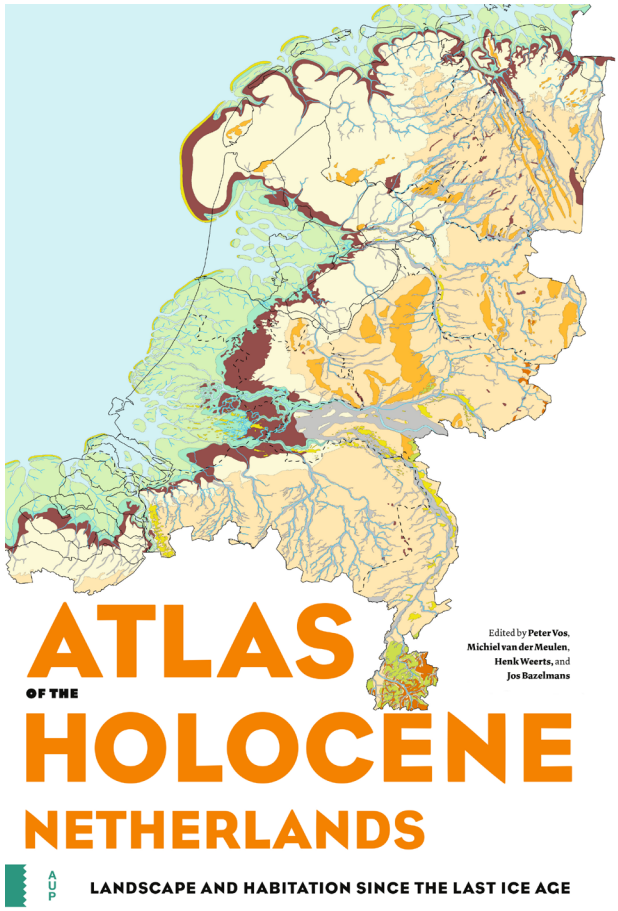
Review

Peter Vos, Michiel van der Meulen, Henk Weerts, and Jos Bazelmans (eds): *Atlas of the Holocene Netherlands: Landscape and habitations since the last ice age*

Amsterdam: Amsterdam University Press, 2020. 96 p.
ISBN 9789463724432

Reviewed by Henry Hooghiemstra



Can. J. of Netherlandic Studies/Rev. can. d'études néerlandaises 41.1 (2021): 165-173

The Netherlands is a very appropriate name in reference to its low elevation and flat topography, with only about 50% of its land exceeding 1 meter above sea level and nearly 17% falling below sea level. It is often said that the Netherlands is a present of the rivers Rhine, Meuse and Scheldt. In the *Atlas of the Holocene Netherlands*, a team of authors has examined this geological gift. Two geologists from the Netherlands Institute of Applied Geosciences and two researchers from the Dutch Cultural Heritage Agency directed a team of another thirty scientists, together covering a welcome and broad multidisciplinary field concerning the central topic of this atlas, as indicated in its subtitle: *Landscape and habitations since the last ice age*. Like humans, landscapes are mortal. They are born, thrive, and they eventually disappear. The presentation of environmental development in this atlas begins at the last glacial maximum, some 20,000 years ago when the Netherlands was covered by a windy polar desert almost devoid of vegetation. Fine-grained sands were blown around. Towards the end of the last ice age, climate conditions became less cold, increasing precipitation and triggering a metamorphosis from mainly treeless steppe-like plains to a forested landscape. At this very turn in environmental conditions, reflecting the start of the Holocene 11,700 years ago, the atlas starts its focus. The reader is given the opportunity to experience 13 stops for a careful view of the constantly changing landscape. With stunning detail readers may discover the history of their favourite landscape or their birth ground. The contours and land cover of the Netherlands have changed dramatically during the Holocene. By examining the scholarly set of palaeo-geographical maps in the atlas, the reader will obtain a new perspective on the environment, a skill which may be extremely helpful when exploring and assessing scenarios for the future.

