

# An integrated approach to reconstruct the Saalian glaciation in the Netherlands and NW Germany

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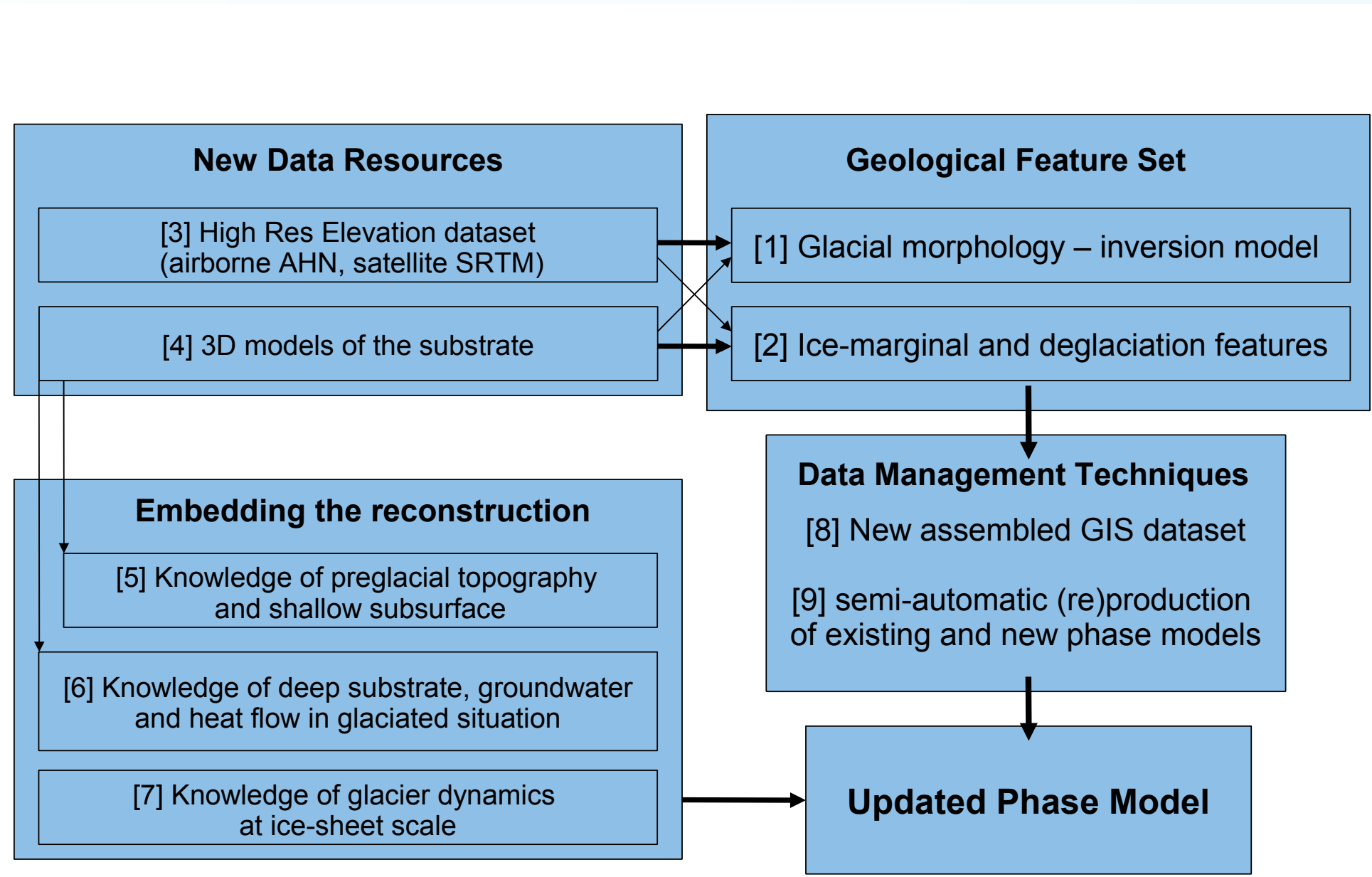
3) Deltares | BGS Applied Geology and Geophysics, Princetonaan, Utrecht

