



Rijkswaterstaat
Ministerie van Infrastructuur en Milieu

Climate Change and Inland Waterways

... and the issue of
morphology and subsidence

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Recall

Several research programs on the effects of Climate Change on the inland waterways within the Netherlands:

- Knowledge for Climate

"The impact of climate change to inland waterway transport and the competitive position of the port of Rotterdam" (2011)

- Deltaprogramma

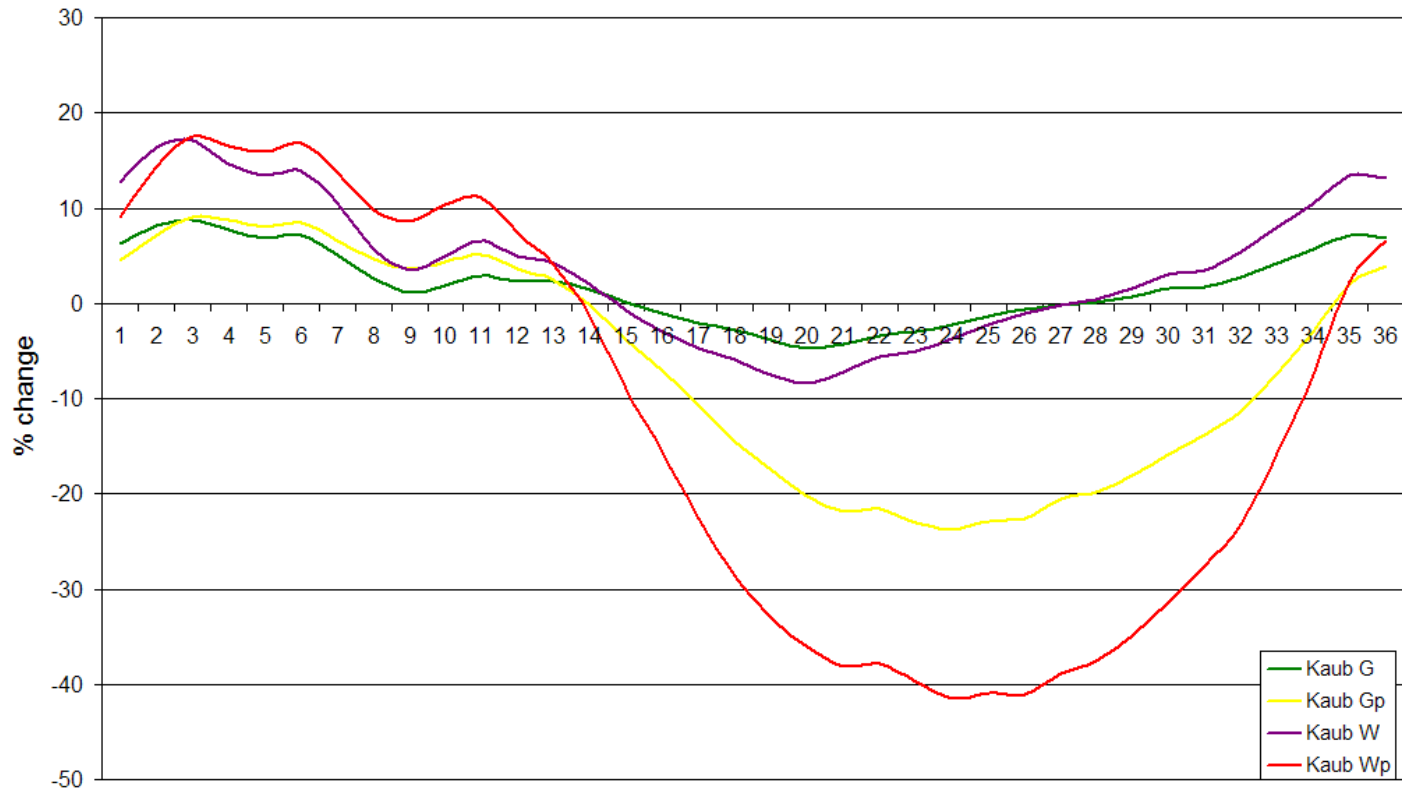
"Protecting the Netherlands against high-water and taking care for sufficient fresh water for the users of the fresh water system" (up to 2014)



