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### **New land, old history: past landscapes and hominin activity covering the last 220,000 years in Flevoland, The Netherlands**

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2017

#### **document version**

Publisher's PDF, also known as Version of record

[Link to publication in VU Research Portal](#)

#### **citation for published version (APA)**

van den Biggelaar, D. F. A. M. (2017). *New land, old history: past landscapes and hominin activity covering the last 220,000 years in Flevoland, The Netherlands*. [PhD-Thesis - Research and graduation internal, Vrije Universiteit Amsterdam].

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# Summary

## **Chapter 1: General introduction**

The polder that is called the province of Flevoland since 1986 was created in the 20<sup>th</sup> century by reclaiming the Zuiderzee, an inlet of the North Sea that reached to the central part of the Netherlands. During the reclamation of the polder, (pre)historic archaeological remains were found, together with remnants of past landscapes that existed in the area during and after the penultimate Glacial Period (~ 150 ka). These remains and remnants indicate that the ‘new’ land was much older than expected. In addition, it appeared that the subsurface of Flevoland is well-preserved and contains valuable information on hominin history.

To improve the fundamental scientific knowledge of the past and present of Flevoland the research program ‘Biography of the New Land’ was initiated. This research program was a collaboration between the Research Institute for Heritage and History of the Cultural Landscape and Urban Environment (CLUE) of the VU University Amsterdam and the Nieuw Land Erfgoedcentrum (Lelystad). The overall aim of this program is to reinforce the coherence and applicability of scientific research into the (pre)history, development and heritage of Flevoland. Within this program there are five PhD-projects in various disciplines: (1) cultural history, (2) water management history, (3) economics, (4) public administration and (5) geoarchaeology. These PhD-projects either focus on the pre(history) of Flevoland (projects 1, 2 and 5) or are aimed at translating historical knowledge into current social applications (projects 3 and 4).

This dissertation aims to demonstrate that the subsurface of Flevoland contains a stacked sequence of various landscapes that are (potentially) well-preserved and contain evidence for the nature of traces of hominin activity within these landscapes. In addition, the interrelationship between hominins and their environment is investigated. To attain the aims of this research, an earth sciences and an archaeological approach were combined on four selected periods of investigation: (1) late Middle to Late Saalian (220–170 ka; early Middle Palaeolithic), (2) Younger Dryas (12.9–11.7 ka; Late Final Palaeolithic), (3) mid-Holocene (6000–5400 BP; Early Neolithic) and (4) Late Holocene (1200 BP up to AD 1942; Medieval period and Modern history).

## **Chapter 2: A niche construction approach on the central Netherlands covering the last 220,000 years**

In chapter two a niche construction theory (NCT) approach is applied to better understand the interrelationship between hominins, landscape gradients and water in the central Netherlands over four selected time windows within the last 220,000 years. These time windows are the (1) late Middle to Late Saalian (220–170 ka; early Middle Palaeolithic), (2) Younger Dryas (12.9–11.7 ka; Late Final Palaeolithic), (3) mid-Holocene (6000–5400 BP; Early Neolithic) and (4) Late Holocene (1200 BP up to AD 1942; Medieval period and Modern history). Furthermore, the landscape development and traces of hominin activities in the central Netherlands covering the last 220,000 years is reviewed. In addition, this review indicates that traces of observed and potential niche construction behaviour in the central Netherlands can be shown for both sedentary and non-sedentary communities. Based on these traces, the transition between inceptive to counteractive change in the environment in the central Netherlands is placed between the Early Neolithic and the Medieval Period.

## **Chapter 3: Depositional context of the early Middle Palaeolithic assemblages from the central Netherlands**

The results of this chapter show that the trend in artefact size decrease of early Middle Palaeolithic (EMP) assemblages in ice-pushed Rhine-Meuse deposits in the central Netherlands corresponds to downstream fining of gravel and the downstream decrease of cobble abundance in those deposits.

Furthermore, these gravel and cobble data indicate that EMP artefacts could be present in the buried part of the ice-pushed ridges in the northern part of the central Netherlands (southwest Flevoland). In addition, these data, in combination with a literature review, are used to argue that the EMP artefacts present in the central Netherlands likely date to MIS 7–6. This review also indicates that at the time of final deposition of the EMP artefacts by the Rhine-Meuse fluvial system in the central Netherlands (early MIS 6), the area was characterised by a braidplain in a slightly incised river valley that was probably bordered to the north by a polar desert.

#### **Chapter 4: Predictive modelling of Younger Dryas archaeological remains in southern Flevoland (central Netherlands)**

In the western part of the Netherlands no archaeological remains have yet been found that date to the Younger Dryas (YD) (12.9–11.7 ka), most likely due to the thick Holocene cover on top of the YD hominin habitation surface. Due to the promising preservation condition of this buried surface in southern Flevoland (central Netherlands), combined with the high coring density and the availability of a freshwater source in the area, southern Flevoland is selected for the research presented in chapter four. In this chapter an inductive predictive modelling approach is used to select locations in southern Flevoland with the highest probability of YD archaeological remains (e.g. traces of activities of Federmesser and Ahrensburgian hunter–fisher–gatherers). To map and determine these locations, first the geomorphology of the YD surface is classified by the concept of Topographic Position Index. Secondly, data on the geomorphological setting and the distance to the nearest freshwater source of well-dated YD archaeological sites in the Northwest European Plain are extrapolated to southern Flevoland. According to the predictive model, the areas with potential YD archaeological remains constitute less than 10% of the total study area. In this model, Federmesser remains are expected to be located at the elevated parts at a maximum of 1500 m from the Eem fluvial system and Ahrensburgian remains may be present at the higher grounds at a distance of up to 2500 m. The results of this study require further testing before it can be used to locate YD remains in buried landscapes (e.g. western Netherlands and the North Sea). Locating YD remains in these landscapes is crucial to advance our understanding of YD settlement patterns, spatial organisation and subsistence economy in northwest Europe.

