3.4 THE THREAT OF DESSICATION - RECENT WORK ON THE *IN SITU* MONITORING OF ARCHAEOLOGICAL WETLAND SITES IN THE NETHERLANDS

R.M. van Heeringen & E.M. Theunissen

Wetlands: a vulnerable archaeological resource

Large areas of the pre- and protohistoric wetlands along the present coast of the Netherlands dating back as far as 5500 cal BC are under agrarian and urban pressure (Fig. 3.4.1). This is because large parts of the region have been under the influence of human activity since about 1000 AD. Actually most of these former wetlands are now diked areas with a controlled water level (*polders*). Arable farming has also taken its toll on this unique cultural heritage, through the ploughing of occupation layers near the surface, desiccation as water tables were lowered, oxidation of organic materials, and so on (Van Dockum *et al.* 2001).

Growing awareness of the rapid erosion of the archaeological record has meant that the mission of the National Service for Archaeological Heritage (formerly State Service for Archaeological Investigations in the Netherlands/ROB) has changed in recent years (www.archis.nl , see under English content: Archaeology Report 2002). Large-scale rescue excavations in rural and urban areas have now been handed over to the private sector, under strict conditions and, hopefully, from 2006 under a new Monuments and Historic Buildings Act (revised in accordance with the 1992 Valletta Convention). The ROB now collaborates closely with provincial and municipal planning departments, other government agencies, and private landowners, focusing on an integrated conservation policy. Preservation of sites and monuments in their historical landscapes is one of the main objectives (Valletta Convention, article 4).

Monitoring the physical quality of archaeological sites in situ in the western Netherlands

Over the past five years, the ROB has conducted a series of projects in the coastal area of the western Netherlands, focusing on the quality of sites of archaeological importance (Fig. 3.4.2; Table 1).

The projects established baseline measurements for a number of special manmade landscapes with a long occupation history. The landscapes are special because many are home to unique remains rarely found in Pleistocene sandy soils. Favourable preservation conditions have allowed organic material and structural elements to remain intact in the oxygen-poor burial environment. They include unburnt botanical macro remains, zoological material, wood and wooden tools, fishing weirs and fykes (bags for catching fish), vehicles and house structures (NOaA in prep.). Where this highly perishable part of the archaeological resource remains well preserved, it largely determines the value of the archaeological wetlands in the Holocene area of the Netherlands.

No.:	1
Province:	Noord-Holland
Project area:	West-Friesland and the Kop van Noord-Holland (de Gouw)
Project realization:	1999-2000
Number of sites:	15 (37)
Archaeological periods:	Late Neolithic, and Early Bronze Age
Literature:	Van Heeringen & Theunissen 2001a; 2001b

No.:	2
Province:	Zuid-Holland
Project area:	Voorne-Putten
Project realization:	2000-2002 (PLANARCH)
Number of sites:	18
Archaeological periods:	Late Neolithic, Iron Age, and Roman period
Literature:	Van Heeringen & Theunissen 2002

Table 1: **ROB archaeological monitoring projects (1999-2005) in the Western Netherlands.**

No.:	3
Province:	Noord-Holland
Project area:	Broekpolder
Project realization:	2002-2003 (PLANARCH)
Number of sites:	1
Archaeological periods:	Early Bronze Age, Iron Age, Roman period, and Middle Ages
Literature:	Van Heeringen, Smit & Theunissen 2004
No.:	4
Province:	Flevoland
Project area:	Schokland
Project realization:	1999-2004
Number of sites:	3
Archaeological periods:	Late Neolithic, and Middle Ages
Literature:	Van Heeringen, Mauro & Smit 2004
No.:	5
Province:	Noord-Holland
Project area:	Former Oer IJ estuary
Project realization:	2002-2005
Number of sites:	13
Archaeological periods:	Iron Age, and Roman period
Literature:	Theunissen & Van Heeringen 2005

Table 1 (Cont): **ROB archaeological monitoring projects (1999-2005) in the Western Netherlands.**

The vulnerability of the organic portion of the archaeological resource makes it suitable as a parameter for tracking any decline in quality over time (archaeological monitoring). The layered structure of the soil in the delta of the rivers Scheldt, Maas, Rhine (and Oer-IJ) and Overijsselse Vecht means that the remains are embedded in archaeological layers that can be identified and sampled relatively simply, using non-destructive methods such as boreholes.

