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# 3D-Landschaftsmodellierung und Umweltrekonstruktion

## 3D-Landscape Modeling and Environmental Reconstruction

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### Zusammenfassung

Im Kontext mit archäologischen Untersuchungen nach dem Fund einer eisenzeitlichen Moorleiche im Großen Moor bei Uchte (Niedersachsen, Deutschland) wurde ein dreidimensionales Landschaftsmodell des Moores entwickelt, das die Moorausdehnung in der Mitte des ersten vorchristlichen Jahrtausends zeigt. Über 2750 anhand der Moorstratigraphie synchronisierte Torfprofile aus den zurückliegenden 60 Jahren bilden zusammen mit etwa 2500 Höhenpunkten aus dem Moorrandbereich die Basis für die Rekonstruktion der eisenzeitlichen Landschaft.

### Abstract

In accordance with archaeological investigations conducted after the discovery of an Iron Age bog body, a 3D-landscape model of the Grosse Moor near Uchte (Lower Saxony, Germany) was developed. It shows the extension of the peatland during the middle of the first millenium BC. More than 2750 soil profiles taken during the last 60 years were stratigraphically synchronized and together with about 2500 geodetic points from the surrounding area used for the reconstruction of the Iron Age landscape.


## 1. Introduction

The Große Moor near Uchte is a peatland complex of about 70 km$^2$, approximately 50 km northwest of Hannover (Germany), in the districts of Nienburg/Weser and Diepholz (Fig. 1). It is composed of fen and raised bog, emerged by mineral islands upon which farms are situated. Currently, the entire area is meliorated and used as farmland and for peat harvesting.

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*Note: This paper is the extended abstract of a presentation given at the Conference of the International Peat Society (IPS), June 2012 in Stockholm, Sweden (*http://www.ips@peatsociety.org*)


Fig. 1: Location of investigation area.
Lage des Untersuchungsgebietes.

In 2005, an Iron Age bog body was discovered in this area. The 16-19 year-old girl was unearthed by a peat cutting machine (PÜSCHEL et al. 2005). In connection with this find, archaeologists began comprehensive investigations in regards to the landscape and environmental situation in this area during the Iron Age. Several questions arose from these explorations: Did Iron Age humans settle in the area? If so, how did they influence the landscape? In which state was the peatland when the girl became deposited into the bog?

To answer these questions, archaeological and palaeobotanical investigations were conducted and a 3D-landscape model of the area was created (BAUEROCHSE et al. 2008, 2012). In this paper we focus on the modelling of the Iron Age landscape, particularly the peatland.

Taking into account that the peat layer growth of raised bogs averages approximately 1mm $a^{-1}$ (OVERBECK 1975), one of the most pressing questions in this context focused on the expansion of the mire during the life time of the Iron Age girl around 650 BC (determined by radiocarbon dating). How large were the mineral islands within the bog, how many of these islands existed, and where was the run of the outer edge of the peatland?

To answer these questions, old soil profiles were interpreted, numerous new corings were made for peat stratigraphical documentations and terrestrial surveying, and palaeobotanical investigations were accomplished.

## 2. Material and methods

Since the late 1940s, numerous investigations have occurred in the area. Pedological investigations for inventories and peat mining proposals from which a great number of profiles with detailed stratigraphical records still exist. Some of these profiles were taken in the 1950s and early 1960s, when the peatland was still in a largely virgin state. However, the old profiles were not connected with elevations, while the younger data from modern peat mining proposals are given with heights, which were required for the calculation of the l.

Basis for the modelling were profiles taken in a 250 x 250 m grid during an area-wide bog-mapping in the 1950s and 60s. Because all of them were without elevations, new corings located with satellite-based surveying system with an accuracy of measurement of +/- 3 cm in elevation and latitude were made. In this context, a distinct boundary horizon, characteristic for North German raised bogs, the recurrence surface („Grenzhorizont", WEBER 1902), was of particular importance. This is due to the fact that when the bog body was pulled out of the peat by a peat cutting machine, light as well as black peat adhered to it and gave a first indication of which depth the body was situated. This boundary horizon marks the transgression from the younger, low decomposed (light peat) to the older, high decomposed (black peat) raised bog peat.

Radiocarbon dating of bones as well as of peat attached to the body proved that both belong to the Iron Age. In addition, radiocarbon dating taken of this horizon at the finding site as well as from other sites of the Uchter Moor display this boundary to the middle of the first millenium BC; the period of early Iron Age, and the time window of interest. Based on this information, we used this conspicuous layer as a stratigraphic level to synchronize the peat profiles. In total, about 2750 profiles (about 800 of them without altitudes) were generated for the peatland. In those areas where only light decomposed peat is spread, we assumed that no paludification was required during Iron Age.

