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Reconstructing Holocene regional background subsidence in the Netherlands

Utilizing interpolated coastal plain water table rise

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Introduction

Both glacio-isostatic adjustment (GIA) and tectono-sedimentary basin loading and sinking contributed to the relative sea-level rise in the Netherlands [Kooi et al. 1998; Vink et al. 2007]. Isolating these deeper subsidence components in the total subsidence signal is difficult because:

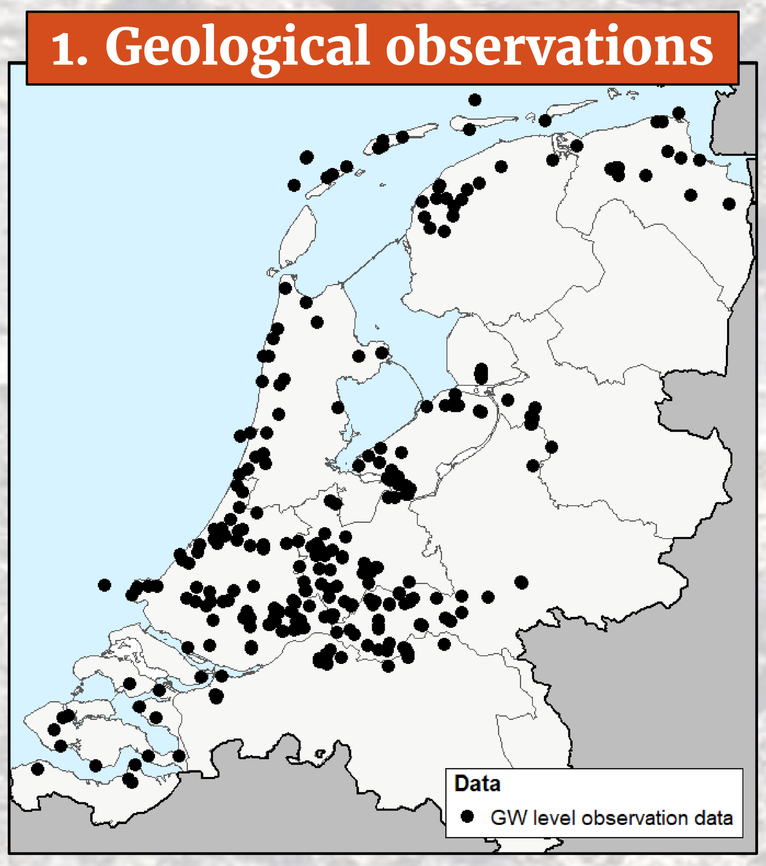
- The relative contribution of both components is not well constrained
- Both processes act on a similar temporal and spatial scale
- Their subsidence rates in the Netherlands are of a similar order of magnitude

Paleo-water table proxies

This study uses different sedimentary markers as proxies for past water tables, such as basal peat layers. The input dataset consists of >550 existing (legacy) water table indicator observations.

Reconstructing the current depth of water table indicators in the subsurface, reveals the relative coastal plain water table rise in the Netherlands.

1. Geological observations



Water table interpolation steps through time

1. Selection of geological paleo-water table observations
2. Designing regional spatial-temporal trend:

$$Z_n = \left(1 - c_{(x,y)}\right)\left(1 - e^{-a_{(x,y)} q_{(x,y)} p_{(t)}^{\,b}}\right) + \left(c_{(x,y)} * p_{(t)}\right)$$

3. 3D block kriging of residuals
4. Select water levels above Pleistocene surface
5. Filter sea-level related water levels based on slope and max elevation

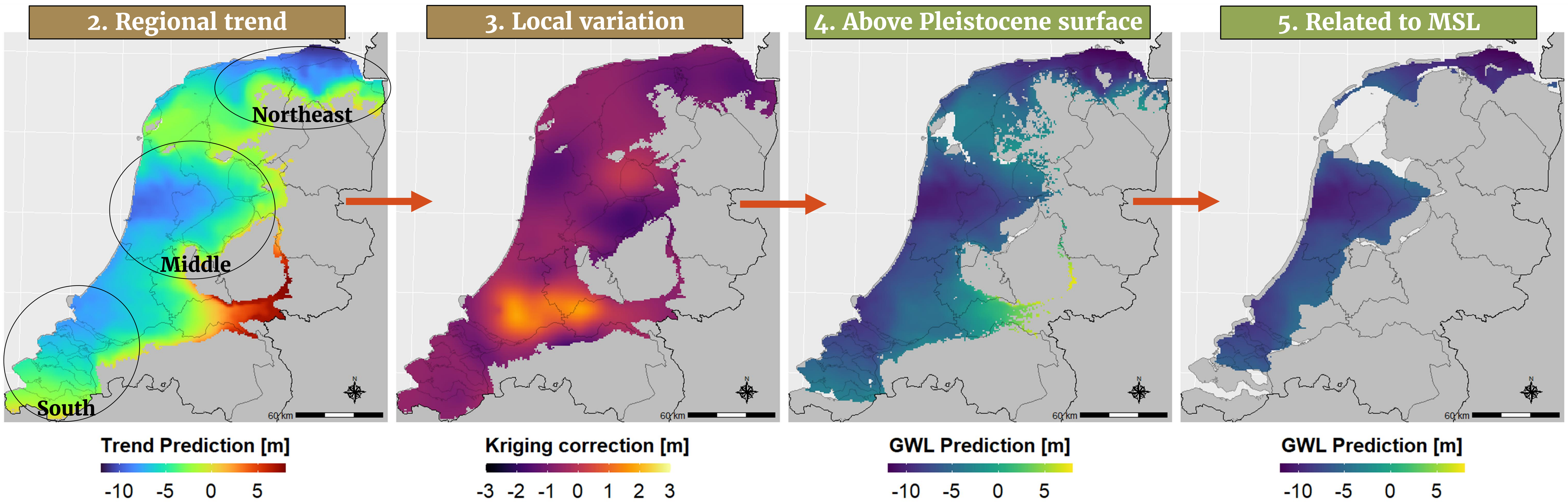


Figure 1 Example of output of the interpolation method steps at timestep 6000 cal. years BP.

