

Regional sediment deficits in the Dutch lowlands

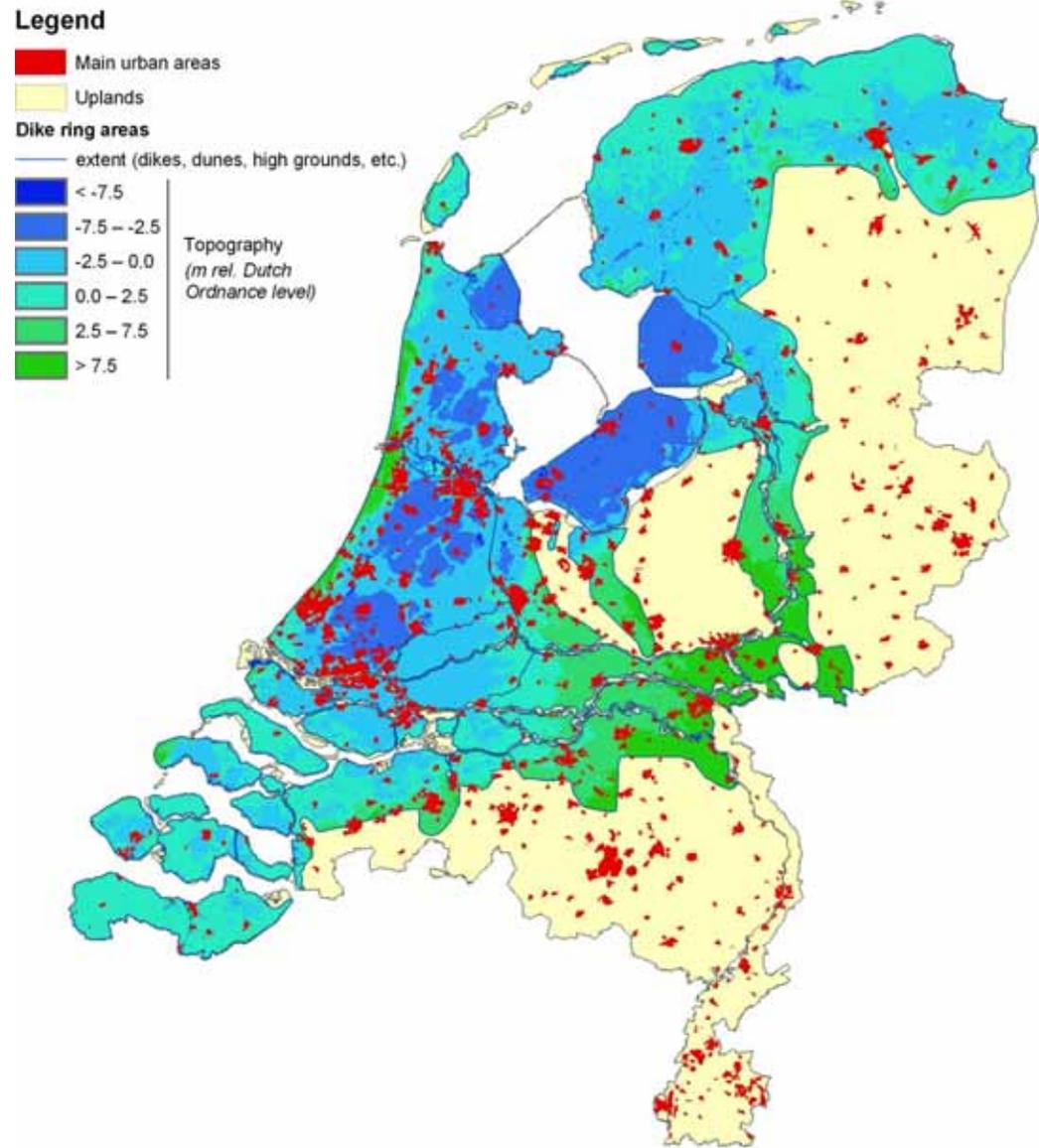
Implications for long-term land-use options

