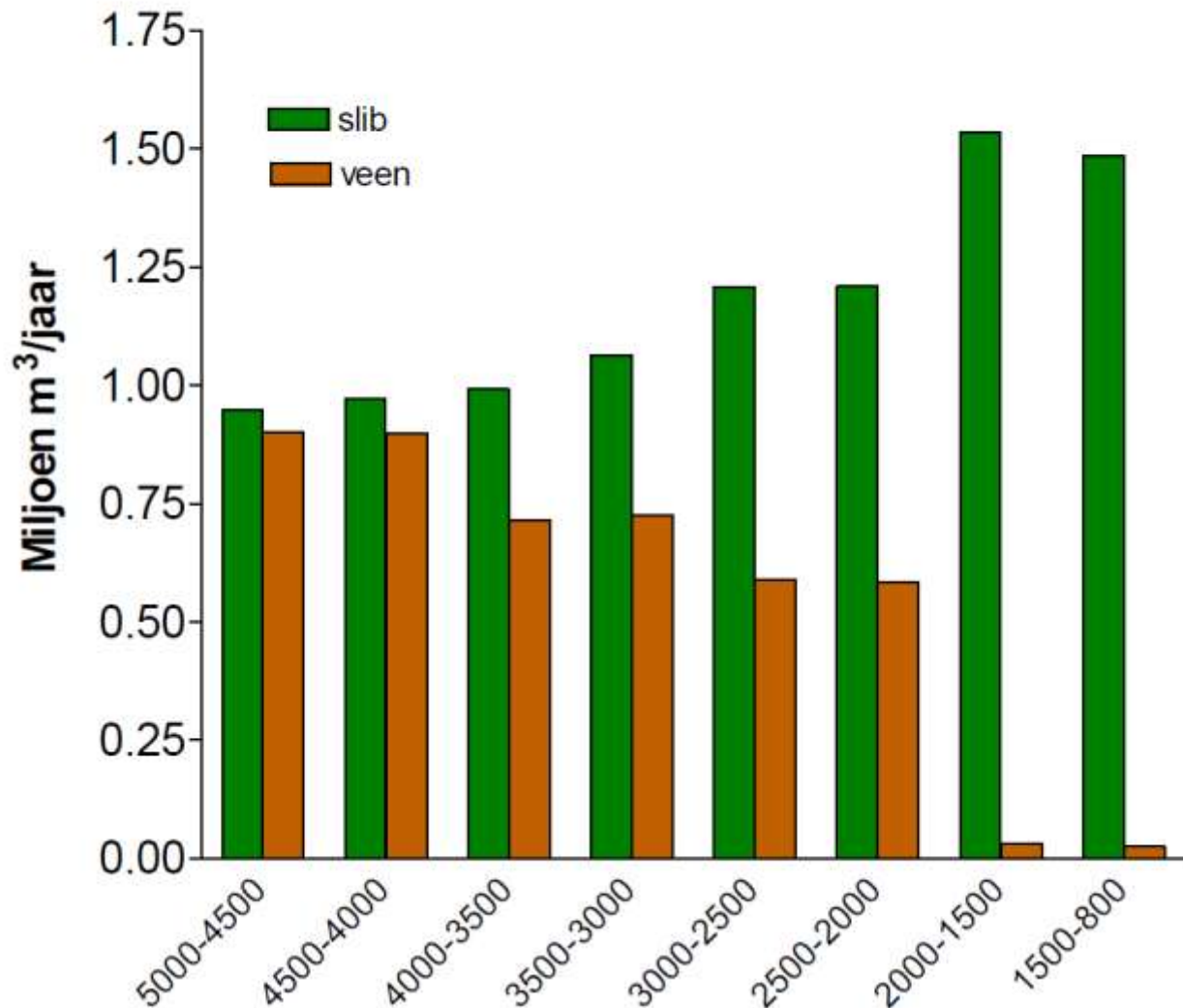
A photograph of a forest path. The path is dirt and leads into a dense forest of tall, thin trees. In the foreground, there is a large pile of dry sticks and branches on the right side. A red, semi-transparent overlay covers the middle part of the image, with the text 'Verdwenen grond' written in black. The text is centered within the red area. The overall scene is a natural, wooded environment.

