

# Permafrost distribution and degradation throughout the Netherlands since the Last Glacial Maximum

## A pingo based reconstruction

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Pingos are ice-cored mounds that form under permafrost conditions. In the Netherlands several pingo remnants occur, of which most are situated in the northern Netherlands. These pingos are regarded as open-system pingos and therefore must be related to former drainage patterns. This study focusses on the distribution and degradation of pingo remnants. In order to answer the research question; “what was the distribution, minimum permafrost depth and permafrost decay throughout the Netherlands since the Last Glacial Maximum?” the following sub-questions were posed;

- Is there a spatial relationship between pingo remnants and brook valleys?
- Do the southern Netherlands pingo remnants differ in size, distribution and age from those in the northern Netherlands?

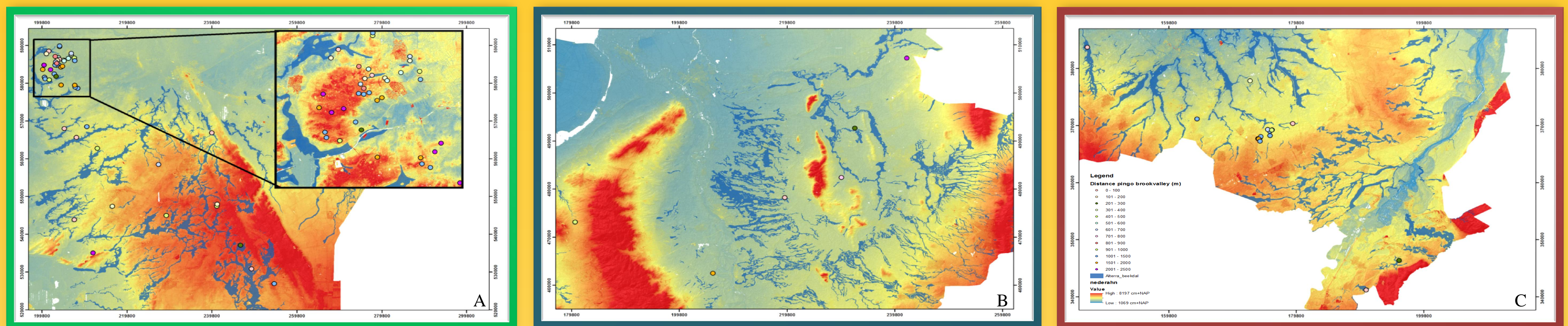


Figure 1: Pingo distribution and distance to nearest brook valley for the northern (A), central (B) and southern (C) Netherlands

