Phase models and concepts of Saalian ice cover in The Netherlands and NW Germany

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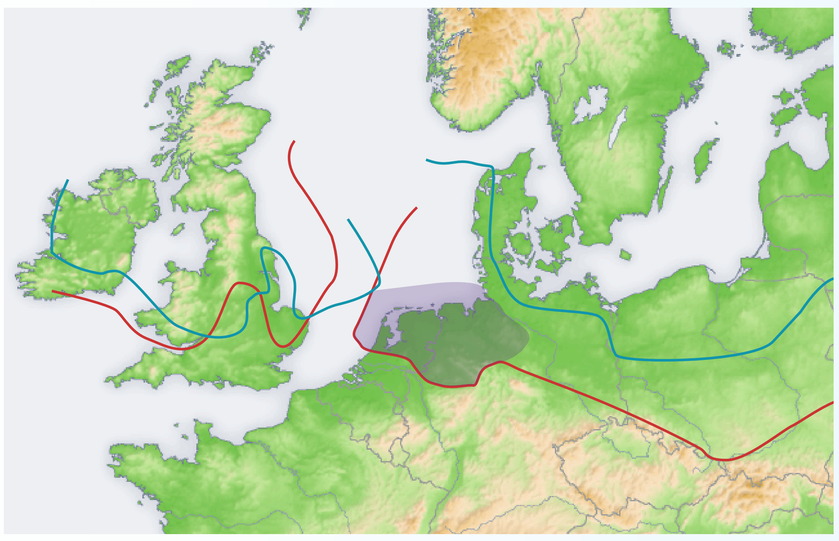
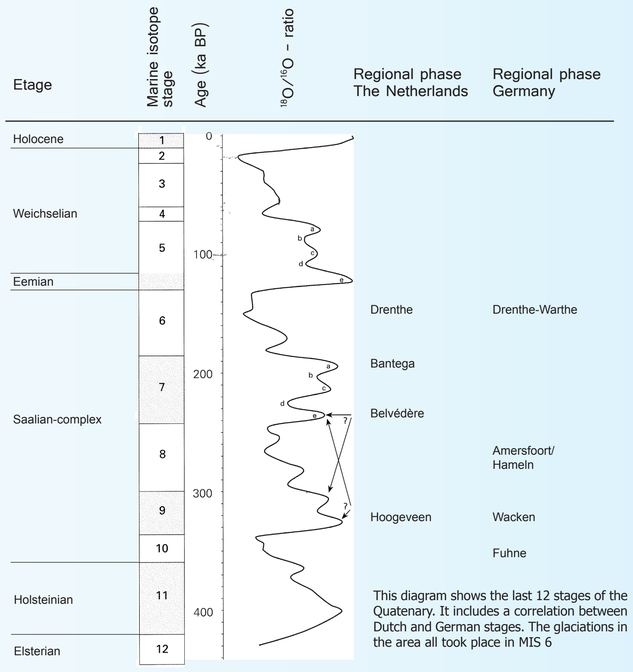
Introduction

During MIS6 in the Saalian The Netherlands and Germany were partly covered with an ice sheet. This ice cover left a very distinctive geomorphology with large thrust moraines, sandur plains and glacial basins. In the last 50 years several phase models of the glaciation in both the Netherlands and Germany were developed. These models, however, are biased to specific features/types of data and are on aspects inconsistent for neighbouring regions. Besides, new data and insights have risen since the early nineties when a phase model was last constructed.
This MSc-research focuses on describing the Saalian glacial morphology that is present in both The Netherlands and Germany and combining this in an interactive GIS. This is done to create overview of the glacial features and to include both the Dutch and the German features, to link and label them according to the different existing phase models. A second step is to label the elements according to a new developed phase model. A concept version for this new glaciation model will be presented.