Verdwenen grond

Gevolgen voor Nederland



Volumes slib en veen in de Rijndelta



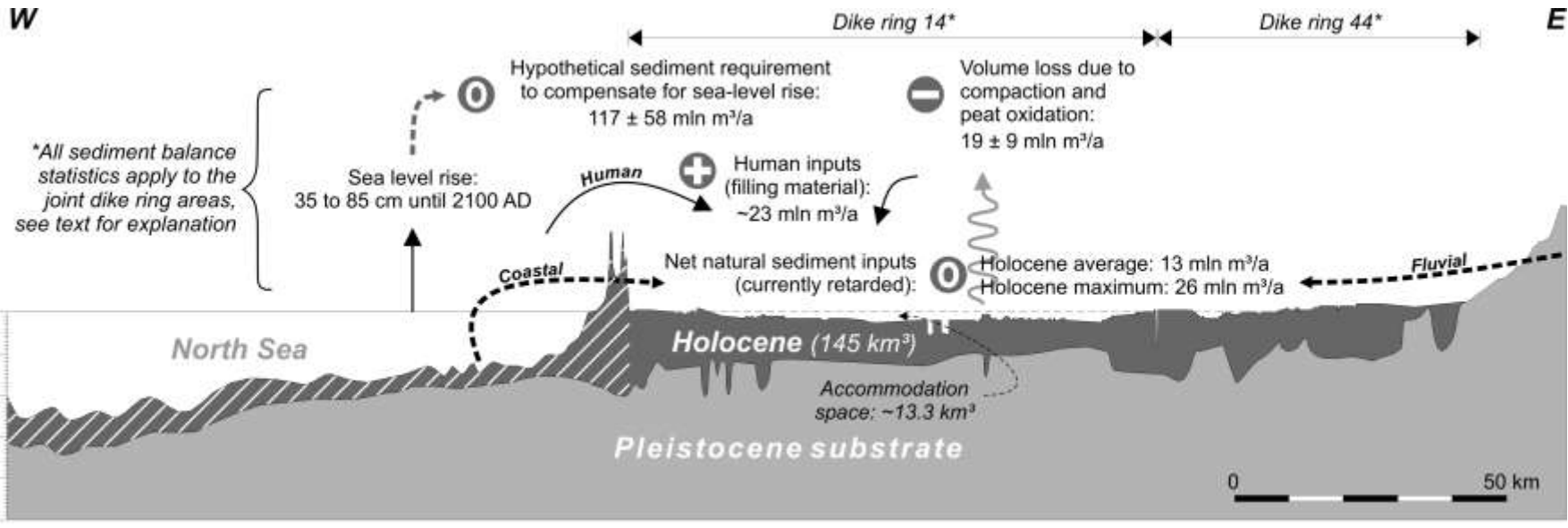
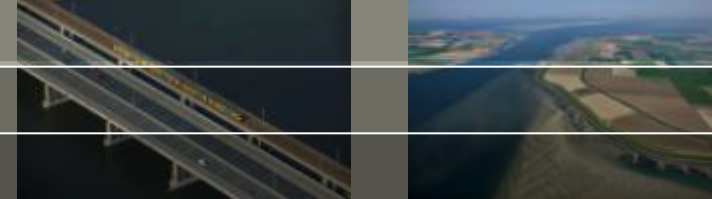
Uiterwaard opslibbing