#### **Chapter 5: Landscape potential for the adoption of crop cultivation: Role of local soil properties and groundwater table rise during 6000–5400 BP in Flevoland (central Netherlands)**

Although the prehistoric transition from hunting, gathering and fishing (broad-spectrum economy) to crop cultivation is one of the most studied events in archaeological research, the question remains why people adopt crop cultivation and why there are temporal and regional differences. In chapter five a geoarchaeological perspective is presented on the initial adoption of crop cultivation within wetlands during the period 6000–5400 BP in Flevoland (central Netherlands). In this chapter the relationship is studied between this adoption and the mid-Holocene inundation history and soil conditions within the Eem and IJssel-Vecht valleys, two wetland areas within Flevoland. To study this relationship, the mid-Holocene palaeotopography, palaeohydrology, soil conditions and distribution of Swifterbant archaeological remains was combined with grain size analyses of cored sediments in two selected study areas within these valleys. The results show that there appears to be a relation between the initial adoption of crop cultivation and natural soil fertility in wetlands as the traces of crop cultivation have yet only been found in areas with a high natural soil fertility (i.e. glacial till ridges and clayey levees). A similar relation was also found in other wetland areas in northwest Europe.

#### **Chapter 6: Storms in a lagoon: Flooding history during the last 1200 years derived from geological and historical archives of Schokland (Noordoostpolder, The Netherlands)**

Floods have a major impact on the lives of coastal communities. Reconstructing flooding history improves our understanding of this impact. One of the coastal areas where its inhabitants have a long tradition of living and struggling with the North sea was the former island Schokland, located in northern Flevoland (central Netherlands). In this chapter the flooding history of Schokland during the last 1200 years is reconstructed by studying the clay sequence that was deposited on the former island since the Medieval Period. The depositional history of this sequence is inferred from a literature study, two new <sup>14</sup>C accelerator mass spectrometry (AMS) dates and laboratory analyses (thermogravimetry,

grain-size in combination with end-member modelling (un-mixing of grain size distributions), foraminifera, bivalves and ostracods). The results show that the depositional history and spatial pattern of the Late Holocene clay sequence at the former island can be explained by a combination of the location of its embankments and proximity to the coastline. The deposition of this sequence on Schokland started after AD 770–900 or AD 920–940, based on a new AMS date. The results also indicate that the surficial clay on Schokland contains sandy intervals that were deposited by storm surges.

### **Chapter 7: Optical dating of Late Holocene storm surges from Schokland (Noordoostpolder, The Netherlands)**

The coastal areas of the Netherlands have frequently suffered from storm surges, influencing the lives of its inhabitants. This influence can be better understood by correlating long-term historical storm records with sedimentary remains of storm surges. However, so far few studies have applied such an approach. One of the coastal areas in the Netherlands where the lives of its inhabitants was heavily influenced by storm events, is the former island Schokland, located in the northern part of Flevoland (central Netherlands).

During the Late Holocene, the peat marshland at Schokland inundated around 1350 yr ago and gradually transformed into an island in a fully marine environment (~400 yr ago); today, it forms a landlocked island (created around 70 yr ago). Between 1350 BP and 70 yr ago, a silty clay sequence formed on Schokland. This clay contains sandy intervals deposited during storm surges. In this chapter, these intervals are dated using optically stimulating luminescence (OSL). In addition, the top of the peat underlying this sequence was dated to AD 650–690 using  $^{14}\text{C}$  accelerator mass spectrometry (AMS), providing the maximum age for the start of the formation of the clay sequence.

In total, ten sandy laminae indicative for storm surges were dated by OSL. State-of-the-art methods were used to take into account incomplete resetting of the OSL signal. The results show that there were two distinct periods of deposition, around 400 years ago and between 270 and 230 years ago. These results demonstrate that the sandy storm-surge sediments and related clay deposits are younger than previously postulated. The existence of two storm surge periods at Schokland are corroborated by the results from laboratory analyses (thermogravimetry, grain-size, foraminifera, bivalves and ostracods).

### **Chapter 8: General discussion**

The subsurface of Flevoland consists of a stacked stratigraphic sequence of different landscapes. In this chapter, four of these landscapes representing different time periods are examined, together with evidence for hominin activity in these landscapes. The four selected time periods are: (1) late Middle to Late Saalian (220–170 ka; early Middle Palaeolithic), (2) Younger Dryas (12.9–11.7 ka; Late Final Palaeolithic), (3) mid-Holocene (6000–5400 BP; Early Neolithic) and (4) Late Holocene (1200 BP up to AD 1942; Medieval period and Modern history). The four selected landscapes and associated evidence of hominin activity are discussed to demonstrate that these landscapes extend back at least 170,000 years, are (potentially) well-preserved and contain valuable information on hominin habitation history. Furthermore, for each of these landscapes the context of this activity is determined by examining the lithological characteristics of these environments. Also, the periods in between the selected time frames are considered. Finally, the Niche Construction Theory (NCT) mode of hominin – environment interaction over the four selected time windows is discussed. According to this Hominin Niche Construction (HNC) approach, the transition from inceptive to counteractive change in ecosystem management style most likely occurred in Flevoland around 1150 BP. Apart from responding to the main aims of this dissertation, this chapter also presents directions for future research.