TNO Built Environment and Geosciences
Geological Survey of the Netherlands



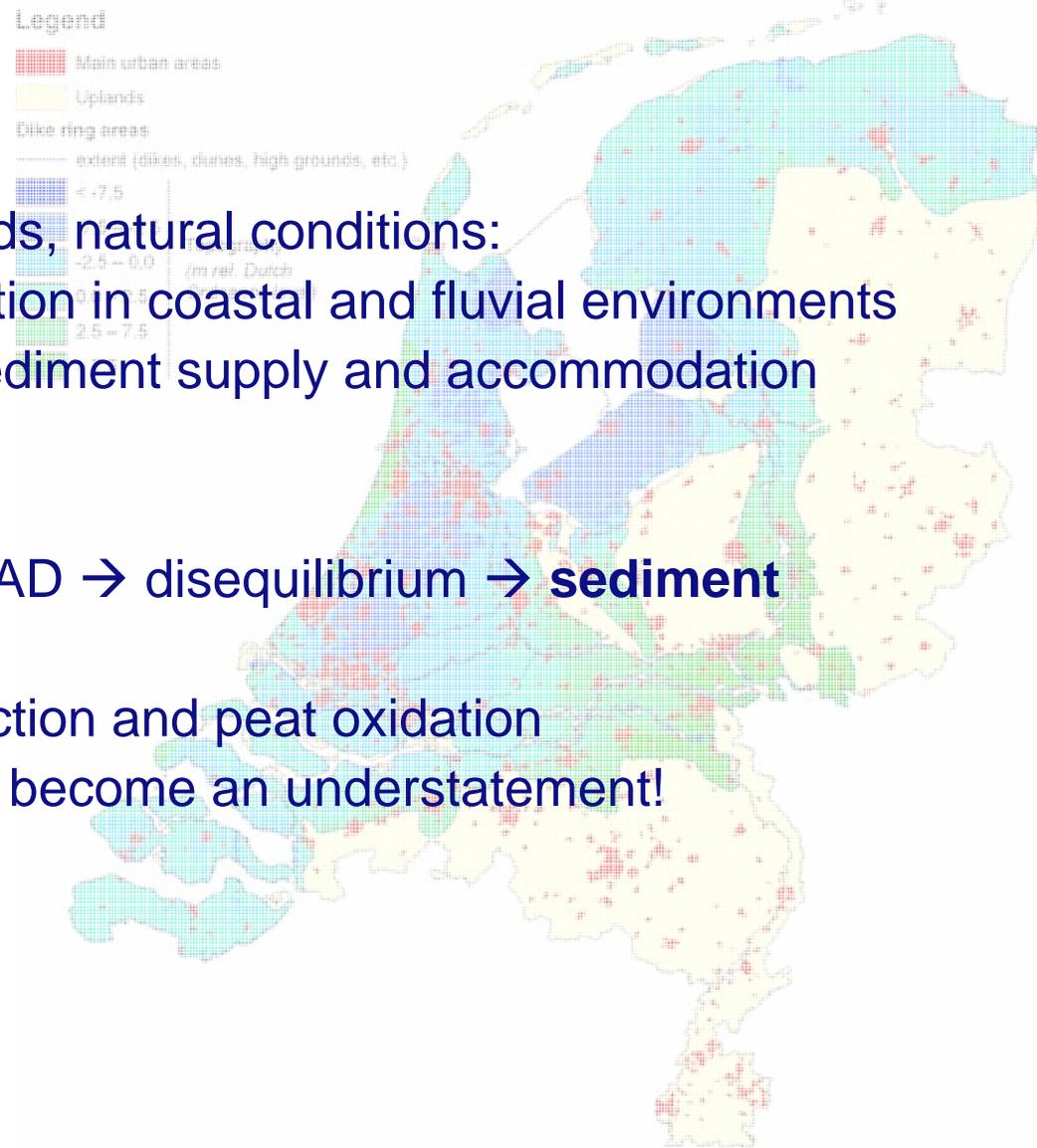
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Introduction (1)



Introduction (2)

- Dutch Holocene lowlands, natural conditions:
 - Sediment accumulation in coastal and fluvial environments
 - Balance between sediment supply and accommodation
- But now ...
 - Diking since ~1000 AD → disequilibrium → **sediment deficiency**
 - Additionally: compaction and peat oxidation
 - Term 'lowlands' has become an understatement!



Introduction (3)

- Perspective:
 - Climate change (storm surges, river discharges, precipitation)
 - SLR
- These problems:
 - are broadly acknowledged
 - cause concern
- Water-management perspective
- Alternative perspective:
 - No excess of water but a shortage of sediment
 - Manageable?