Results

- Long-term subsidence rates highest in the northeast (**Figure 2**)
- In the Middle Holocene (8-4 ka) a southward reducing GIA subsidence pattern is evident.
- Decrease of GIA signal in the Late Holocene (2-4 ka)

  → remnant GIA signal of similar magnitude as the basin subsidence in the northwest of the Dutch coastal plain.

Take-home

- Data-based approach for reconstructing long-term subsidence
- Northeast to southwest trend: Up to 4 m difference in middle Holocene
- Clear decrease in GIA signal in Late-Holocene

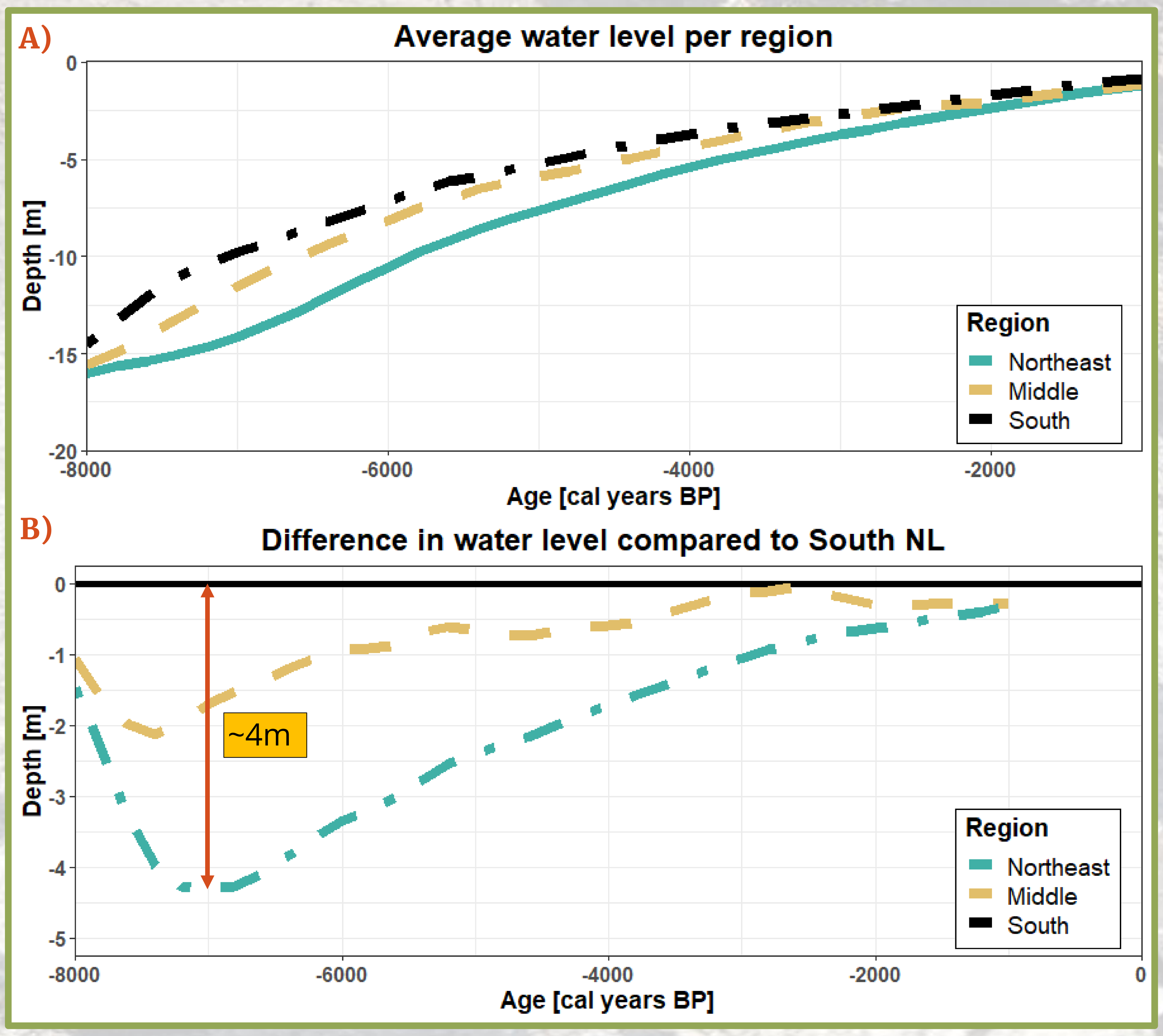


Figure 2 A) Reconstructed and filtered Holocene water level rise averaged for three regions **B)** Difference in reconstructed average water level for the northeast and middle of the Netherlands compared to the southwest of the Netherlands

References

a) *Vink, A., et al. (2007). Holocene relative sea-level change, isostatic subsidence and the radial viscosity structure of the mantle of northwest Europe (Belgium, the Netherlands, Germany, southern North Sea). QSR .*

b) *Kooi, H., Johnston, P., Lambeck, K., Smither, C., & Molendijk, R. (1998). Geological causes of recent (~ 100 yr) vertical land movement in the Netherlands. Tectonophysics, 299(4), 297-316.*

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