Some highlights

The impact on river discharges

Forecast 2050 for the River Rhine



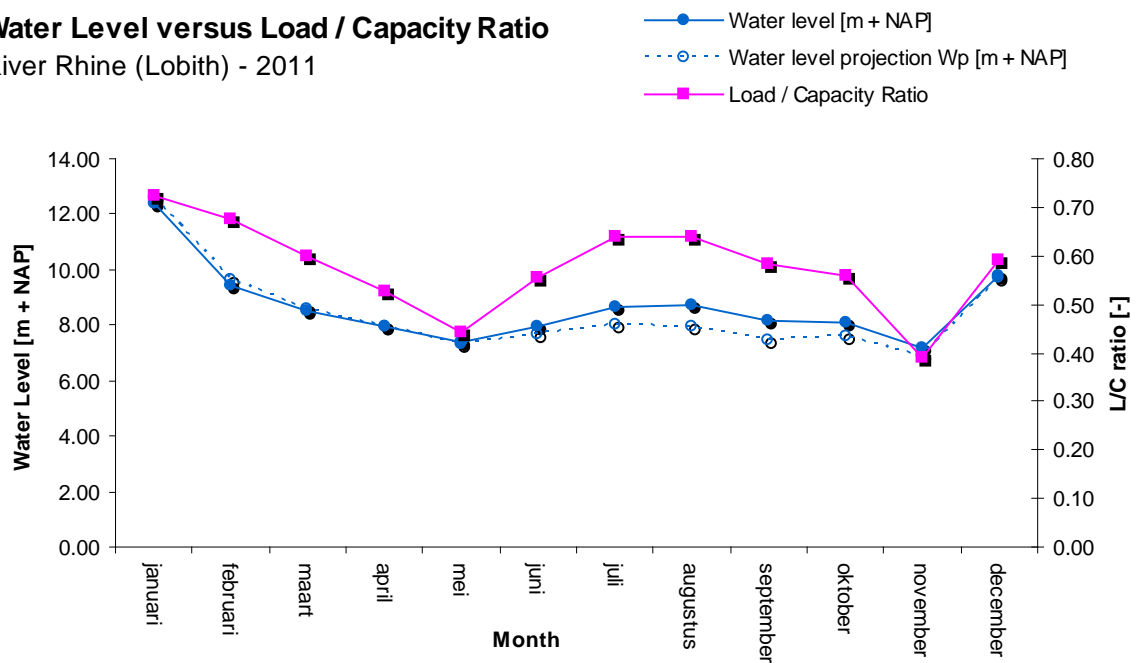
- G moderate increase temperature
- Gp moderate increase temperature and altering circulation
- W increase temperature
- Wp increase temperature and altering circulation



Some highlights *And the impact on water levels and navigation*

- Lower discharges will lead to lower water levels
- Restrictions in loading capacity
- More trips needed to transport same amount of cargo
- Transportation costs per ton will increase
- Modal shift to road and rail