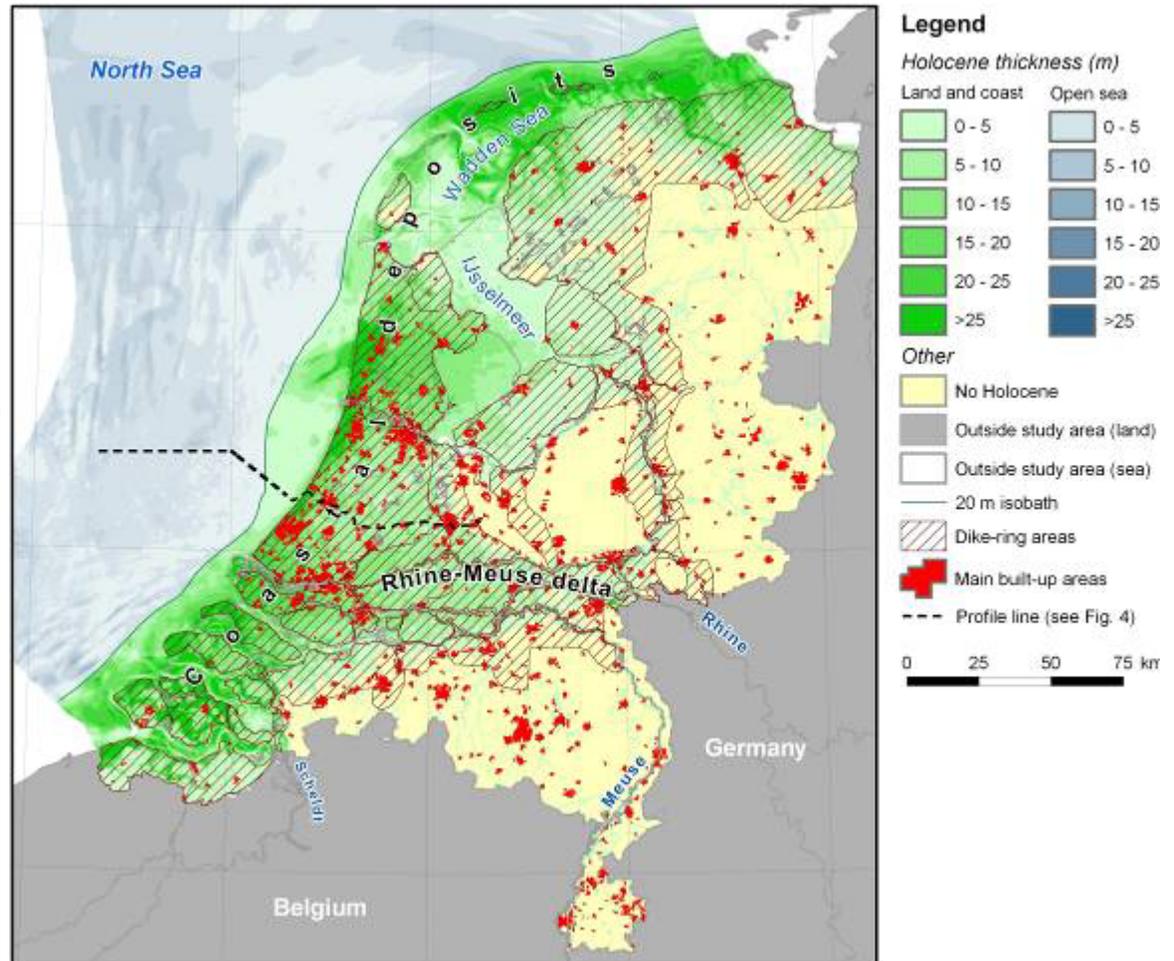
Approach

- Sediment balance for the 'dike-ring areas'
- Calculate / estimate:
 - Compensation for SLR
 - Volume loss (peat oxidation, compaction)
 - Human inputs
- Compare with natural sediment balance