The projects form part of a well-considered whole and are aimed not only at establishing the quality of the sites but also at developing methods and standards for relating it to the preservation potential of the burial environment (Table 1). Such a tool would allow archaeologists to give better advice about the future prospects of sites and mitigating measures for stable preservation *in situ*. Many methods for measuring specific parameters have been tested in the field and the techniques that produced usable data have been further developed (Table 2). To go into this subject in any further depth would be beyond the scope of this paper, but three examples are given below.

	Projects	1	2	3	4	5	SAM
coring							
	soil profile description	x	x	x	x	x	x
	oxidation-reduction boundary	x	x	x	x	x	x
occupation layer							
	organic matter content	-	x	x	x	x	x
	thin sections (micromorphology)	x	x	-	x	-	pm
	archaeo-samples: artefacts	x	x	-	x	-	x
	archaeo-samples: shell material	x	-	-	x	-	pm
	archaeo-samples: botanical remains	x	x	x	x	x	x
	archaeo-samples: pollen	-	-	-	-	x	pm
	archaeo-samples: bone	x	x	-	x	-	pm
	archaeo-samples: wood	-	-	-	-	-	pm

Table 2 Recorded parameters during the monitoring projects 1-5 (see table 1).

Projects	1	2	3	4	5	SAM
dipwell (water measurements)						
water level	x	x	x	x	x	x
redox potential	x	x	-	x	-	-
oxygen (O_2)	x	x	x	x	-	-
electrical conductivity (Ec)	x	x	x	x	-	-
acidity (pH)	x	x	x	x	-	x
nitrate, sulfate a.o.	-	x	x	-	-	-
chloride	x	x	-	x	-	pm
temperature	x	x	-	-	-	-
burial environment (soil measurements)						
redox potential (occupation layer)	-	-	-	-	-	-
redox potential profile	-	x	x	-	x	x
chalk presence	-	-	x	-	-	x
acidity (pH) profile	-	-	x	-	x	x
pH buffering capacity	-	-	-	-	-	pm
soil water measurements	-	-	-	-	-	pm
climate /meteological data						
precipitation/(crop)evaporation	-	x	x	-	x	x
on surface integrity data						
(not further worked out here)	(-)	(-)	(-)	(-)	(-)	x

Table 2 (cont.) Recorded parameters during the monitoring projects 1-5 (see table 1).

Measuring the groundwater level

The groundwater level, or water table, is one of the most important parameters affecting preservation conditions. Below the water table, the oxygen content of the burial environment is much lower, which slows down or stops the decay of organic remains (oxidation). Two years after the first cautious attempt at installing a dipwell and measuring the water table at three archaeological sites in De Gouw in 1999, 13 sites on the former islands of Voorne and Putten were subjected to structural hydrological examination. The water table there was measured by hand every two months for a whole year (Fig. 4.3.3). The method was refined during the pilot project at Broekpolder, where the water table was measured automatically four times a day for a year using a diver, and the data transmitted to a website via a GSM modem (a so-called 'e-sense system') (see, *inter alia*, SMIT 2004a, 2004b). Monitoring over a year allows a series of measurements to be used, in combination with precipitation and evaporation data, to forecast the future water table after climate change, provided a number of hydrological conditions are met.

Measuring the redox potential

The redox potential is a measure of the total oxidising capacity of the soil. Initially, measurements were taken in the groundwater. Later, however, for various reasons, it was decided to take measurements in the soil itself (see, *inter alia*, SMIT 2002). Redox electrodes and the necessary equipment have now been developed specially for this purpose (Fig. 3.4.4). At the moment, the preferred method is to take a series of measurements at different depths (redox profiles), to give an idea of the vertical variation in the oxidising capacity of the soil over time. Work is also underway on digitally generated maps that can predict the archaeological preservation conditions in various hydrogeological units.

Fig 3.4.1. Aerial photograph of Aartswoud with channels and levees dating from the Neolithic near and at the surface (Single Grave Culture).