Based on a large body of data, geologists, sedimentologists, hydrologists, palaeoecologists and archaeologists have visualized sedimentological structures and patterns of past vegetation in a three-dimensional space to reconstruct the palaeogeography. Over the last two decades, computerized geological models have greatly stimulated the synthesis of data from tens of thousands of prospective bore holes (De Mulder et al. 2003). The atlas is divided into an introduction (pages 9-34) and a section with 13 maps of strategically chosen time windows (pages 35-87). Further, it contains a glossary (pages 88-93) and an acknowledgements section (pages 94-96) in which sources in the text and those of the figures are explained, guiding the user of this atlas to a wealth of publications where more information can be found. The introduction is well-structured and gives a first impression of what can be expected in units such as "The Netherlands in the Holocene"; "What came before?"; "Rising sea levels," (seen in Figure 1 of this review); "Tides and waves shape the coast"; "The big rivers

fill the delta"; "Peat covers the land"; "Human intervention"; "How the maps were compiled"; and "Notes on the map legends."

The palaeogeographical maps presented in this atlas go back to the pioneering work of geologist and palaeobotanist Waldo Zagwijn. He was the first to show on spatial-temporal maps how the Netherlands was shaped during successive stages (Zagwijn 1986). He became well-known for his popular scientific palaeogeographical maps that demonstrated how the Low Countries got their shape over the course of the Pleistocene and Holocene epochs. At the turn of the 21st century, palaeogeographical understanding of the Netherlands expanded rapidly. Meticulous data collection in the field and advanced computerized data syntheses enabled the development of the present set of 13 palaeogeographical maps, showing the landscape with stunning detail.

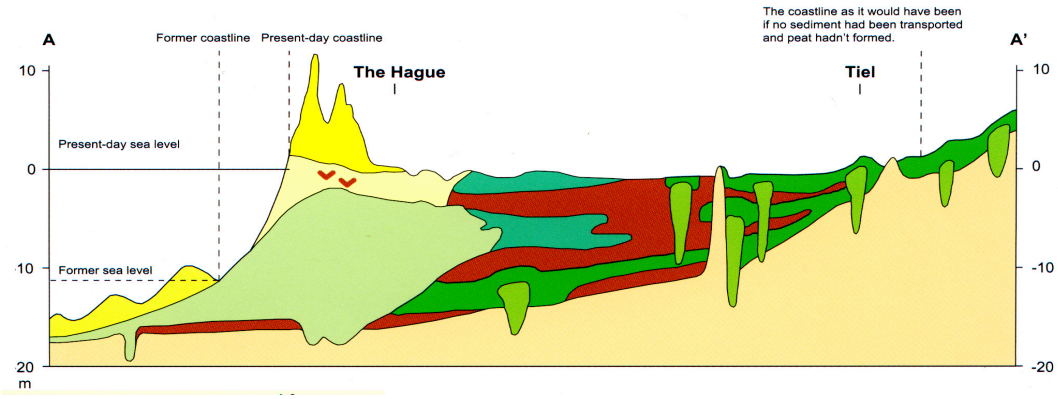
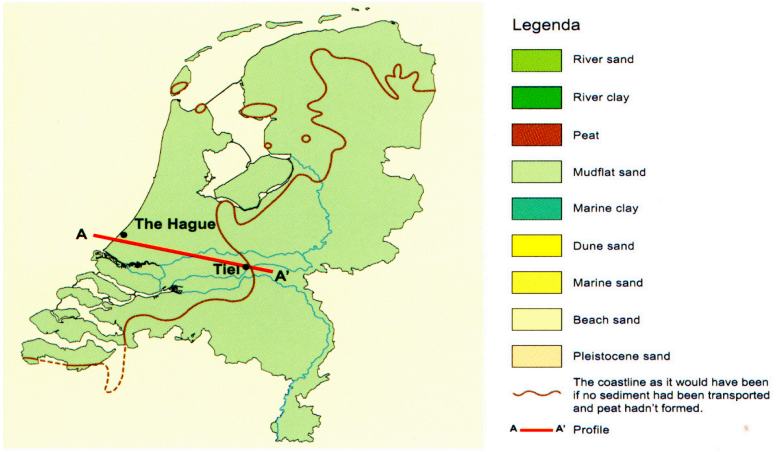


Figure 1. Top (cross section) and below (map and legend): the western Netherlands showing sediment deposited and peat formed due to Holocene era sea level rise. The diagram indicates the sea level in about 6000 BCE and where today's coast would be in the absence of this sedimentation and peat formation (Vos et al. 2020, 15). Reproduced from Atlas *with permission.*



Providing snapshots of the Holocene past, the atlas' explanatory text to the palaeogeographical maps follows the flow of time and each period is briefly characterized. Around 9000 years Before the Current Era (BCE), the Netherlands consisted of an open and dry landscape with vigorous winds transporting large amounts of sand that covered the surface. Today, these cover sands, as they are called, serve as the foundation layer for millions of formerly wooden poles, now made of concrete, on which buildings in most parts of the Netherlands are built. Sea level was about 50 meters lower than it is today. The North Sea was largely dry land, and it was home to fishermen, hunters, and gatherers, who shared these steppes with mammoths, horses, steppe wisent, rhinoceros, and hyenas (Mol et al. 2008).