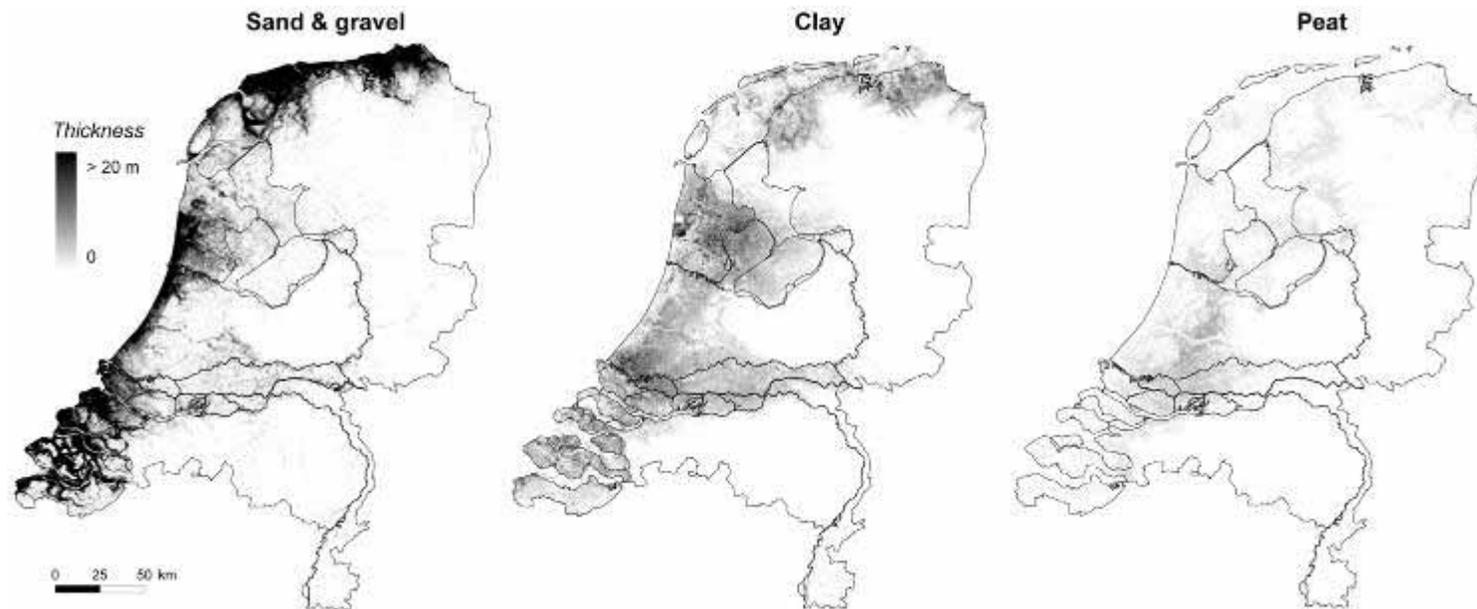
Holocene Dutch lowlands: some figures

- Total volume: 275 km³
- i.e. 25-30 Mio m³/yr
- Onshore: almost completely 'sterilized'