Quality of botanical macro remains and bone material

Archaeobotanists and archaeozoologists have developed methods for describing the state of preservation of vulnerable organic material, and the degradation processes to which it is subject (incl. VERNIMMEN 2002; JANS 2002; JANS ET AL. 2004). They have devised preservation categories which allow different sites to be compared. The main thing is to consider the quality (information value) of the material compared with the quality after deposition. Human and natural formation processes play an important role. Micromorphological analysis of thin sections can help produce an insight into these processes (Kooistra & Makaske 2002; Exaltus 2004). The above implies, for example, that poor quality, in a *botanical* sense, might be the best we have available from a certain period in a certain area for *monitoring* purposes. And it is the monitoring potential that needs to be safeguarded for the future.

The results of the specialist studies to establish the quality of the archaeological material and the hydrological and pedological conditions were eventually combined, in line with a recently developed quality assessment system (Deeben *et al.* 1999). Such an interdisciplinary synthesis provides an insight into the most desirable preservation conditions, and how to achieve them. Unfortunately, there are no conditions that provide the best guarantee for the preservation of all archaeological materials (KARS & SMIT 2003). A tailor-made solution will therefore have to be found for each site, depending on the state of preservation and information value of the archaeological material and features present.

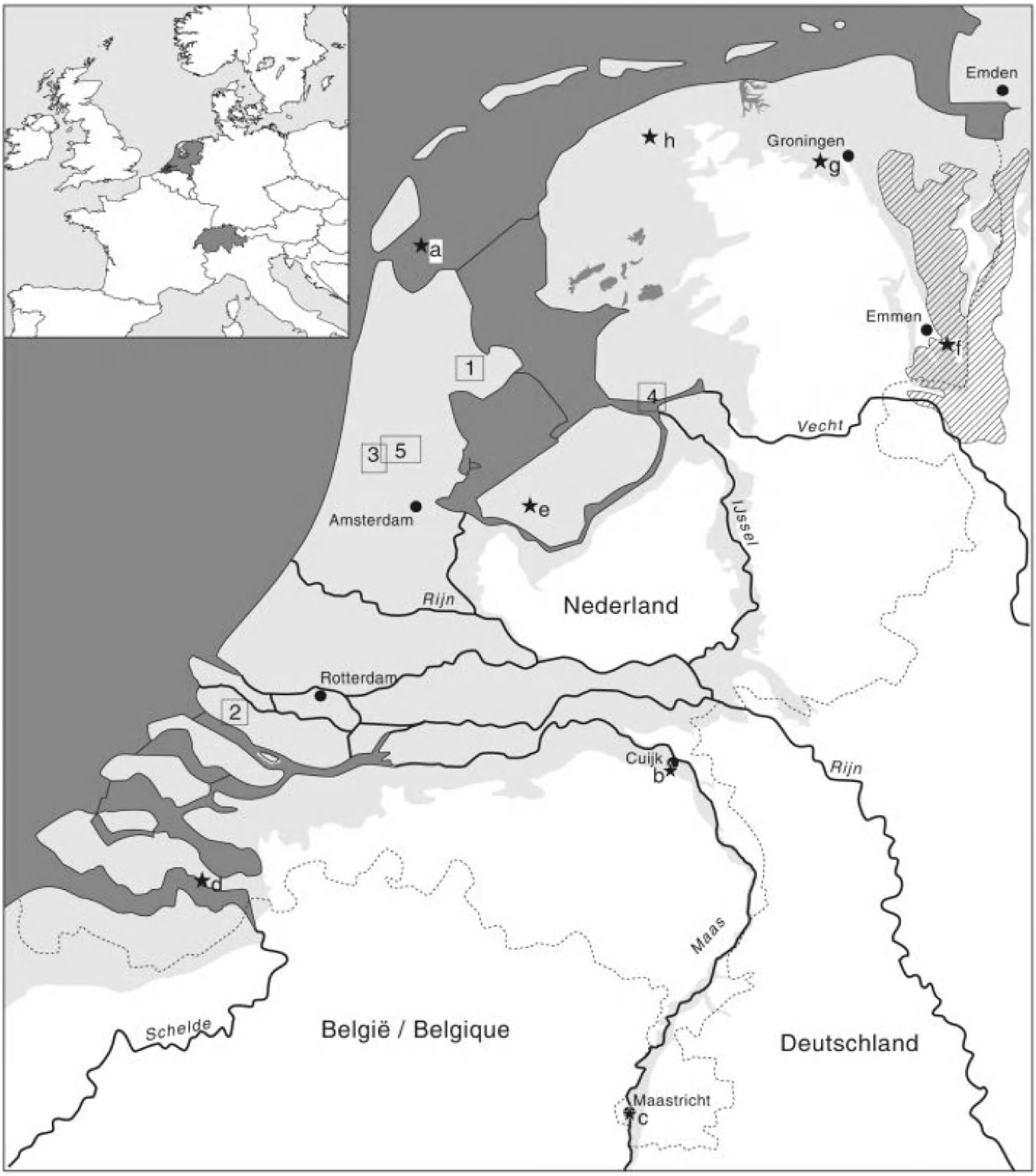
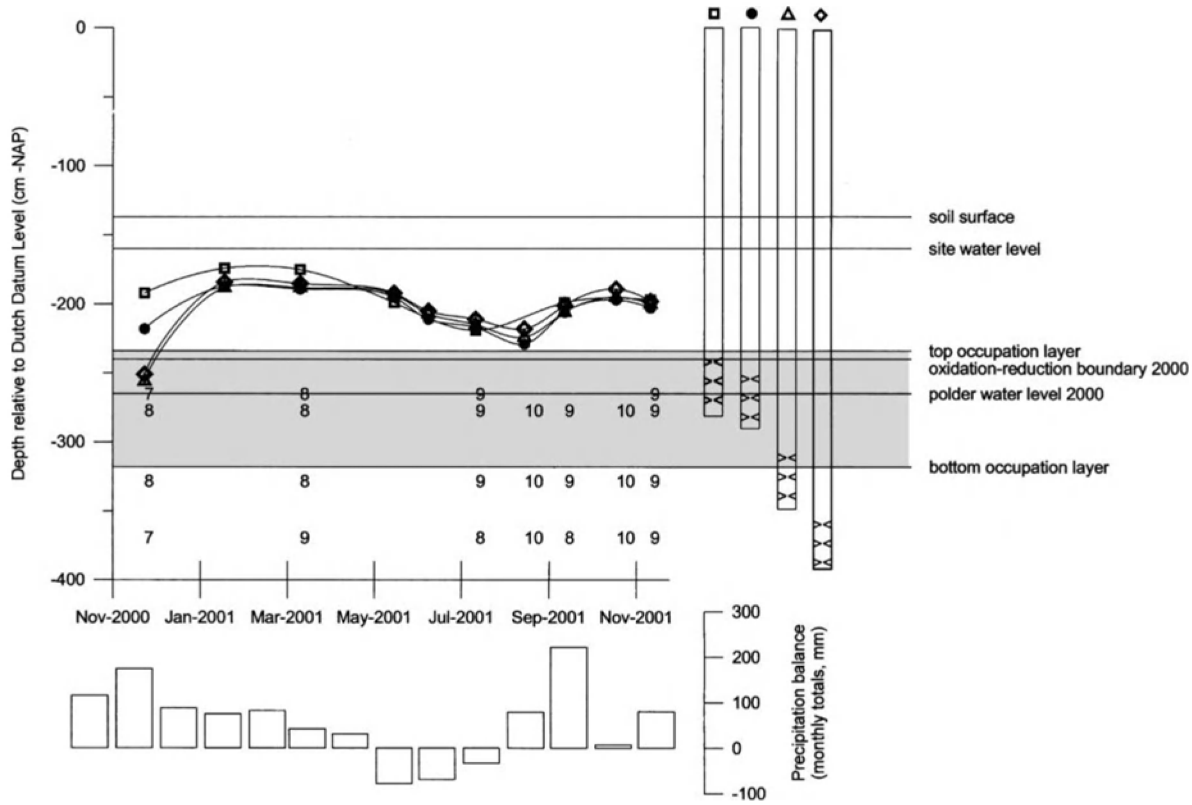


Fig 3.4.2 Overview map of the western Netherlands showing places and sites mentioned in the text. The map has been radically simplified.