Between 9000 and 5500 BCE, the sea level rose rapidly, approximately 60 to 75 cm per century. Around 5500 BCE (illustrated on the map featured on the cover of *Atlas*), rising water levels in the coastal area caused the formation of vast peat lands at 20 to 25 meters below the present sea level, but at that time above sea level. At several kilometers distance from the present coastline beach barriers were present. The river delta revealed the presence of Pleistocene river dunes, which were high and dry locations. Nomadic people lived in temporary seasonal camps, as they focused on hunting, fishing, and foraging for roots, nuts, and fruit. At a local level they had quite some impact on the landscape, in particular through burning and clearing the forest.

By about 3850 BCE, the deposition of mainly riverine sand and clay lifted the surface of the mainland at a similar rate as sea level rise. As a consequence, the Netherlands stopped declining in size. Sea level was 4 to 5 meters below the current mean. Vast peat lands developed in the low coastal zone as well as in elevated southern and eastern parts of the Netherlands. Hunter gatherers lived in the Rhine and Meuse deltas, the levees of the Rhine, and other stream valley peat bogs and beach zones. They hunted red deer, wild boar, beavers, otters, and gradually developed livestock farming of cattle, sheep, goats and pigs, and small-scale horticulture. All parts of the landscape were exploited.

Around 2750 BCE, the ice caps of North America and northern Europe had almost completely melted. The isostatic subsidence now became the main reason for sea level rise in the Netherlands. The coastline in the western Netherlands closed and the current contours of the country became established. Inland peat growth continued and grew several meters above their surroundings, relying on rain for their water supply. Peatlands stretched from western Brabant to northern Drenthe. The Netherlands was inhabited by farming communities with agriculture and livestock farming on drier, more elevated ground.

Around 1500 BCE, the entire western Dutch coastal landscape had turned into one vast peat bog, as illustrated in Figure 2. Large lakes had appeared in the

IJsselmeer region, which continued to expand over time as wave action caused their shores to crumble away. The inhabitants of farming settlements carried out ever-greater interventions in the landscape, such as large-scale tree felling. Cattle farming ensured a stable supply of animals for food. The stone flint disappeared as a cutting tool, as it was gradually replaced first by copper and later by bronze.