Water Level versus Load / Capacity Ratio
River Rhine (Lobith) - 2011

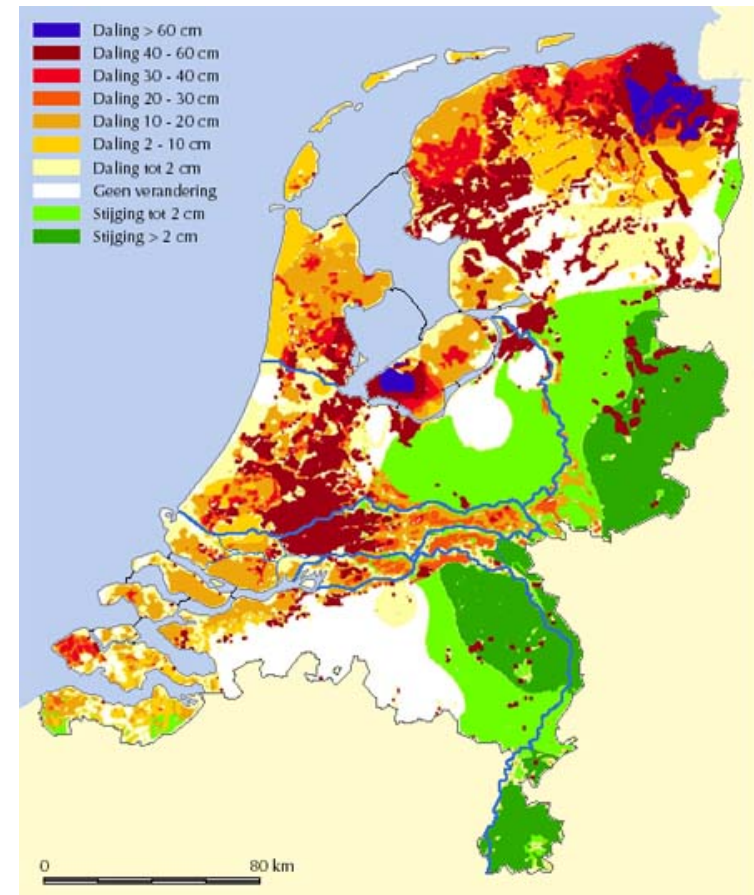
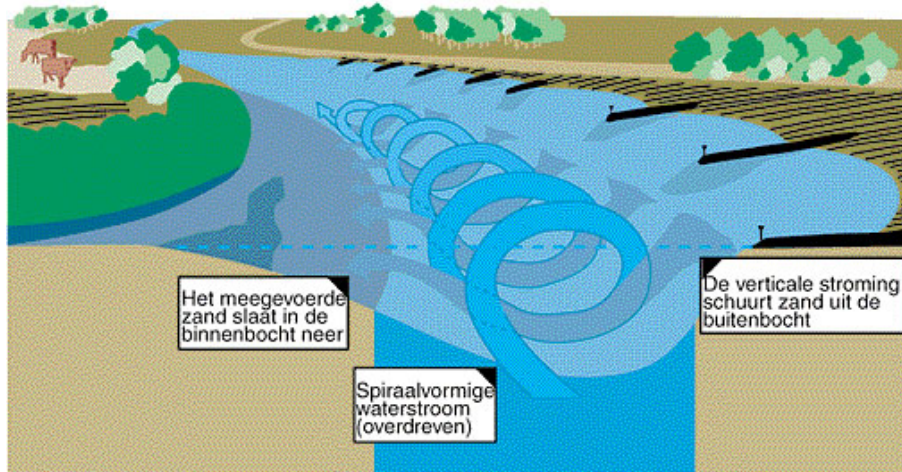