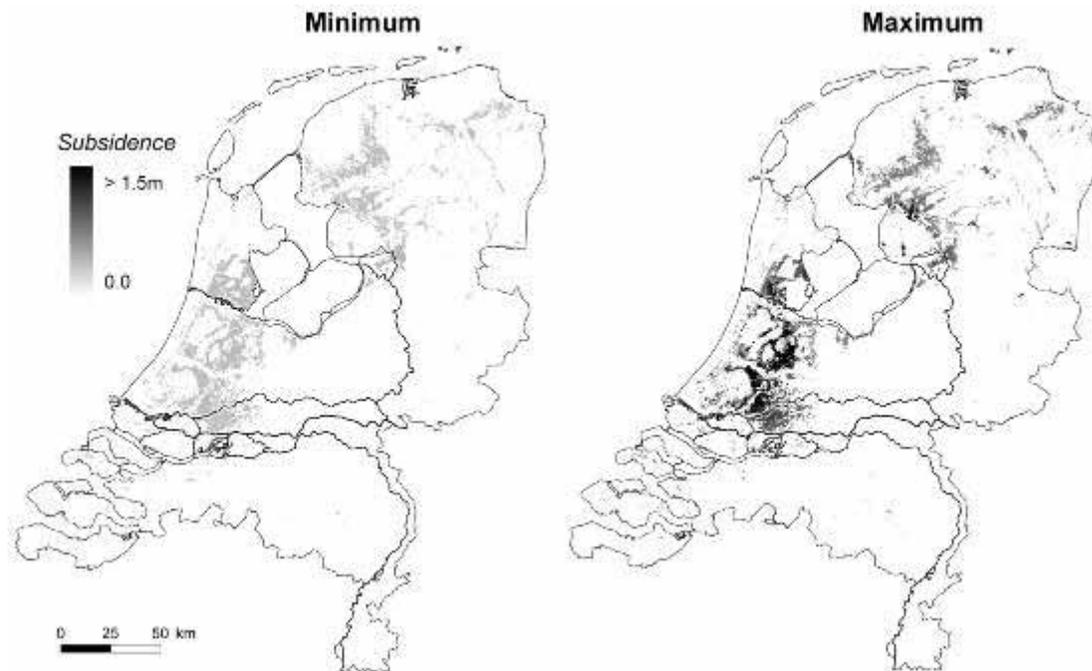
Holocene Dutch lowlands: some figures

- sand and gravel: 59%,
- **clay 33%,**
- **peat 8%**



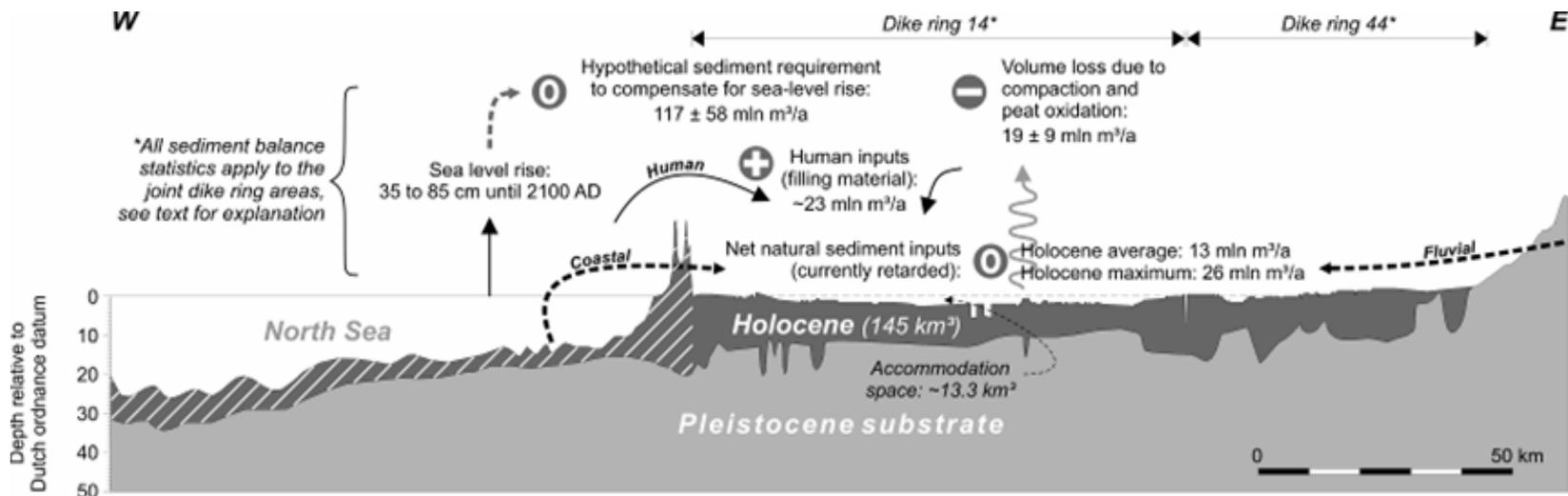
Sediment deficiency and drainage effects

- Volume loss: 9-28 Mio m³/yr
- Land subsidence
- Deep polders (down to 6 m below sea level)



Sediment balance (dike ring areas)

- Annual sediment deficit 140 Mio m³/jr
- Cumulative sediment deficit: 13 km³
- Natural inputs: 10 - 26 Mio m³/jr → **impeded!**
- Human inputs: 25 Mio m³/jr → **upscalable?**