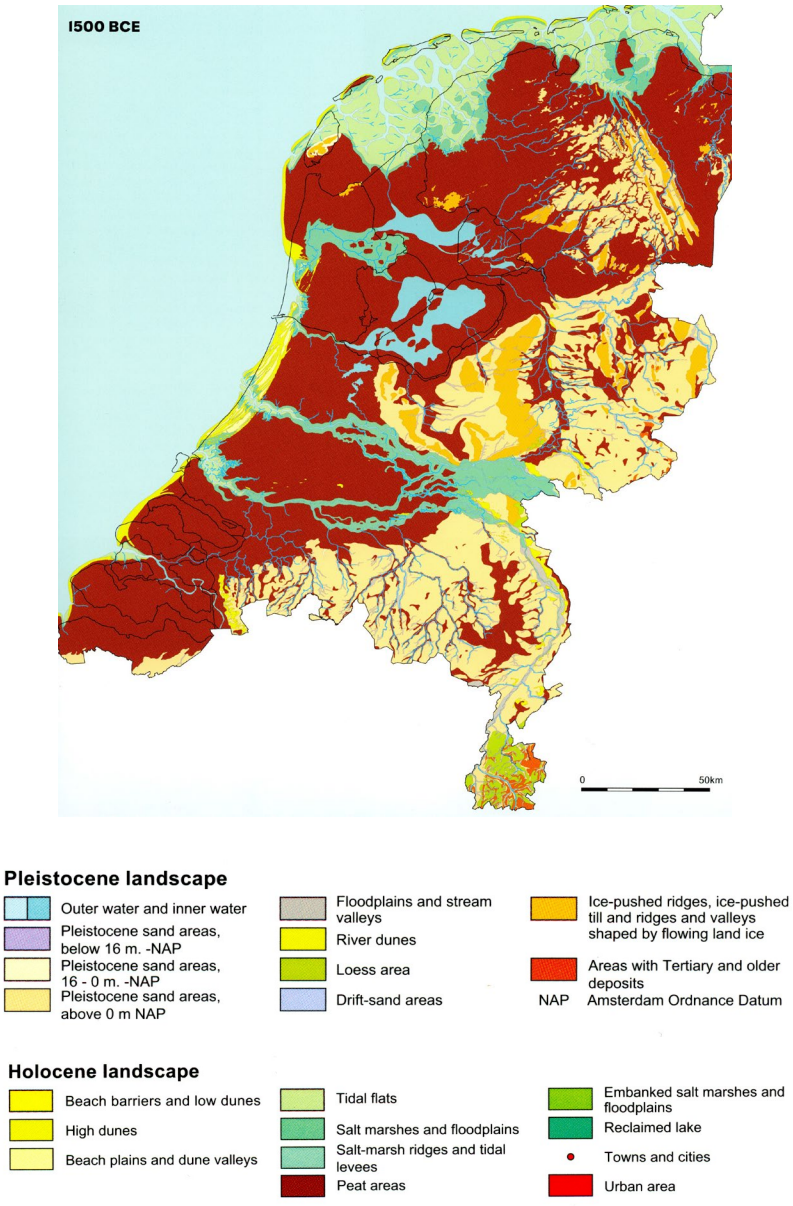


Figure 2. Palaeogeographical map of the Netherlands 1500 BCE (Vos et al. 2020, 53). Reproduced from Atlas of the Holocene Netherlands *with permission.*

Around 500 BCE, as a consequence of massive deforestation in Germany, the Rhine began supplying an abundance of clay, while peat bogs in the eastern Netherlands were overlain with river clay. An increasing surface of land was being cultivated on the sandy soils of the southern and eastern Netherlands. The last remnant of primary forest disappeared and heath vegetation advanced. Farmers would build and rebuild their byre houses anew each time at some distance from the previous one. Hunting had lost its relevance. For the first time iron was used.

Around 250 BCE, the coastline of Zeeland was gradually broken up as sand supply from the south stagnated. In the elevated parts of the Netherlands peat continued to expand until eventually only the highest Pleistocene features in the landscape, such as the ice-pushed ridges, remained uncovered. Houses were occasionally clustered together in a small group and sometimes settlements were ditched. Salt was used as a flavoring agent to preserve meat and dairy products, and to process animal skins. For the first time people began building dwelling mounds ('terpen') in the northern Wadden area to protect their houses from floods of the North Sea.

By 100 CE, the salt marshes and peatlands in the coastal area became inhabited. Similarly, the tidal systems from Zeeland to Groningen became populated, seeing cultivation of the land. Human impact started to shape the landscape. By improving the natural drainage with ditches and canals, along with the digging up of peat for fuel and salt extraction, subsidence of the peat surface resulted. The inaccessibility of peatlands north of the Oude Rijn suggests why the Romans had chosen this river as the northernmost border of the Roman Empire. Although the Netherlands occupied only a peripheral position within the Roman Empire, its main importance was as a route connecting the Rhineland and Britannia. Its absorption into a state structure triggered various processes of change in the political, social, cultural and economic spheres, known as Romanization. Cattle and horses were important. The Romans introduced chicken in the diet, while cats developed into the new pets, and black rats became an enduring part of the fauna.

By 800 CE, human intervention in the southwestern Netherlands had caused a large tidal area to evolve which now reached its maximum extent. Large-scale Roman reclamations, involving the drainage of peatlands, had caused significant subsidence. Ultimately, these reclamations had catastrophic consequences. The process of subsidence, increasing tidal volume, expanded tidal channels, and peat erosion was self-perpetuating, causing the Zeeland peat to disappear at a great rate. The Zuiderzee had become a large inland sea as the Flevo lakes merged to become one body of water. Texel was cut off from the mainland in about 800 CE when a tidal area formed there and developed into an island. Along the rivers, peatlands were being covered by riverine clay. The departure of

the Romans triggered a significant drop in population after the 3rd century. Human impact on the landscape also declined. When population numbers rose anew several centuries later, the inhabitants once again began to fell trees on a vast scale and to build water-management systems.