To integrate the bog into the landscape, some 2500 elevations from the surrounding of the bog were taken from the digital elevation model of the Topographical State Survey. For the calculation of the model all elevation data were put into a Triangulated Irregular Network (TIN; FREIWALD & JANY 2005). The modelling was made with ESRI ArcView 9® and the application ESRI ArcScene® (Fig. 2).

## 3. Results

As a consequence of decadal peat cutting, the Iron Age bog surface is already cut over in large areas of the Uchter Moor. For these areas, the old profiles were used and stratigraphically synchronized with the younger data from modern peat mining proposals and the data collected by our working group.

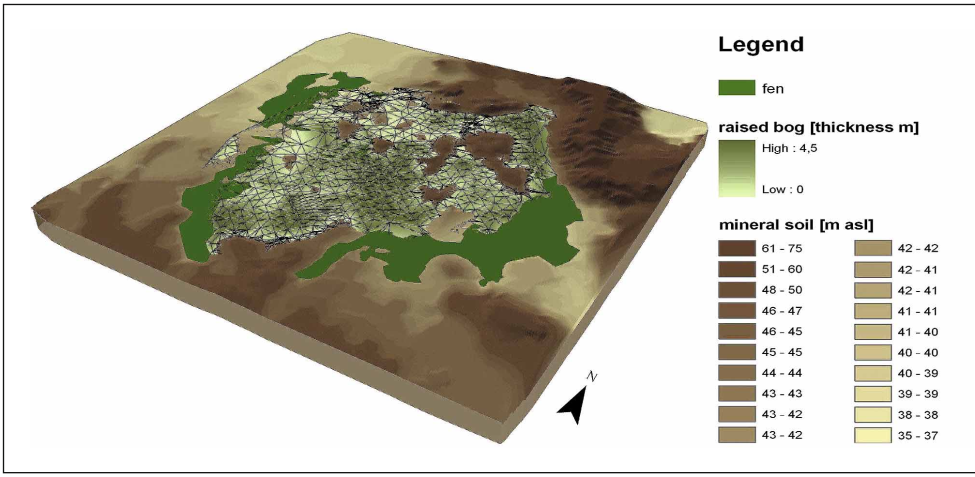


Fig. 2: 3D-model of the of the Iron Age bog surface applied to sea level (vertical exaggerated). The grid shows the Triangulated Irregular Network (TIN), each branch point connected with an elevation value.
3D-Modell der eisenzeitlichen Mooroberfläche bezogen auf m NN (überhöht). Jeder Schnittpunkt innerhalb des Netzes (Triangulated Irregular Network, TIN) besitzt einen Höhenwert.

The second step was to reconstruct the mineral surface by putting the leveled profiles into a TIN. This irregular grid (each branch point connected with an elevation value) was transformed by an interpolation process into a grid with edge lengths of 25 m. As a result, a continuous picture of the underlying mineral surface was created (Fig. 3A).

The third step was the reconstruction of the Iron Age surface of the bog. To do this, the thickness of the peat layer from the bottom up to the boundary horizon between the high and low decomposed peat was copied on the mineral surface and also transformed in a 25 x 25 m grid. Fig. 2 shows the interpolated bog surface, displaying the situation reconstructed for the period some 2500 years ago. The figure pictures the landscape with an altitude of the Iron Age bog surface about 1.5 to 2 m below the surface documented from the 1950s and 1960s. In this picture, not only was the area of the currently existing mineral islands within the peatland larger, there was also a greater number of them. They have been overgrown by the transgrading bog during the younger periods. Also, the area of the peatland was considerably smaller than it is today (Fig. 2, 3).

Based on the elevation of the mineral ground, the model also displays the thickness of the Iron Age peat complex and imparts an idea of the raised bog formation. Starting from small depressions and channels of the Pleistocene basement, after a period of fen formation, raised bog transgraded predominately in a synchronous manner from several cores and formed the large peatland, most of it directly on the mineral ground (“wurzelecht”) (Fig. 4).