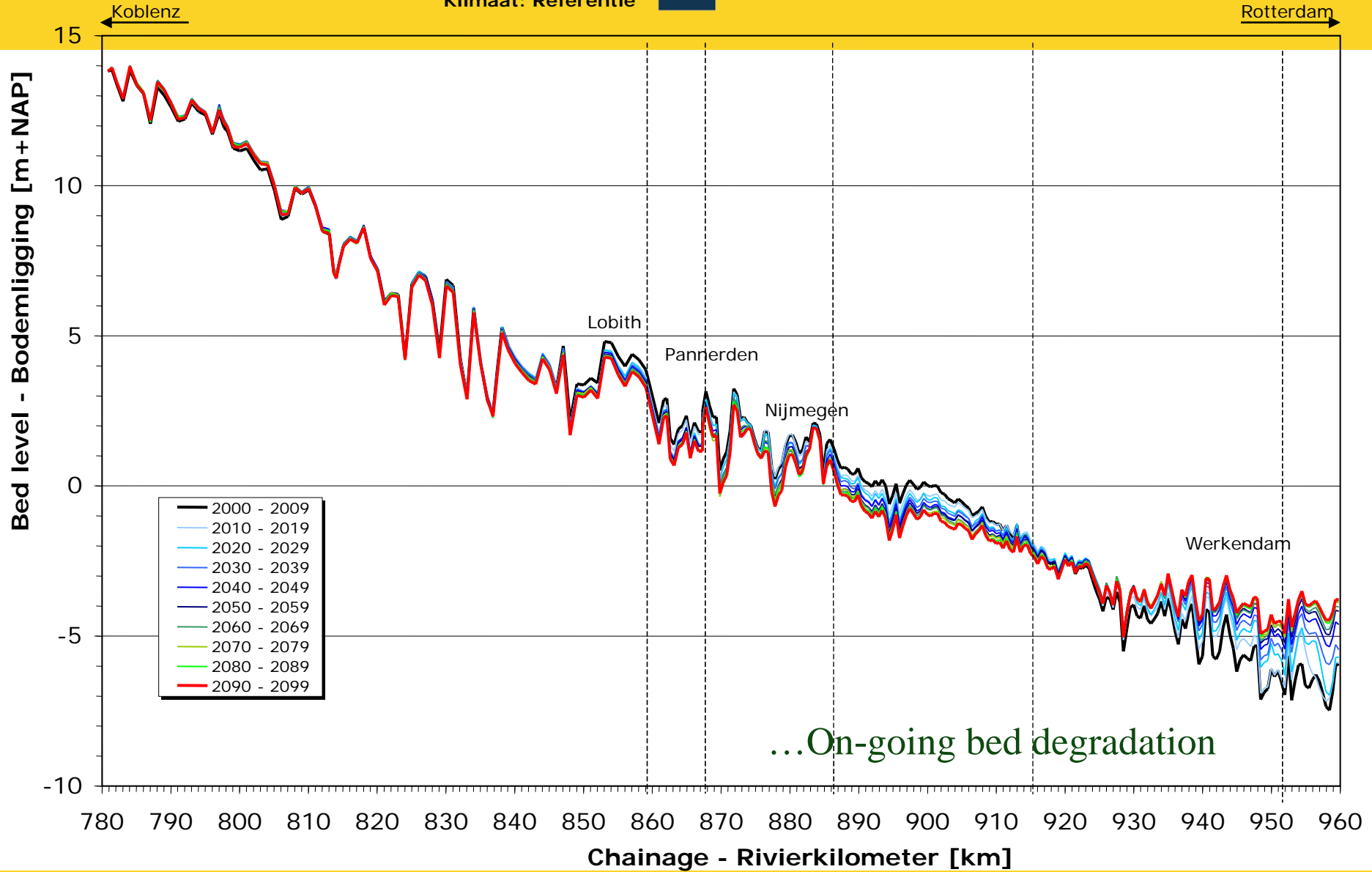
Some highlights

The issue of morphology and subsidence

The river is not only transporting water: also sand is replaced throughout the stretch. So called bed erosion and sedimentation



Parts of The Netherlands are shifting down,
parts are lifting up

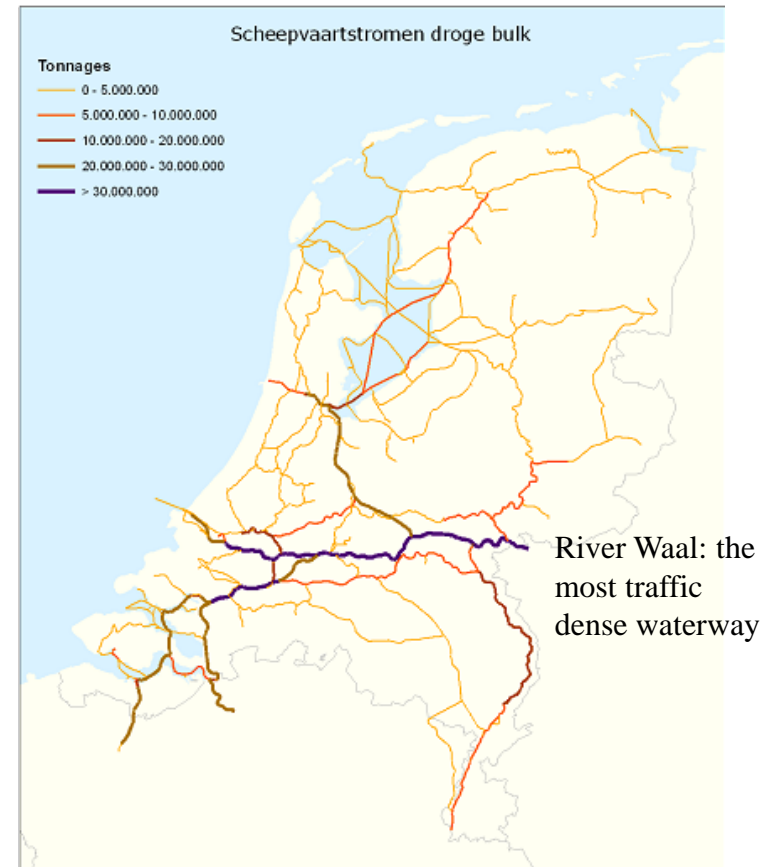
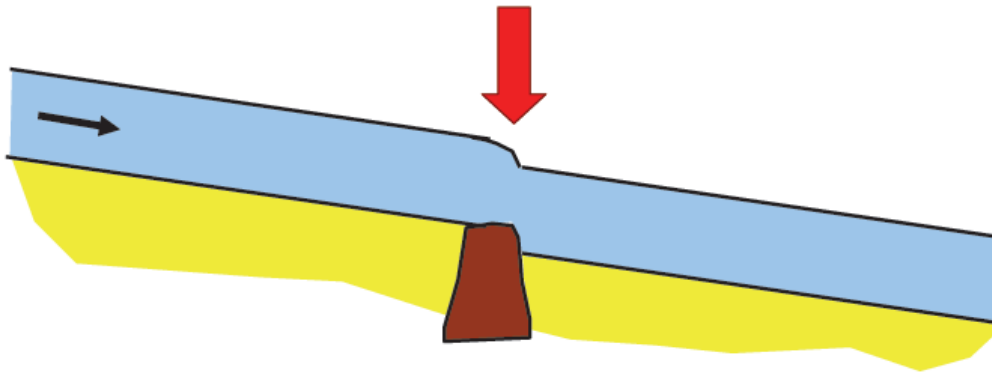




