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SOME CONCLUSIONS REACHED AT THE SYMPOSIUM ON GEOLOGICAL CHANGES IN THE WESTERN NETHERLANDS DURING THE PERIOD 1000-1300 AD[1]

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ABSTRACT

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Factors that possibly influenced the events during the period 1000-1300 AD are: climatic changes, sea-level changes, changes in river pattern and human influence. The impact of these factors is briefly discussed and the most important conclusions of the symposium are summarized.

INTRODUCTION

On March 25, 1983, a symposium was held at the University of Amsterdam on "geological changes in the western Netherlands during the period 1000-1300 AD". The symposium was organized by the Sedimentologische Kring of the Koninklijk Nederlands Geologisch en Mijnbouwkundig Genootschap (KNGMG) and the INQUA-Commission of The Netherlands, and was attended by 206 participants from The Netherlands and Belgium.

In The Netherlands, the period 1000-1300 AD is characterized by important changes, that led to an ever increasing influence of man over nature. The changes that occurred as well as their possible causes have aroused much debate in the literature.

Because of the complexity of the subject-matter a multidisciplinary approach to the symposium was chosen. Therefore speakers from various fields were invited to explicate on the present stage of research in their field.
Most of the lectures presented at the symposium are included in this Special Issue of Geologie en Mijnbouw.

AIM

The symposium's main objectives were:

1. to present new evidence from current research, and to critically evaluate the literature on geological changes during the late Middle Ages;
2. to gain a better insight into *what* happened *where* and *when*;
3. to retrace any synchrony of important geological and human changes, and if possible;
4. to gain insight into the factors that brought about these changes.

It was realized by the organizing Committee that these goals could not be fully achieved. Still, it is hoped that the symposium, as a meeting-place of different viewpoints, will further research on this important and very interesting period of the recent geological past.

EARLIER WORK

The period 1000-1300 AD has for a long time drawn the attention of many researchers in The Netherlands. Geologists, archaeologists, geographers and historians are equally interested in this period, because both geological and human changes seem to have occurred that drastically altered the appearance of the landscape.

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Although hardly any authentic medieval written documents remain, the amount of literature reporting on geological, geographical, political and economic changes is impressive. Among the changes reported are the silting up of rivers, the formation of the Younger Dunes, erosion of the coast, the formation of great tidal inlets, the construction of dikes and large-scale reclamation of peat bogs. Moreover, some of these changes occurred more or less synchronously, and therefore might have a common cause.

Although opinions in the available literature sometimes diverge widely, four possible factors are mentioned repeatedly to explain the observed phenomena. They are 1. *Climatic changes*, 2. *Sea level changes*, 3. *Changes in river pattern*, and 4. *The human influence*. In some cases the observed phenomena may be explained by a combination of these factors.

Here, only a brief review of the most important literature will be given, arranged according to the factors that were held responsible for the explanation of the phenomena described. To critically evaluate each author's opinion would be beyond the scope of this article. It should be stressed, however, that a thorough investigation should be carried out of *what* happened *where* and *when*, and that the processes involved should be understood, before any credible explanation may be offered.

1. *Climatic changes*

Increased river discharge is reported for the periods 250-450 AD, 850-1000 AD, and 1250-1400 AD by PONS (1957) and PONS & WIGGERS (1960). The increased river discharge was attributed to an increased amount of precipitation during these periods.

However, increased precipitation during the period 850-1000 AD is not confirmed by recent research, see BERENDSEN (this volume) and HEIDINGA (this volume).

JELGERSMA ET AL. (1970) studied the evolution of the Dutch coastal dunes. Soil formation occurred here during the periods 150-650 AD, 800-900 AD, around 1250 AD, 1600-1700 AD. Soil formation was thought to be related to a relative increase in precipitation. However, according to ZAGWIJN (this volume) for some periods another explanation, not necessarily connected with climate, may be offered.

A relative increase in river flooding is reported by GOTTSCHALK (1971, 1975, 1977) for the periods: 800-900 AD, 1135-1160, 1174-1200, 1230-1233, 1250-1260, 1265-1281, 1420-1430, 1524-1533, and 1564-1590. Very few river floods seem to have occurred in the 10th century. A relatively dry 10th century is in accordance with the observations of HEIDINGA (this volume) and the relatively narrow tree-rings of 10th century oaks in northern Germany (HOLLSTEIN 1965), indicate dry spring and summer seasons.

