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CLIMATE CHANGE AND THE CULTURAL HERITAGE OF DIKES

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The Netherlands have more than 17 500 kilometres of dikes and a significant amount of them is several hundreds of years old. An accelerated sea level rise, increased high-water discharge of Rhine and Meuse and more frequent torrential rainfall urges the need for large-scale maintenance. Driven by a promptness coming from a long tradition of coastal engineering, old dikes are subject of raising, profile changing or even dike-cutting. The magnitude of these measures and the machinery used suggests that this can have consequences for the heritage value of dikes. Conserving the existing situation is not an option for most of the dikes because of the threat of flooding. The heritage value of a dike which is still in use must therefore primarily be found in the recognizability of the history and not in its originality. In the Netherlands already much is done to protect dikes and to keep them recognizable but there are still questions to ask. In this paper I will give a short overview on this subject.

Introduction

Situated in the largest delta of Western Europe, one quarter of the Netherlands is below sea level (Fig. 1). The Dutch have had to learn to live with the water. Without the protection of our levees and dunes, more than half of the country would be flooded. Due to the climate change large-scale dike maintenance is necessary which can have consequences for the cultural heritage value of the dikes which are still in use. A significant amount of these dikes is several hundreds of years old and valuable from a heritage view of point. However, dikes are functional elements and the fact that they are reinforced and therefore change is nothing new. Through the centuries, dikes are strengthened regularly to keep them safe.

There are numerous different subtypes, but three main types of dikes can be distinguished. Protection against direct flooding from the rivers and the sea is provided by a system of 3200 km of primary dikes. The area that is protected by a linked system of primary flood protection structures is called a dike-ring area. Within a dike-ring, a large network of smaller secondary dikes exists, which protect the land against flooding from the canals, lakes and rivers within the dike-rings. A third group of levees can also be found within the dike-rings but has lost its function as an embankment. These dike relicts can be very valuable from a heritage point of view. The group of dike relicts is not directly affected by the climate change and they are, therefore, beyond the scope of this paper. Further we will describe how the cultural heritage value of the still functioning dikes in the Netherlands is protected. After an historical outline in which account is given of changes in flood risk management and the consequences of the actual climate change, we will focus on