Research Area

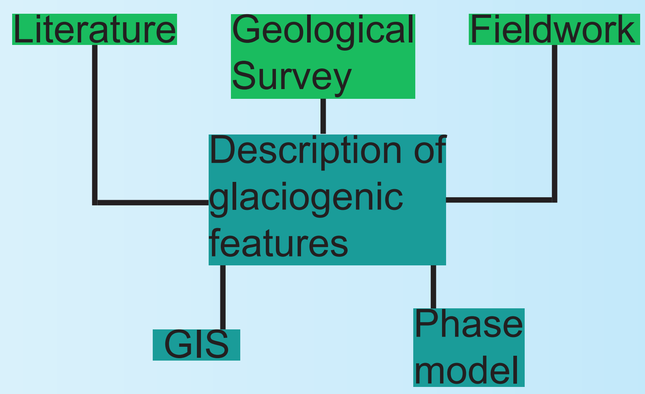


The research area is located between the Weichselian maximal ice extension (blue) and the Saalian maximal ice extension (red). It covers a major part of The Netherlands, the north sea near the Dutch coast and northwestern Germany.



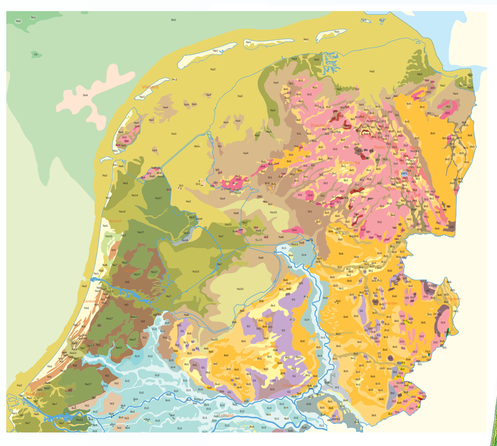
This diagram shows the last 12 stages of the Quatenary. It includes a correlation between Dutch and German stages. The glaciations in the area all took place in MIS 6

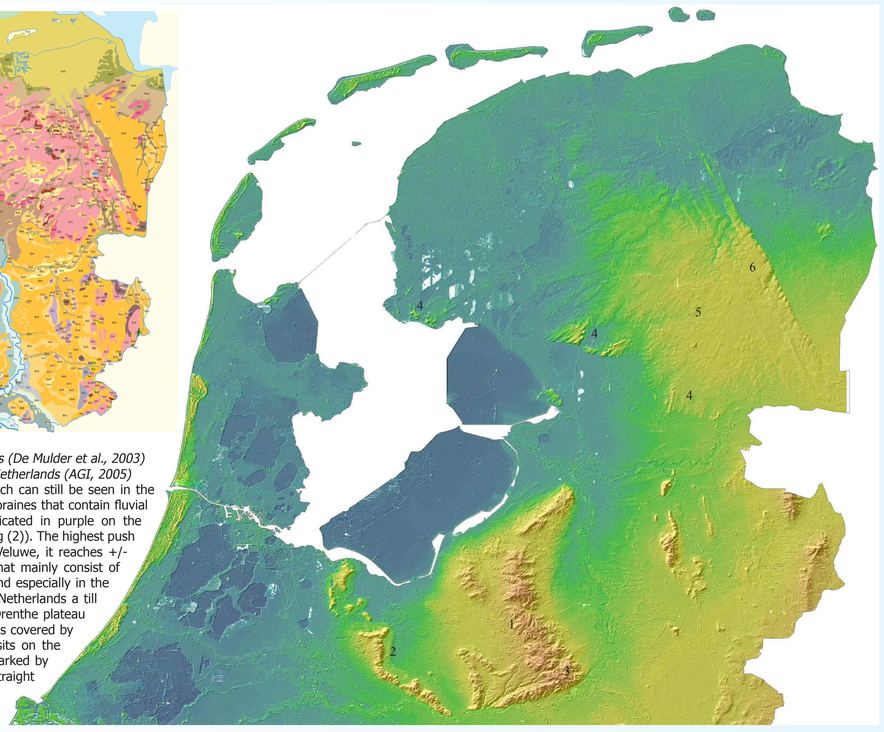
Methods



Aim of the research is to map and describe the Saalian glacial morphology in the research area and to reconstruct the sequence of events. This will be achieved by combining the currently available knowledge on the glacial features in the research area. Most information will be obtained from the literature. Additional information will be taken from German geological survey and by doing a small fieldwork. This knowledge will be implemented in an easily accessible GIS and used to construct a new glaction phase model.