The number of severe storm surges seems to have increased after approximately 1400 AD, and reached an absolute maximum in the 16th century (GOTTSCHALK 1971, 1975, 1977). The increase after 1200 AD (see also BERENDSEN, this volume, Fig. 9), may partly be explained by an increase in the quantity and quality of the historical sources, but the 16th century maximum is real.

LAMB (1982) indicated warm and dry conditions from 910-930 AD, and 990-1000, moist conditions from 1052-1160, and cold and wet after 1300. Average temperatures in central England around 1200 AD were about 1°C higher than between 1300 and 1900. During this relatively warm period in the Middle Ages up to 7 per cent higher average yearly total rainfalls are indicated, with usually lower rainfall in the summertime.

2. *Sea level changes*

Sea level changes, resulting in what were supposed to be transgressions or local ingressions have been reported by various authors.

The much debated Carolingian-Ottonian period of transgression was thought to have occurred between 800-1000 AD (PONS 1957). However, GOTTSCHALK (1971, p. 18) showed that practically all literature on 9th century storm surges is based on an unreliable account written by John à Leydis (ca. 1490). GOTTSCHALK (1971) therefore denied the existence of the Carolingian-Ottonian period of transgression. Connected with the formation of the Younger Dunes (beginning around 1000 AD), however, important changes in the coastal pattern must have taken place. The origin of these changes is not yet fully understood (see ZAGWIJN, this volume; ROEP, this volume; JELGERSMA ET AL. 1970; VAN STRAATEN 1965).

In the 12th and 13th centuries many storm surges struck the northern and the southern parts of the Netherlands (GOTTSCHALK 1971). Storm surges probably also widened the tidal inlets Vlie and Marsdiep in the northern Netherlands and eroded peat in the area of the present Noordoostpolder (Ente, unpublished).

In the southwestern part of The Netherlands the storm surges eventually led to an enlargement of the estuaries, which caused tidal influences to reach farther upstream (GOTTSCHALK 1975).

3. *Changes in river pattern*

Changes in river pattern have been studied by DE BOER & PONS (1960), who dated the origin of the River Lek between 800 and 1000 AD. This date is now shown to be incorrect (BERENDSEN, this volume). For the origin of the River Waal no accurate datings are available yet, but it is likely that no major shifts of rivers occurred during the period 1000-1300 AD. However, some river branches like the Kromme Rijn, Hollandse IJssel and the Linge obviously silted up during this period and eventually were dammed up. The damming of the Kromme Rijn finally caused the closing off of the estuary near Katwijk, and not the other way around as suggested by VAN DER MEER (1952). See also BORGER (1977).

Changes in river gradient during the last few thousand years have been studied by DE BOER & PONS (1960) and BERENDSEN (1982).
So far no changes in gradient can be proven to have occurred during the period 1000-1300 AD, although the present rivers seem to have slightly steeper gradients than recently abandoned meander belts.

4. *Human influence*

During the Middle Ages human influence became a very important factor in the evolution of the landscape (HALLEWAS, this volume; BERENDSEN, this volume).
Amongst the changes reported are:

1. the construction of dikes (e.g. VAN HENGST, 1898; PONS, 1957; VAN VLIET, 1961; DEN UYL, 1963; GOTTSCHALK, 1971);
2. the damming of the Kromme Rijn in 1122 (DEKKER, 1980), of the Hollandse IJssel in 1285 (VAN HENGST, 1898) and the Linge in 1304 (VINK, 1954);
3. the clearing of forests in areas farther upstream (PONS, 1957);
4. the reclamation of peat bogs (VAN DER LINDEN, 1955; BORGER, 1977);
5. an increase in population;
6. the digging of peat for fuel or salt.