In many cases, the paleowetlands in the western Netherlands are currently close to the surface. One example is the Neolithic settlement site at De Gouw (Fig. 3.4.1). Not only is the water table too low there, the site is also subject to erosion as a result of annual ploughing. Optimum preservation would be possible if the site were transformed into an extensive meadow with a relatively high water table, where no ploughing was allowed (Fig. 3.4.5).



Fog 3.4.3 Groundwater level and redox measurements taken in 2000-2001 (Planarch) at the Neolithic Spijkenisse-Vriesland site in the province of Zuid-Holland. Symbols indicate recorded values, lines are interpolation. Numbers indicate redox quality at various depths: 1 (very poor quality) through 10 (very good quality).

Preserving for the future

Many initiatives have been launched and projects completed in the field of quality assessment. An evaluation of all the project results mentioned above is due to commence shortly, to gather all the knowledge acquired in this new field. The aim is to produce a standardised set of guidelines for archaeological monitoring studies (SAM, or Archaeological Monitoring Standard) in 2005. The guidelines will form part of the Kwaliteitsnorm Nederlandse Archeologie (KNA; Dutch Archaeology Quality Standard (KNA), which is maintained under the supervision of the Stichting Infrastructuur Kwaliteitsborging Bodembeheer (SIKB - www.sikb.nl; Foundation Infrastructure for Quality Assurance of Soil Management).

The quality assessment studies performed in various parts of the palaeowetlands in the western Netherlands have added a great deal to our knowledge of the condition of the archaeological resource and the processes affecting it. Gradually, we are developing a policy tool that should allow us to make better recommendations for the future, about what quality we can expect to find and how sites should be managed and developed (Fig. 3.4.6). These are the first steps on the road to the sustainable preservation *in situ* of the vulnerable wetlands in the Dutch coastal area. We still have a long way to go, but we have made a start.

Fig 3.4.4Recording a redox profile, using equipment developed during the ROB Degradation of the Soil Archive Programme (Senter project 2003/2004, TSA02102: A. Smit/A. Beeker).

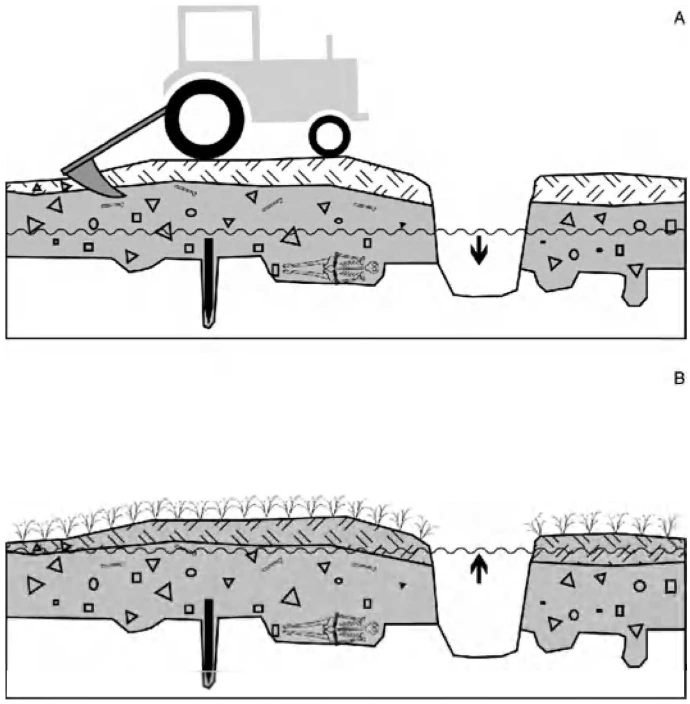


Fig 3.4.5 Preferred proactive policy: from insidious erosion (A) to sustainable preservation (B). Legend: A. during ploughing, the upper part of the shaded occupation layer is disturbed (ploughed up and incorporated into the soil); B. the site is managed in an archaeology-friendly way, arable land has been converted to meadow and the water level has been adjusted.

Fig 3.4.6 Active *in situ* preservation. Vlaardingen Culture settlement, Late Neolithic (Spijkenisse-Vriesland, Voorne-Putten, Zuid-Holland): one of the few protected monuments in the Netherlands where the water table is controlled (Photo Ruurd Kok, Leiden / Planarch).