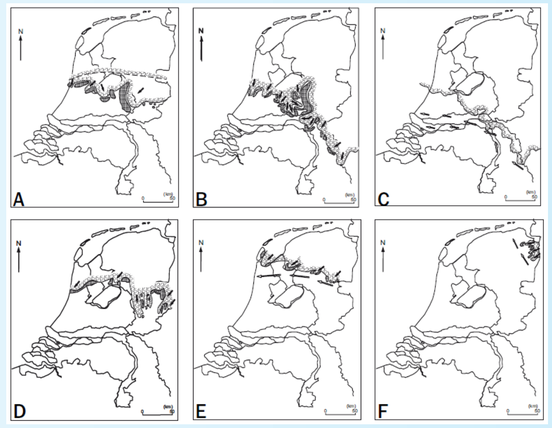
Description of the morphology

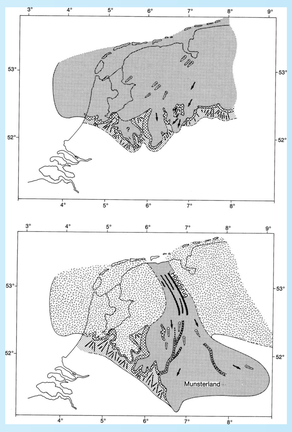




Above: Simplified geological map op The Netherlands (De Mulder et al., 2003)
Right: High-resolution digital elevation map of The Netherlands (AGI, 2005)
In The Netherlands many push moraines occur which can still be seen in the topography quite clearly (right image). The push moraines that contain fluvial deposits deposited prior to the glaciation are indicated in purple on the geological map (e.g. Veluwe (1), Utrechtse Heuvelrug (2)). The highest push moraine can be found on the eastern part of the Veluwe, it reaches +/- 100m +SL near Arnhem (3). The push moraines that mainly consist of tills are indicated in dark pink (4). They can be found especially in the northern Netherlands. In the northern part of The Netherlands a till sheet (light pink) occurs that is referred to as the Drenthe plateau (5). This plateau tilts slightly towards the west and is covered by Holocene marine (green) and peaty (brown) deposits on the western side. The eastern side this till plateau is marked by the Hondsrug consisting of several parallel striking straight ridges (right image, 6).