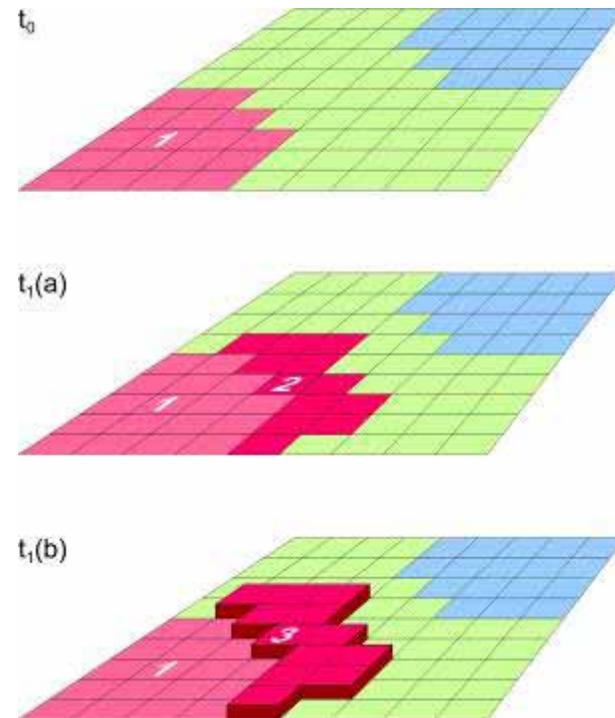
Preliminary conclusion

- Sediment deficiency:
 - No 'natural' solution
 - Manageable
- Human inputs:
 - 3 times current effort: significant compensation in ~100 yr
- Approach: raising lands prior to building