## Introduction

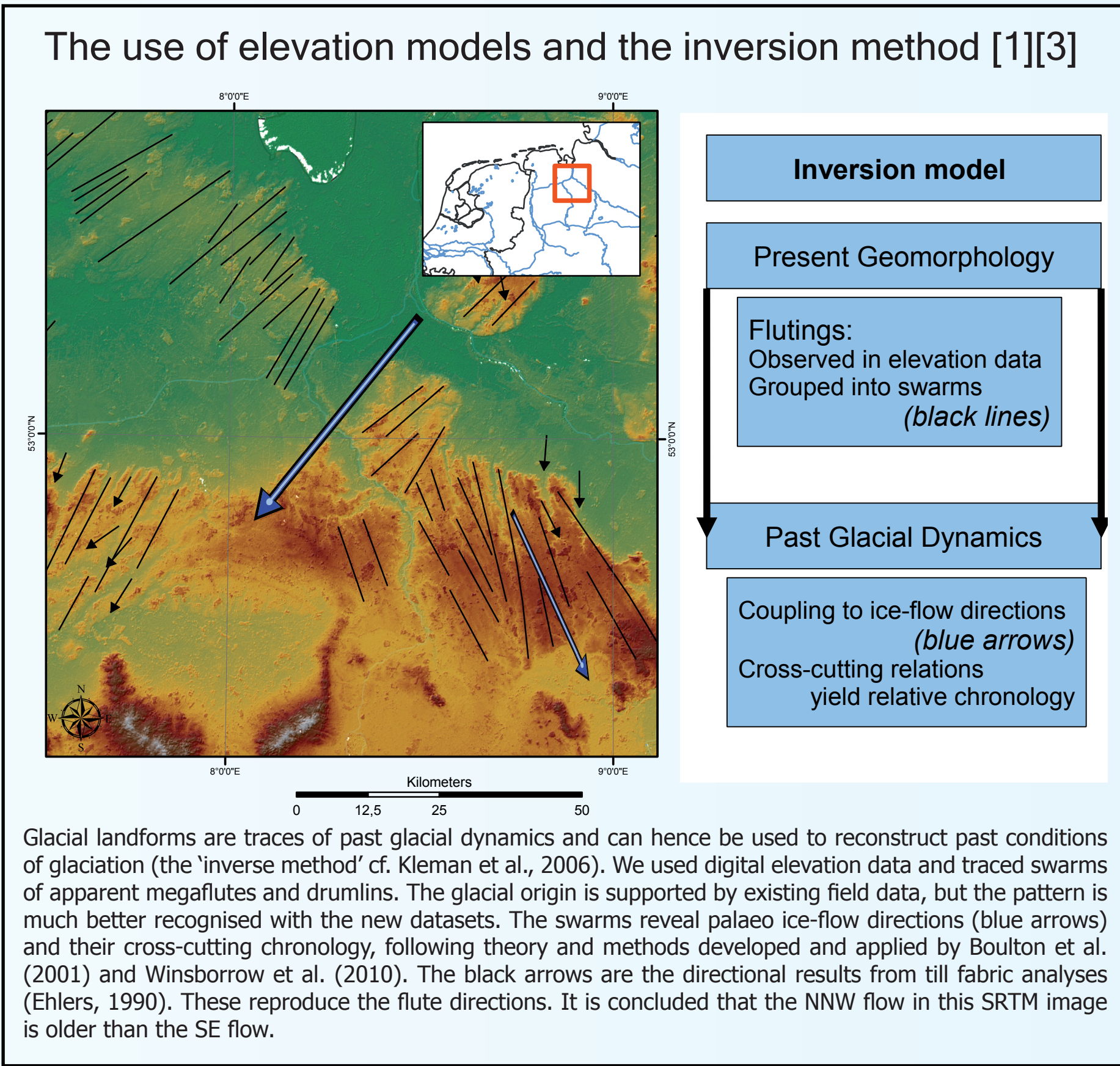
In MIS 6, around 170,000-150,000 years ago, large ice masses last covered the Netherlands and NW Germany (Saalian Drenthe Substage). It left many geomorphological features in the landscape, e.g. push moraines, sandurs and glacial basins. Throughout the 20th century extensive research has been done on this geomorphological assemblage and the sequence of glacial events, resulting in glaciation phase models. However, the various phase models each appear biased to specific features, subregions and types-of-data. Besides, new data and insights have risen since the construction of these models. In this research we newly reconstructed the sequence of events, unifying the evidence in NW Germany with that in the Netherlands. Elements of 'classic'