In the Middle Ages, around 1250 CE, humans became the dominant factor in the shaping of the landscape. Peatlands were opened up on a vast scale and dams and embankments were built on the high salt marshes and along rivers. In this period the foundations were laid for the manmade landscape that we know today. By about 1250 CE, most of the coastal and river region was enclosed by dykes. Large-scale peat erosion occurred on the shores of the Zuiderzee, which by now had almost reached its maximum size. The peat area south of Wieringen was lost, to some extent due to cultivation, making it part of the Zuiderzee. As the forests on the sandy soils were used for wood extraction and extensive cattle grazing, they turned into a landscape with more open woodland vegetation. The increase in cultivated area was accompanied by improvements to the plough and the development of the horse collar, which was a wooden yoke that unlike earlier horse gear did not interfere with the horse's breathing.

Towards 1500 CE, much of the coastal and river region had become one vast area fully enclosed by dykes and with its own water management system. Surplus water was drained artificially when water levels outside the dyke were low, initially by opening a sluice. However, as the ground surface inside the dykes continued to subside, additional mechanisms using handmills and horse-driven mills were introduced. Windmills were first used for this purpose shortly after 1400 CE. The Biesbosch was once a vast polder landscape and was lost during the St. Elizabeth Flood of 1421 CE. The St. Felix Flood of 1530 CE led to the permanent loss of parts of Zuid-Beveland and the creation of the Westerschelde. In the elevated sandy regions of the Netherlands virtually all the remaining closed forest disappeared in this period, making way for fields and intensively grazed, open woodlands with much heathland. The settlement pattern acquired a more definitive form and the number of towns and villages rose sharply in the 14th and 15th centuries. By about 1500 CE, the vast majority of today's towns and villages were already in existence.

By 1850 CE, the Netherlands had more or less acquired its present landscape. Although we consider this as "natural," almost all of it is the result of far-reaching human intervention. Present-day urbanization increased dramatically, while each hectare of the Netherlands has been designed by the Dutch.

The authors of this atlas reached an unprecedented level of disciplinary integration, painting in amazing detail the history of the Netherlands with maps and texts. Very often human impact on the landscape was the cause of later catastrophes. However, the human intrusion in the landscape was always, as it is

today, driven by objectives within the human dimension, not within the dimension of centuries or millennia (Kroonenberg 2010, 2017). During the Holocene, the Netherlands was the outcome of a balancing act between sea level rise and land surface subsidence, sediment erosion and accretion, and land loss and land reclamation. One lesson learned is the devastating impact throughout history of deforestation and drainage. Indeed, a team from Wageningen University and Research articulated a visionary landscape of the Netherlands for 2120 in which water and forests would receive more space (Baptist et al. 2019). This atlas therefore serves a broad readership, which is potentially everybody who is involved in measures affecting the landscape. The Holocene history of the Netherlands is a learning site for coastal sedimentary landscapes all over the world. The international community is indebted to this team of experts that shared their deep understanding of landscape evolution. Learning the lessons from this atlas may prevent future catastrophes. It is the main reason why this book deserves very wide distribution.

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About the reviewer

Henry Hooghiemstra is professor emeritus at the University of Amsterdam's Institute for Biodiversity and Ecosystem Dynamics (Netherlands). He was appointed professor at the University of Amsterdam in 1992, after receiving his Ph.D. in biology at the same institution in 1984. Soon he became interested in earth sciences. He specialized in terrestrial and marine palynology in the tropical areas. He focussed on palaeoenvironmental and climate reconstructions of the

Quaternary, palaeobiogeography and biodiversity of Central and South America, Saharan Africa, East Africa and Indian Ocean islands. Over the course of his career, he studied very long records from sediment cores drilled in the deep sedimentary basins of the Colombian Andes. For more than 25 years he taught a course in Big History, showing that environmental and climate changes impacted early civilizations. Human impact on the landscape was meticulously reconstructed in Mauritius (related to the extinction of the dodo) and in the Dominican Republic (related to the arrival of Columbus). He has published more than 180 papers in international peer-reviewed journals and was elected a member of the Royal Netherlands Academy of Sciences (KNAW) in 1999. Dr. Hooghiemstra continues to give university lectures in the Netherlands and in Colombia, including for the courses Future Planet Studies and Big History. He is also engaged in ongoing international research studies in paleoecology and human ecosystem interference, such as human influence on island ecosystem dynamics, as well as long-term human impact on aquatic ecosystems.