Some highlights

The issue of morphology and navigation

navigation bottleneck





Some highlights

The issue of morphology and navigation

- Ongoing bed level degradation can have great impact on navigation
- Specially at river locations with fixed layers

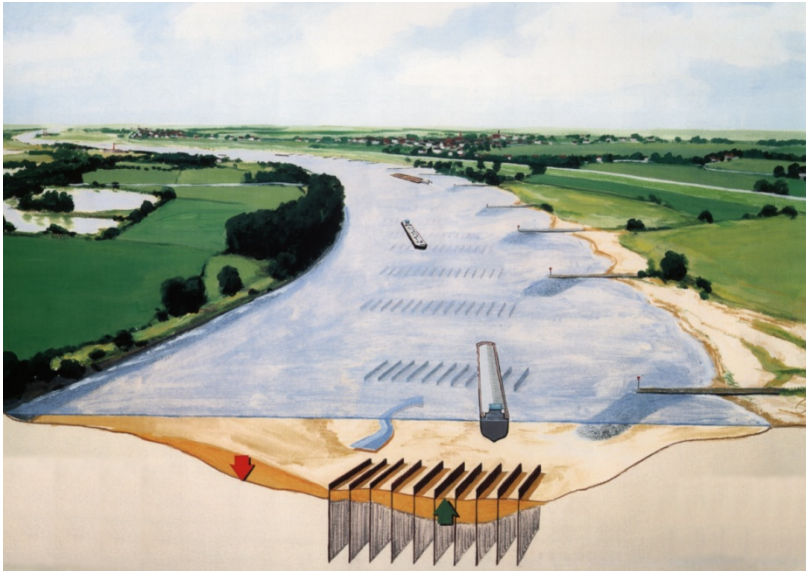




What to do

Some tentations to correct the cross-sectional river profile...

Bottom vanes



Fixed layers



Bendway weirs



Final remarks [1]

- Due to *climate change*: periods with low water levels might occur longer and are more severe;
- Impacts on inland navigation: decreasing load capacity and higher transportation costs during summer times, but until 2050 impact is expected to be low.



Final remarks [2]

- Due to ongoing process of *bed level degradation*: water depths might decrease up to 0,6 meter around 2030;
- Measures in de past were not successful and current river management (dredging and sand suppletion) will not be sufficient to stop bed level degradation;
- Costs to adapt infrastructure to bed level degradation are more or less the same as costs to stop bed erosion;
- Climate change influences the process of morphology/subsidence but the correlation is not very significant;
- So, for the "short" term (2030), measures to deal with the *river morphology* and *bed level degradation* are more urgent to maintain navigation on the fluvial waterways.