knowledge and new lines of reasoning are each outlined. We collected geological-geomorphological evidence (literature inventory) and new high-resolution elevation data in a inventory GIS. We reviewed conceptual models of the phasing of events and related glaciological processes during the glaciation, responsible for the eventual ice-margin landscape. Our newly constructed phase model recognises four phases towards maximum ice-sheet extent, and two deglaciation phases. The GIS stores our preferred phase model, as well as earlier interpretations. This poster presents our results as overview maps.

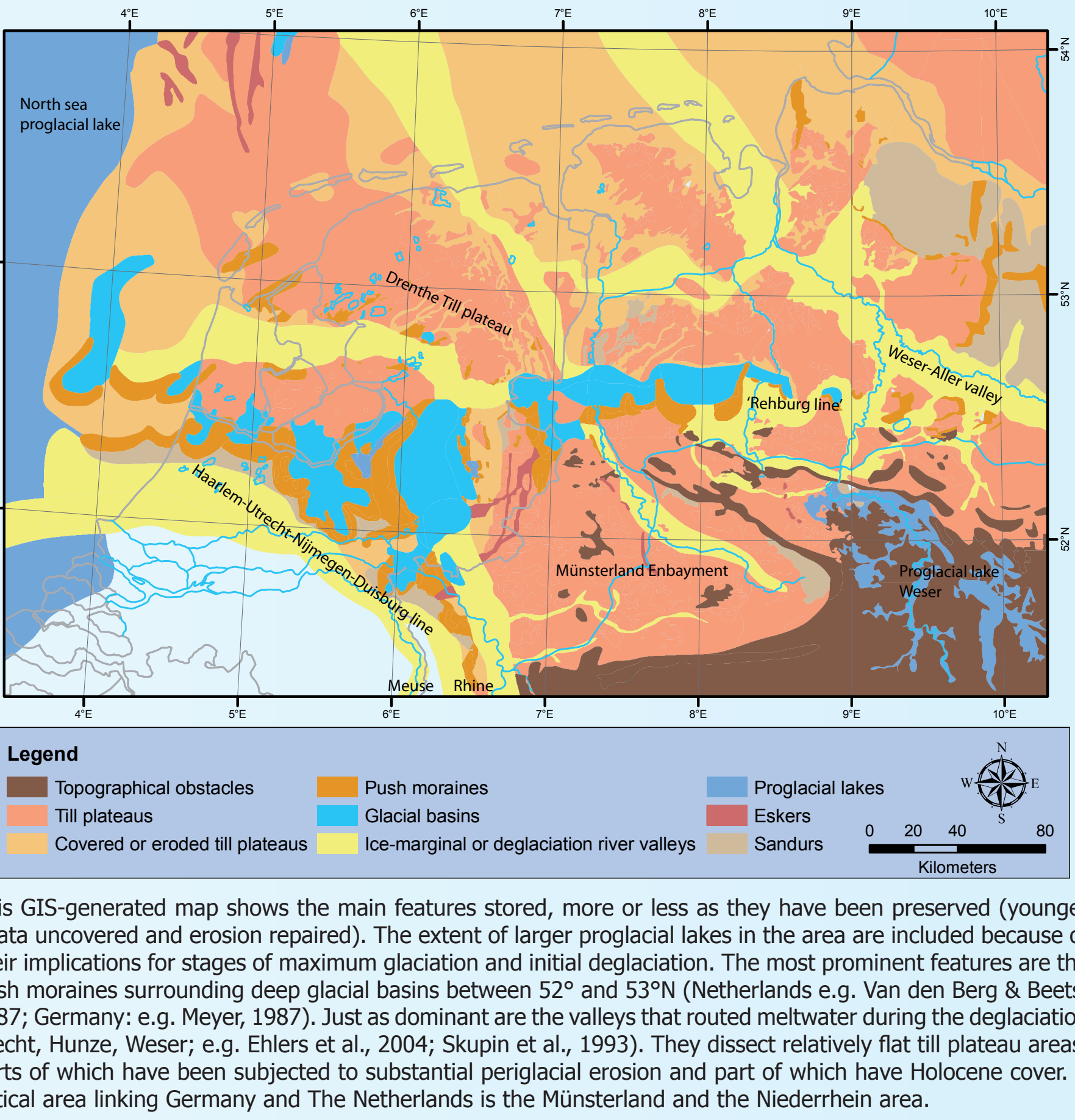
## Methods



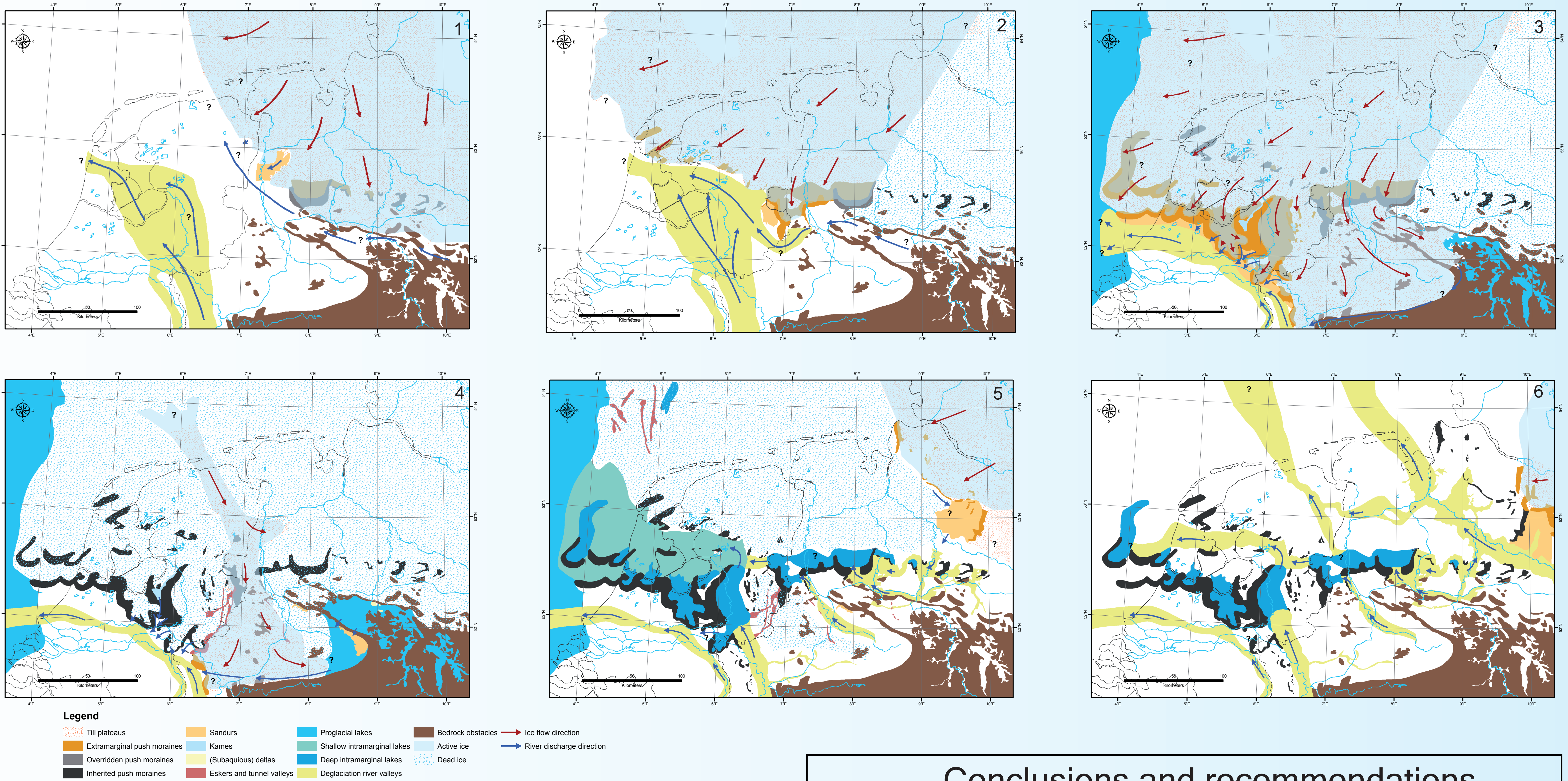
The main sources for the construction of a GIS were existing maps of glacial features [1] and associated documented information, such as till stratigraphical information. Also used are recent reconstructions of the proglacial glaciofluvial areas, and deglaciation-related features 'inside' the ice limit [2]; Busschers et al., 2008; Winsemann et al., 2009). High resolution elevation data [3] are new resources allowing to detail the geological-geomorphological feature sets (see box: inversion model). All the known glacial features are collected in a new assembled GIS dataset [8] and their phasing coded to allow to reproduce existing and newly iterated phase models [9].