SOME CONCLUSIONS OF THE SYMPOSIUM

1. In the river-clay area no avulsion (abandonment of a meander belt by a stream for a new course) occurred during the period 1000-1300 AD. However, a few rivers (Kromme Rijn, Hollandse IJssel, Linge) silted up and eventually were dammed during this period. It is still unknown whether or not the silting up of these river branches is related to other changes in the western Netherlands, and whether there have been any significant long-term fluctuations in river discharge.
2. In the western Netherlands erosion of the beach-barrier complex started between 2300 BP and 1000 AD. The beginning of the erosion and steepening of the coastal profile cannot be dated exactly, but as yet no proof has been found that there was much erosion long before 1000 AD. The available evidence suggests that erosion started around 1000 AD or later. Only in the southwestern part of The Netherlands erosion certainly began earlier, probably in the early Middle Ages. However, the southwestern part of The Netherlands has not been considered.

The cause of this coastal erosion is still unknown. Climatic factors may be involved, as well as changes in the tidal currents. Clearing of forests in the coastal hinterland may have promoted the expansion of the Younger Dune sand area, but can hardly be the primary cause of coastal erosion.

3. Along the west coast of The Netherlands, the formation of the Younger Dunes began around 1000 AD, as a direct result of coastal erosion and the steepening of the coastal profile. The material for the dune building came from the submarine part of the coastal barrier.

From about 1000-1180 AD under relatively dry hydrologic conditions, the dune belt widened considerably. As a result of this there was a delayed rise of the groundwater-table, that caused relatively wet conditions between 1180 and 1330 AD. This was followed by a parabolic dune phase, which originated under a vegetation increasing in density. The formation of the parabolic dunes was essentially completed around 1600 AD.

The changes in the groundwater-table in the dune area during this period can be explained as an aftermath of the widening of the dune area, and need not have a climatic cause.
4. During the 10th century climatic conditions certainly were dry, which played a role in the dune formation on the Veluwe. Wet conditions prevailed after about 1150 AD. It is doubtful whether climatic factors played a part in the formation of the Younger Dunes, since dry circumstances occurred *before* the Younger Dunes were formed.

Wet conditions in the dune area seem to coincide with a climatic wet phase, but probably do not have a climatic cause (see conclusion 3).

The end of peat-growth in the dune area between 900 and 1000 AD may have been caused by climate. However, it may also have been caused by erosion of the beach-barriers and a resulting lowering of the groundwatertable in the dune belt.
5. On the Frisian Islands in the northern Netherlands the formation of the Older Dunes continued until 1200 AD on the western islands and until 1400 AD on the eastern islands. The beginning of the formation of the Younger Dunes also seems to be diachronous: it started around 1200 AD in the west, and around 1400 AD in the east.
6. In the province North-Holland ingressions caused a greater loss of land than in South-Holland. In North-Holland the bulk of the *pik/rekere* clays was deposited under brackish conditions, between 1150 and 1250 AD. During the 12th century the tidal inlets Vlie and Marsdiep became wider, and erosion of peat occurred in the Lake IJssel region.
7. Maybe the most striking characteristic of the period 1000-1300 AD is the dramatic increase in human influence. Loss of land no longer forced people to migrate, but instead dikes were built and reclamation activities were started or accelerated. The characteristic pattern of the "cope"-reclamations (see Appendix) that still dominates the landscape in the western Netherlands is inherited from this period. The changes in the physical environment probably were an important incentive to innovations in technology and in the field of social organisation.