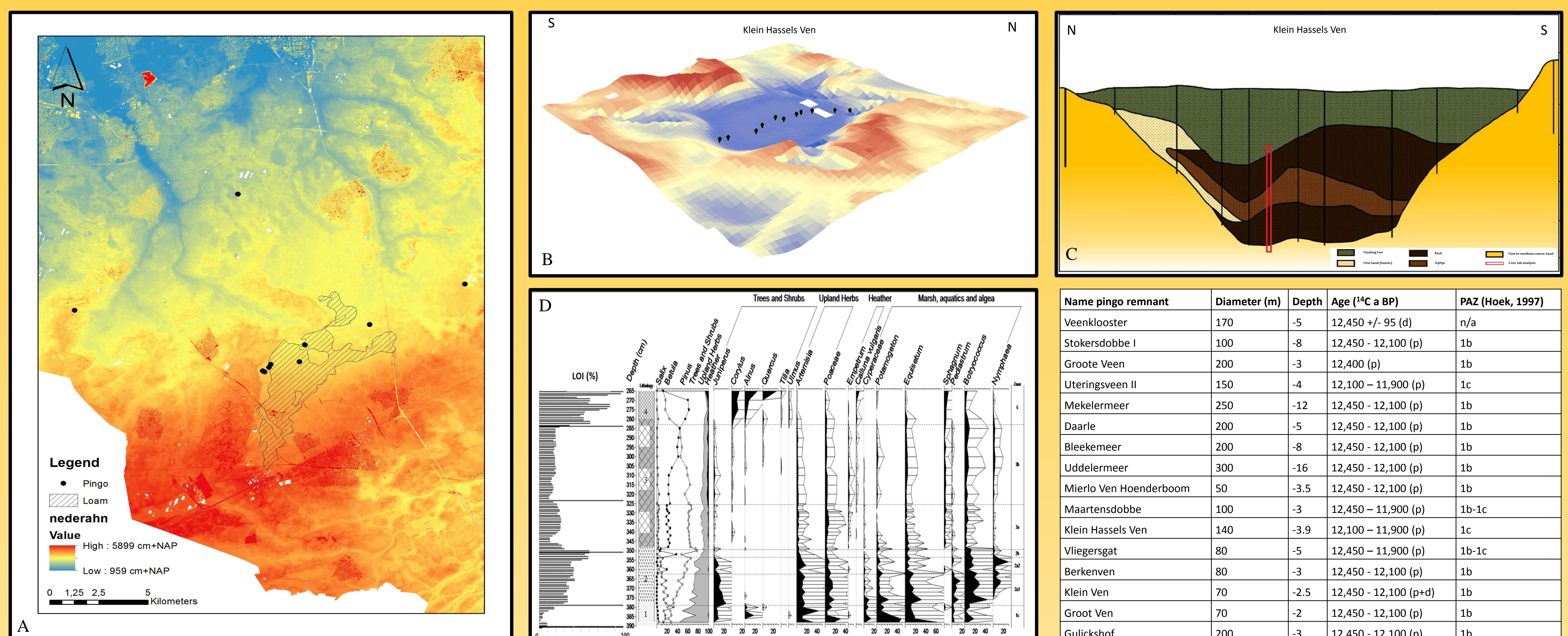


Figure 2: (A) Pingo distribution with respect to brook valleys in the southern Netherlands (south of Eindhoven), (B) Digital Elevation Model of Klein Hassels Ven (KHV) pingo remnant, (C) cross-section of KHV, (D) pollen diagram of KHV. Table 1: Comparison of pingo remnants throughout the Netherlands

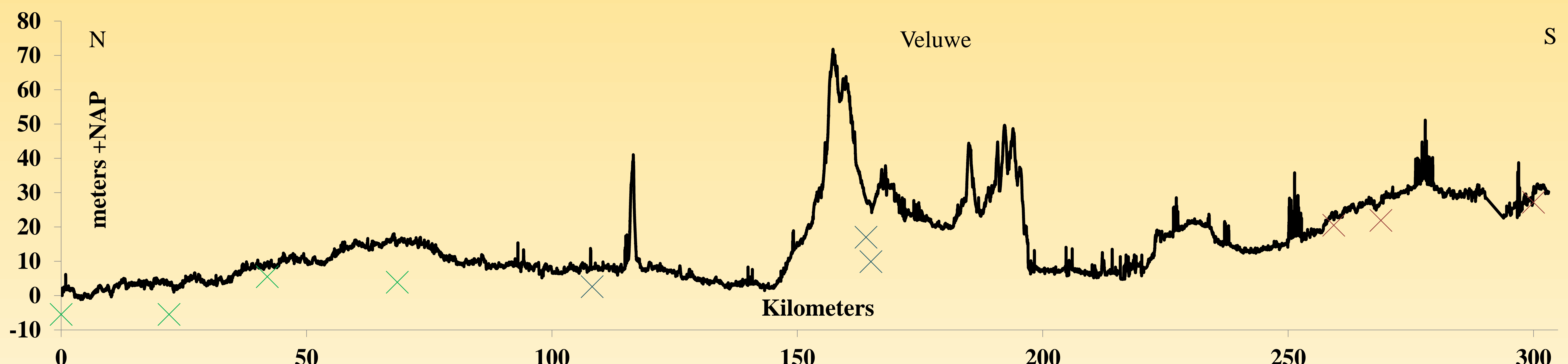


Figure 3: North-south transect through the Netherlands with minimum permafrost depth during the Weichselian Late Pleniglacial as indicated by pingo depth

- A spatial relationship exists between pingo remnants and brook valleys (figure 1), 50% of the studied pingo remnants in the Netherlands is located within 900 meters of a brook valley, and 73% is situated within a distance of 1500 meters.
- Permafrost varied between northern, central and southern Netherlands during the Late Pleniglacial with minimum depth of permafrost between -5m and -16 meters in the northern and middle Netherlands to -2m to -5 meters in the southern Netherlands (figure 2+3). Decay of permafrost in the Netherlands is concluded to occur simultaneously throughout the Netherlands due to climatic warming at the onset of GI-1e (correlating to Bølling)(table 1).