## Glacial morphology



## The proposed new phase model



**Phase 1 and 2:** During the onset of the glaciation the ice first entered the region from the north, later from the northeast. This was probably related to the shift in the ice divide of the Fennoscandian ice sheet. During the onset rivers were deflected towards the west and meltwater deposits were formed in front of the ice (sandurs and ice-marginal rivers) which were overridden by the ice. Causing thick meltwater deposits to be covered by till in large regions of the research area. Push moraines were formed at localities where the conditions of the subsoil favoured their formation (e.g. coarse sediments, presence of faults or dipping hardrock structures). When the ice progressed further, these push moraines were overridden (e.g. Rehburg line).

**Phase 3:** During the maximal extension on the line Haarlem-Utrecht-Nijmegen-Düsseldorf, sometimes large push moraines were formed along the Peel faults, flanked by sandurs that drained into the Rhine-Meuse ice-marginal rivers, which subsequently drained into the large North Sea proglacial lake. In the Weserbergland the ice caused the formation of the proglacial Lake Weser. This integrates recent results from Busschers et al. (2008) and Winsemann et al. (2009).

**Phase 4:** When the ice sheet stagnated a single ice flow from the NNW intruded into the Münsterland, forming the Hondsrug flutings in Drenthe. This phase partially reproduces Van den Berg & Beets (1987). It was probably related to a mass surplus of ice in the North Sea area triggered by the presence of a deglaciation lake in the Münsterland and the presence of thermo sources in the subsoil in Drenthe.

**Phase 5:** During deglaciation large deglaciation rivers formed draining the huge amounts of water from the melting ice sheet. Also, large intramarginal lakes formed, especially in the former glacial basins. In the northeast a readvance of the ice sheet occurred, reflecting the last ice activity of the Drenthe substage, forming small push moraines and thick outwash deposits.

**Phase 6:** During this phase the North Sea proglacial had stopped to exist (ice no longer coalescent between Scotland and Norway), causing the meltwater drainage to go northwards and the valleys to incise deeper. In the northeastern part of the study area a second readvance ("Warthe") occurred.

## Conclusions and recommendations

- Storing spatial data on both glaciation and deglaciation phenomena in a dedicated GIS greatly aided optimisation and documentation of phase model reconstructions for the last glaciation of our study area.
- Our updated 'new phase model' recognises four phases towards maximum ice-sheet extent, and two deglaciation phases. Initially the ice entered from the north, thereafter, flow was from the northeast. A last single ice stream from the NNW marks the first activity of deglaciation
- The large glacio-fluvial valleys formed that discharged huge amounts of water released by the retreating ice sheet margin during deglaciation, at critical positions in the drainage network (in NL, in GER) were interrupted by deglaciated tongue basin lakes.
- The dataset and integrated, updated, new phase model allow future research to focus on mechanisms of interaction of glacial dynamics with substrate processes (waterflow, heatflow) and conditions (lithology, thickness). The area covered by the reconstruction is now large enough to intercompare feature sets that have a comparable substrate setting. The dataset and phase model also serve to focus dating sampling strategies, and vice versa accumulated dating results ('swarms of dates') may help to validate the model.

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