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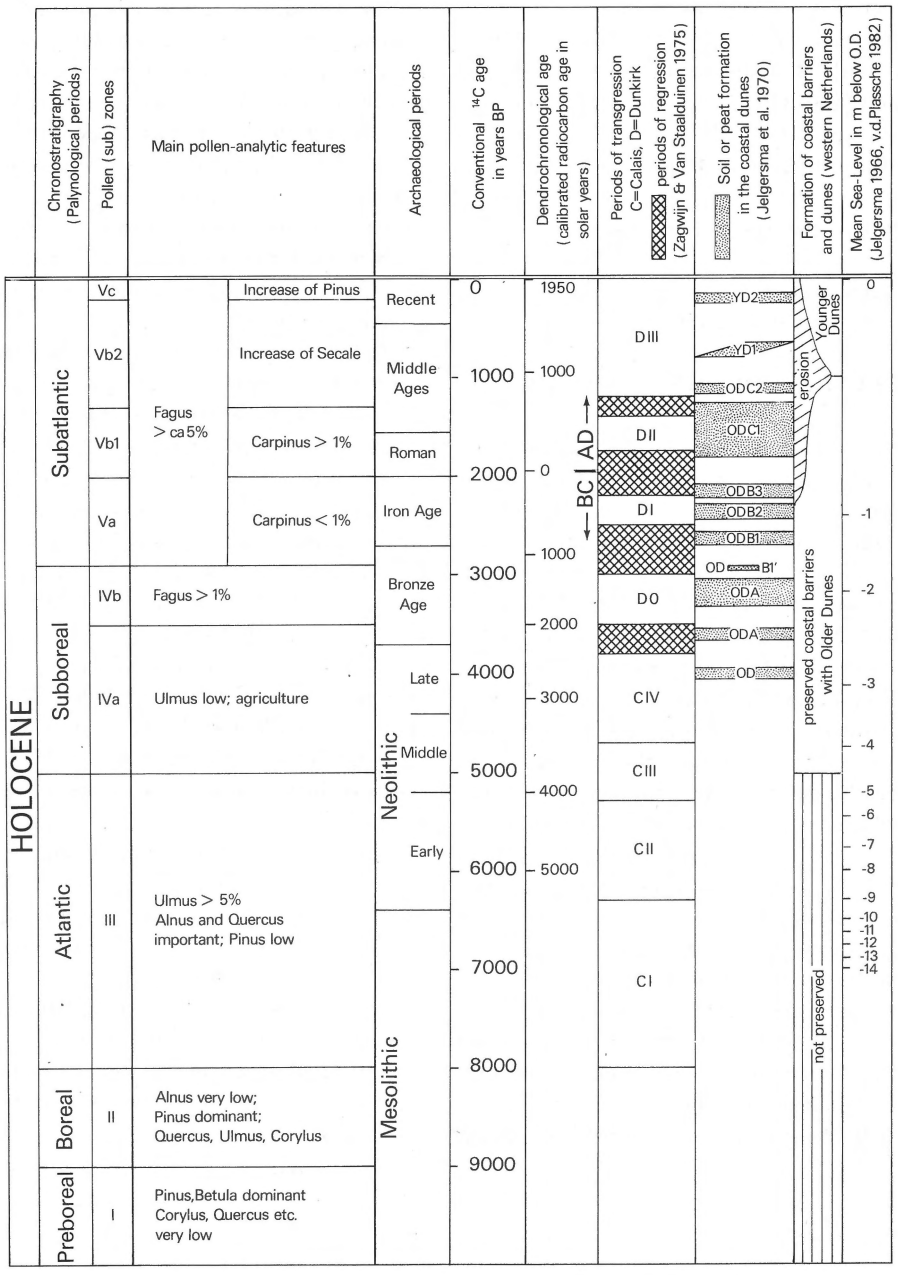
Table 1



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APPENDIX

1. Table 1 (see facing page) summarizes palynological and archaeological subdivisions of the Holocene as well as some other important data.

2. Note that (unless otherwise stated) all radiocarbon dates are conventional ^{14}C ages, which are presented in the form of: Age ± Error in radiocarbon years BP; Laboratory code and sample number. BP relates to years before the present which is adjusted to zero at AD 1950.

Fluctuation in ^{14}C content of the atmosphere results in a discrepancy between radiocarbon years and dendrochronological years which are believed to be true "calendar" years (solar years); dendrochronological calibration of the radiocarbon time-scale is possible up to about 7000 BP.

3. "Historical evidence" refers to the evidence obtained from written historical documents.

4. "Cope"-reclamations are reclamations of the peat bogs in the western Netherlands. They were carried out between approximately AD 1000 and AD 1300, under the auspices of the Count of Holland or the Bishop of Utrecht who owned the land that was to be reclaimed. The colonists, who carried out the reclamations, bought the land (hence the word "cope" = *kopen* = to buy) for a nominal fee, and obtained almost unlimited use of the land. All parcels had the same area and shape; they were approximately 1250 m long and 113 m wide, and invariably bounded by ditches. Farmsteads were built along the river, canal or road where reclamation activities started. Therefore reclamation resulted in very long-stretched villages that still carry the name "cope", e.g. Benschop, Heycop, Willeskop, Boskoop.