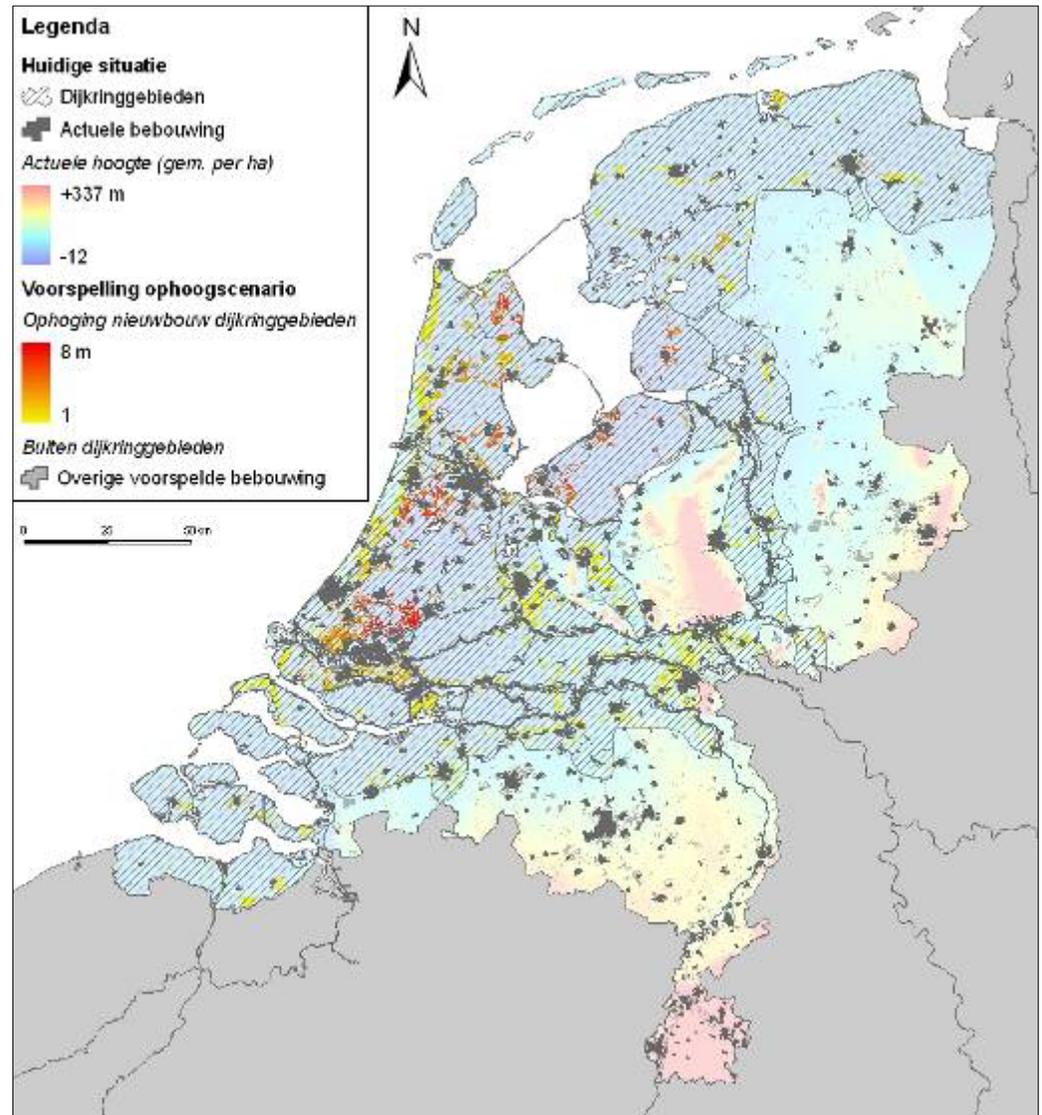
Further work

- Spatial approach
- Raising lands that are to be built up
- Urbanization scenarios as input



Land raising scenario 2010-2040

- **How much:**
 - Below Dutch Ordnance Level: **DOL + 1 m**
 - Elsewhere: **+ 1 m**
- **Sand requirement?**
 - (net) 100 Mio m³/jr



Implications for spatial planning

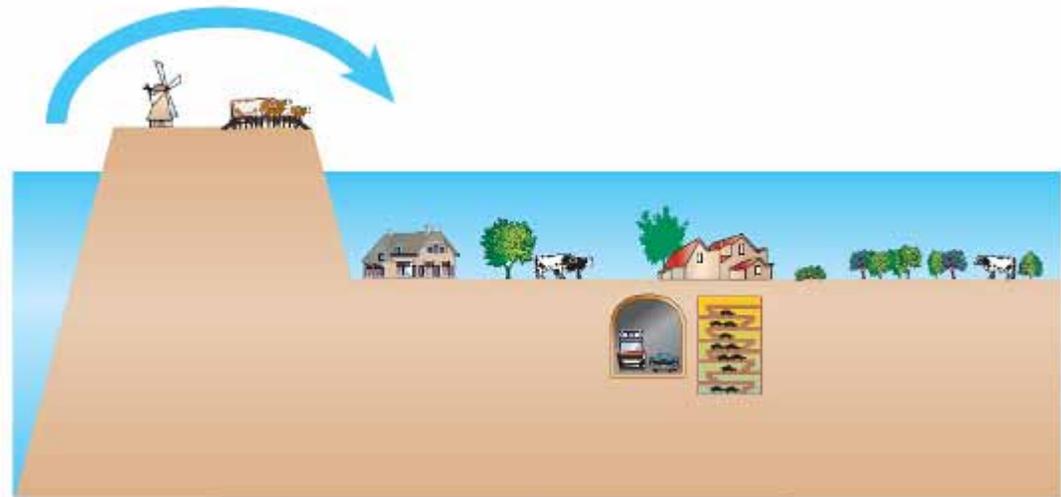
- Patterns:
 - 'Urban highlands'
 - 'Sand lines'
 - 'Megamounds'
 - Wetlands?
- Developments:
 - Scale requirements
 - Risk differentiation (implications, acceptance)
 - Pasture land → wet nature?
 - New approaches in spatial / infrastructure planning
 - Sustained effort → master planning





Here and now?

- Megamound-concept
- Preliminary studies
- “Underground infrastructure above the surface”



Conclusions

- Adaptation to Global Change in the Netherlands:
 - More than a water-management issue
 - 'Living *with* water' \neq 'Living *in* water'
- Land raising seems viable:
 - Resources available
 - Volumes not inhibitive
 - There is time!
- No alternative, but an addition to water management:
 - The dikes are fine, keep them in good order
 - The issue is overdue maintenance behind the dikes



Thank you for your attention

Van der Meulen, M.J., Van der Spek, A.J.F., De Lange, G., Gruijters, S.H.L.L., Van Gessel, S.F., Nguyen, B.L., Maljers, D., Schokker, J., Mulder, J.P.M., Van der Krogt, R.A.A., 2007. **Regional Sediment Deficits in the Dutch Lowlands: Implications for Long-Term Land-Use Options.** *Journal of Soils and Sediments* 7(1), 9-16