Existing Phase Models

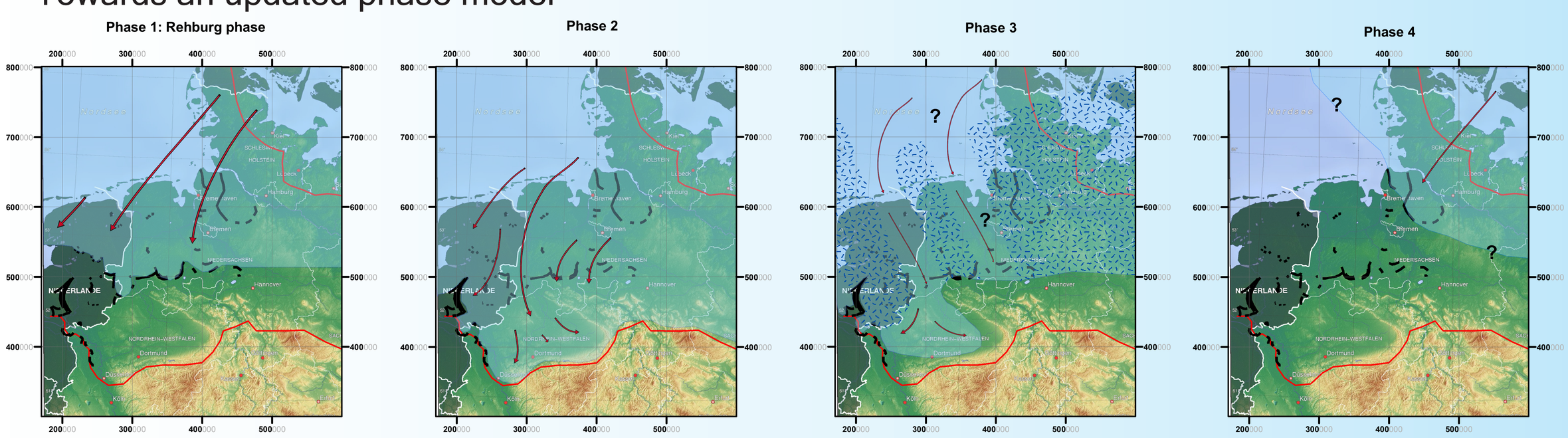




Left: The recessional phase model.
This model was developed by Ter Wee (1962) based on the occurrence and morphology of push moraines in The Netherlands. This model assumed that the push moraines were formed in stages and that each stage was formed during a re-advance within the general recession of the ice margin. The glacier lobes in this model are exceptionally long and narrow to explain the push moraines in the eastern Netherlands. Several things were not explained by this model. The push moraines of the Rehburg phase and the northern Netherlands had been overridden by the ice these must have been formed before an advance of the ice over the push moraine. Also, the explicit feature of the Hondsrug and the distribution of erratics were not explained in this model.

Right: The phase model by Van den Berg & Beets (1987).
Van den Berg & Beets (1987) made a new model considering the following premises: a) One basal till was found, suggesting only one ice cover, b) The NE-SW of the Drenthe plateau and the NNW-SSE lineations of the Hondsrug have a glacial origin, c) The thrust moraines have been formed during an advance of the glacier, d) with the exception of the ridges in the central Netherlands all push moraines have been overridden by the ice.
First, the ice advanced relatively rapidly due to the fine grained bed. This advance came from the NE and stopped where high water pressures were built up causing a higher resistance for the ice. This created horseshoe shaped ice pushed ridges, indicating a lobed ice front.
The front of the glacier was split into separate glacier tongues of piping and pushing. The coarse sediments in the sub surface of the central Netherlands acted as a kind of sediment trap. Van den Berg & Beets (1987) correlated this advance to the Rehburg line in Germany. This rapid advance drained the ice from the north causing a NNW-SSE flow. The ice mass surrounding the flowing ice was cut off its source and became dead ice. The flow advanced into the Münster basin and caused the formation of the Hondsrug complex. After this phase the ice stagnated and dead ice was formed that subsequently melted.
This model only partly explains the distribution of erratics of Zandstra (1987), except for the large amount of east Baltic components on the Hondsrug and the mixed composition of erratics in the areas south of the Hondsrug.

Towards an updated phase model



A concept of an upgraded glaciation model
During the first phase the ice reached the northern Netherlands and formed ablation moraines. Most likely, the ice stagnated for a while in this area. Probably the Rehburg push moraines in Germany were formed around this period as well. The exact correlation of the Rehburg push moraines to the Dutch push moraines remains problematic. During the second phase these push moraines were overridden and the ice has its maximal extension. It intruded the middle Netherlands forming e.g. the large Veluwe push moraines. Most likely, the ice also has its maximal extension in Germany. The Teutenburgerwald actes as an topographical obstacle, this caused most of the ice flow to be concentrated between this hill ridge and the Dutch border (large arrow) (Herget, 1997). In the third phase, the ice flow patterns changed dramatically. The dominant ice flow came from the NNW forming the Hondsrug in Drenthe. Also west of Bremen evidence for such a flow direction were found (Ehlers, 1990). These flow occured between large dead ice masses as suggested by Van den Berg & Beets (1987). The Hondsrug ice flow most likely reached large parts of the Münster basin. This flow is characterized by a more Eastern Baltic erratic composition. During the fourth phase some readvances occured around Bremen and Hamburg. The most important readvance phase is the Warthe phase.

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