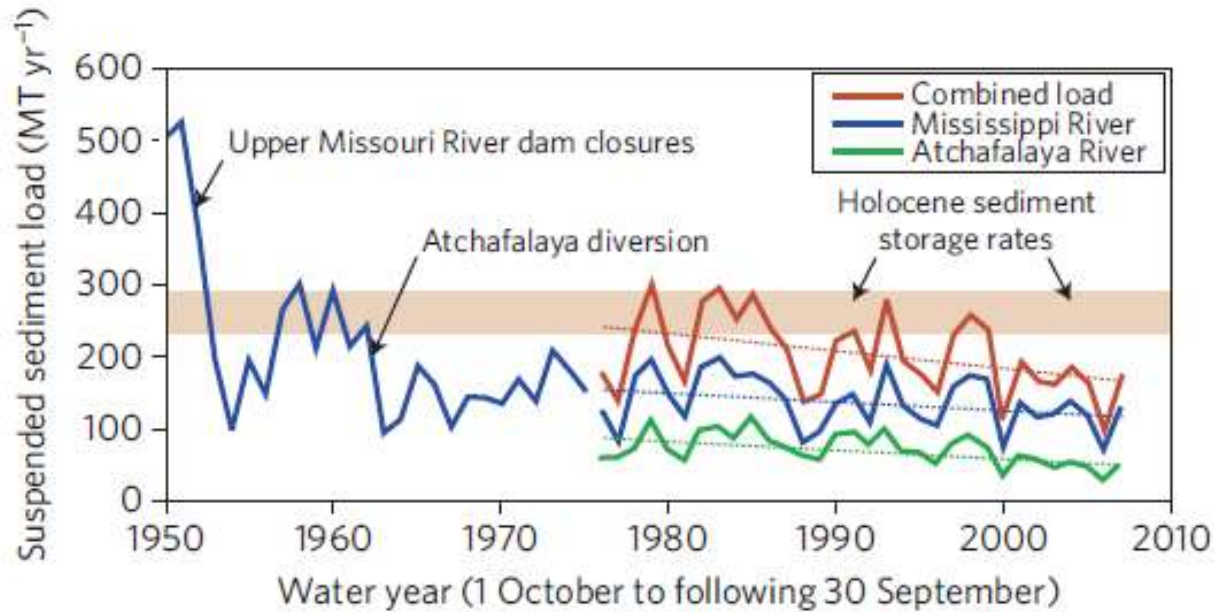
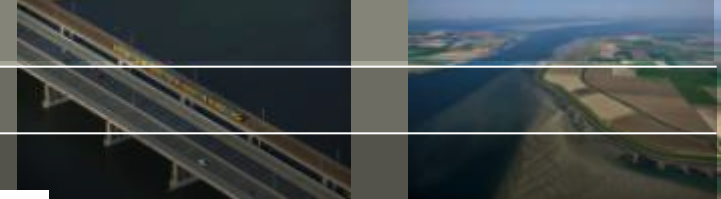
9 november 2010

Deltares

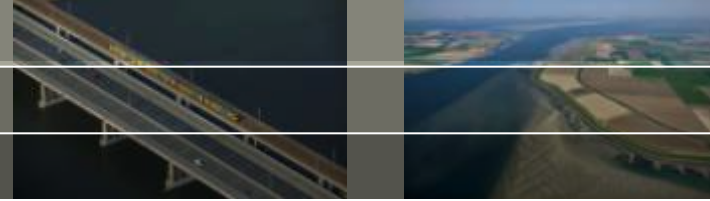
Sedimenttekorten



Voorbeelden elders



Conclusies



1. Met geologische data hebben we de aanvoer van sediment naar de Rijn-Maas delta gedurende de laatste 9000 jaar kunnen bepalen.
2. Landgebruik door de prehistorische mens heeft een merkbare invloed gehad op de aanvoer van sediment.
3. Voor de toekomst zijn veranderingen in landgebruik belangrijker voor de sedimentaanvoer dan klimaatsveranderingen.
4. In de huidige Rijndelta kan het sediment geen kant meer op.

An aerial photograph of a Dutch polder landscape. A prominent dike runs along the edge of a large body of water, separating it from a patchwork of agricultural fields. Some fields are green, while others are brown, suggesting different crops or stages of cultivation. In the distance, a small town or village is visible, nestled between the water and the land. The sky is clear and blue.

Mysteries van het Rijnland

Gilles Erkens e.a.