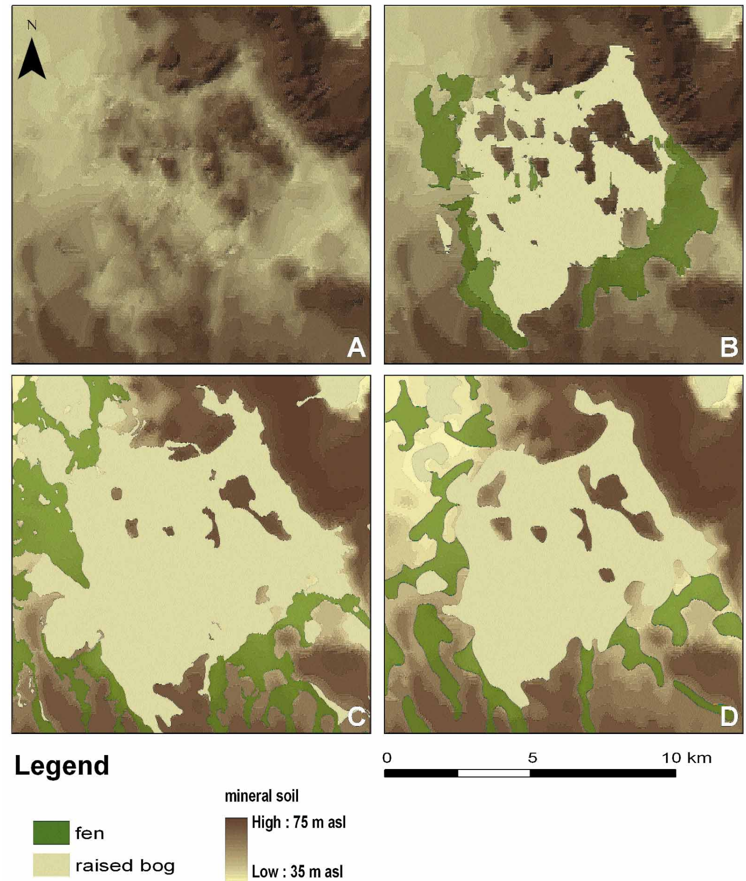


Fig. 3: Altitudes of the mineral ground (A) and expansion of fen and raised bog during Iron Age (B), in the 18th/19th century (C; maximum peatland extension), and today (D).
Höhe des mineralischen Untergrundes (A), Moorausdehnung während der Eisenzeit (B), im 18./19. Jh (C; maximale Moorausdehnung) und heute (D).

## 4. Discussion

When reconstructing an ancient state of a bog, one must consider that it is always a model, that can be developed; even if additional investigations of botanical macro remains, pollen analysis and peat stratigraphy can help to reconstruct former conditions. However, it can only be an approach of the previous situation, not a copy in a reduced scale, particularly in regards to former altitudes of the bog surface because melioration and drainage cause bog subsidence. To deal with this problem, we compared the profiles taken in the middle of the last century with the new ones from areas where no peat harvesting occurred, to determine


Fig. 4a: The 3D-model enables any profile through the bog, displaying the stratigraphy and thickness of the peat.
Das 3D-Modell ermöglicht es, beliebige Profilschnitte durch den Torfkörper mit Torfmächtigkeit und -stratigraphie darzustellen.

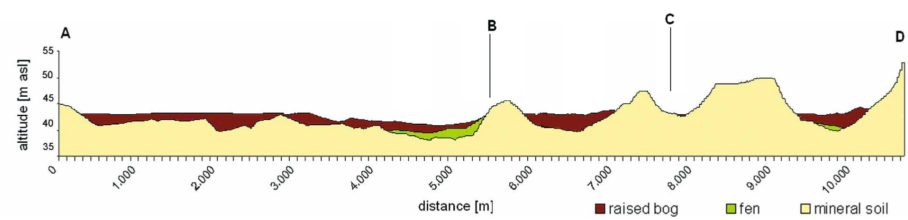


Fig. 4b: Example of a profile (A-D) through the Uchter Moor (vertical exaggerated).
Beispiel eines Profils (A-D) durch das Uchter Moor (überhöht).

the altitudinal differences of the boundary horizon before modelling. In this context, we also considered the annual peat shrinkage caused by mineralisation; we calculated about 1cm $a^{-1}$ for a period of 40 years.

In addition, the surface of a raised bog is built by hollows and hummocks, composed of dwarf shrubs, mosses, channels, bog pools and trees and can show differences in elevation of several decimeters in a greater area. Thus, the altitude of the bog surface given by the model has to be interpreted as a range, particularly when considering that it is a large-area reconstruction showing the situation of a period. This means that when copying the boundary of the Iron Age peatland expansion from the model in the field, one must consider that it is not a line, but a border zone.

As mentioned above, the catalysts that commenced this work were archaeological questions with regard to colonization during the Iron Age. Therefore, knowledge about (potential) settlement sites and land use is essential. In peatland areas, this means knowledge about the time when different subzones paludified. To enable a large scale reconstruction, it requires a maximum number of profiles to be compared.

As the model of the Uchter Moor shows, during the Iron Age, wide areas, especially within the peatland, were not paludified and could have been potenially settlement sites or used as arable land. Also, recently these sites are not available for archaeological prospection because they are still covered by peat, the knowledge about their existence poses a chance for future investigations.

The currently non-paludified mineral islands are intensively used and till this day no ancient traces could be detected, the sites sheltered by the peat may still contain artefacts from former times. Because as a result of pollen analysis demonstrating, man has been already there in earlier times. Pastures, as well as crop farming, occured in the area even before the Iron Age period (Bauerochse et al. 2011).

## 5. Acknowledgements

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