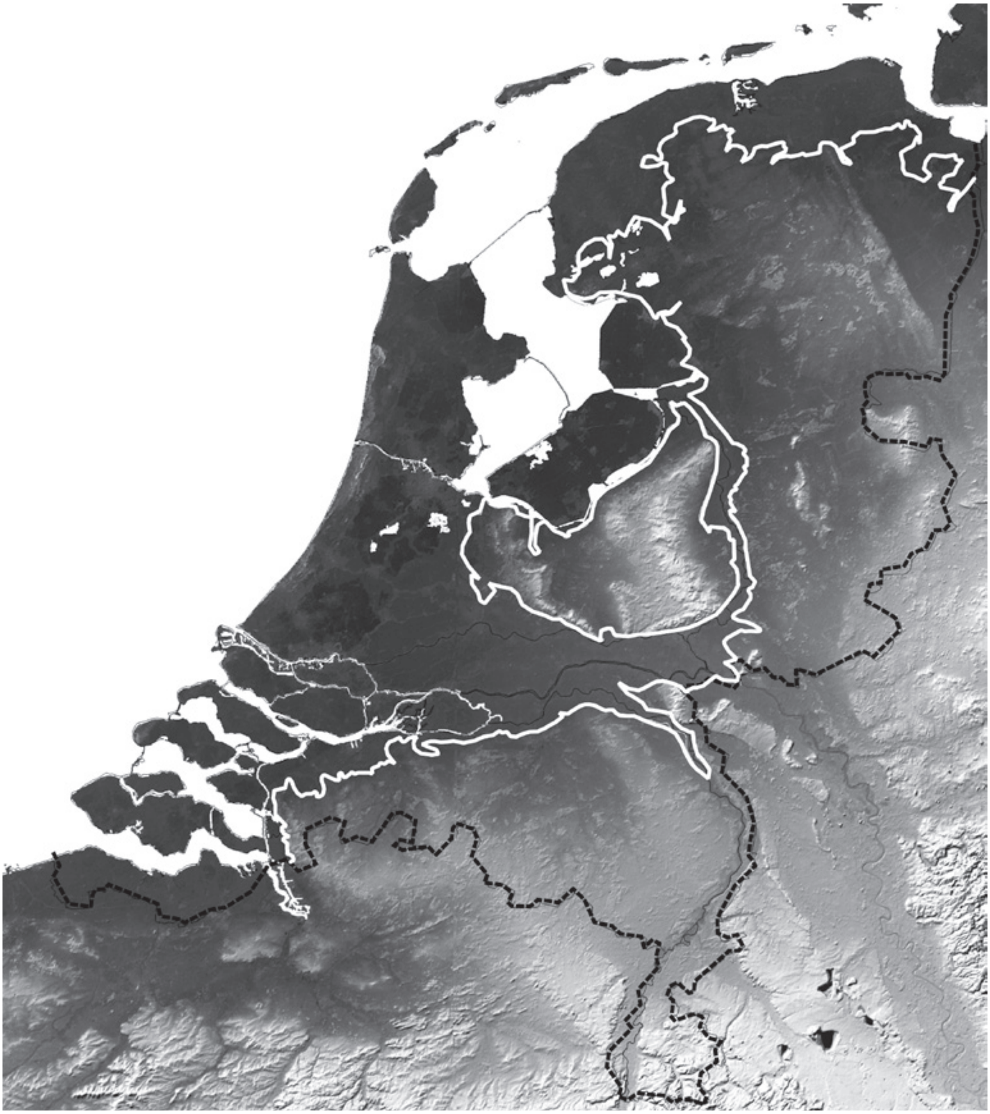

Fig 1. A quarter of the Netherlands is situated below mean sea level (white line). Without flood protection structures, about half the country would be flooded during storm surges at sea or high discharges in the rivers

the cultural heritage value of dikes and the way these values are protected.

Historical outline

The threat of flooding is not a new phenomenon. Already during the Middle Ages, subsidence of the land caused (relative) sea level rise. Since the reclamation and exploitation of the fenlands in the 10th to 12th century, the groundwater level dropped, starting a process of continuous land subsidence in the coastal zone (Van Asselen, 2010). The

Fig. 2. Along the dike deep pools have been scoured out by water swirling through breaches which still can be seen in the landscape. Zomerdijk. Photo: Henk Bol. Province Utrecht

rise of the relative sea level did gradually reduce the capacity of the rivers to discharge their water. At the same time, an increased peak discharge of the Rhine and Meuse rivers took place, connected to large scale upstream deforestation (Ward *et al*., 2008). The inundations and floods that followed had serious consequences. Therefore, huge efforts were undertaken to create defenses against the water. In many parts of the country dikes were build (Van der Ven, 2004). The threat of flooding decreased and man started to settle on previously uninhabitable places. With the continuing land subsidence and increasing river high waters, dikes needed to be maintained at higher levels, requiring growing efforts in construction and maintenance.

Forced by the recurring threat of flood devastation, the Dutch were continuously improving their dike building techniques and, recognizing the profit of good organized flood risk management, regional water authorities, the so-called waterschappen (water boards) were established. Yet the danger of inundation was not over. Despite the progress made in flood risk management, the Netherlands have a long history of dike breaches and flood catastrophes (Fig. 2). Thousands of acres of fertile land have been inundated for shorter or longer periods, and many people died. In the present landscape numerous pools along the dikes and arc-like sections recall the many dike bursts.

In the 19th and especially in the 20th century, several ambitious large scale projects were realized, such as the reclamation of the

Fig. 3. Deep-sea inlets and large inland saltwater lakes such as the Zuider Zee have been cut off from the sea, reducing the country's coastline by hundreds of kilometres

Haarlemmermeer (170 km^2), the reclamation of the IJsselmeerpolders (1417 km^2), the building of the Afsluitdijk (Enclosure dike) and the Delta works. The Afsluitdijk is an enclosure dam, shortening the coastline with over 600 kilometres. The Delta works are a project with several dams and barriers to protect the South western province of Zeeland with another 640 km (Fig. 3).

The realization of these projects increased confidence and the feeling of safety, resulting in the building of infrastructure, houses and other constructions in low laying places. Therefore, both the population and economic value behind the dikes have substantially increased. Consequently, the potential impact of dike breaches is becoming progressively more severe, which changed the attitude towards flooding radically. Less than two hundred years ago, people where convinced that human influence on nature was limited and flood catastrophes were to some extent an act of God. Nowadays even the smallest dike breach is unacceptable.

The 2007 Fourth Assessment Report by the Intergovernmental Panel on Climate Change (IPCC) indicates that during the 21st century the global surface temperature is likely to rise. An increase in global temperature will cause sea levels to rise and will change the amount and pattern of precipitation. Other likely effects of the warming include more frequent occurrence of extreme weather events. These effects will increase the probability of flooding and hence dike reinforcements are needed to maintain the safety standards as required by the Dutch Delta Act on water safety. For over 650 km of the larger dikes was in 2007 concluded that the threat of floods was acute. Reinforcement of these dikes started soon after that and a significant part of those 650 km is already realized. The fact that dikes change is nothing new. Through the centuries, dikes are reinforced regularly, but the scale and velocity of the current dike projects are without precedence. With modern equipment even robust structures like dikes can change rapidly. It is obvious that this can have consequences for the heritage aspects of dikes.

However, the present maintenance of the weak (parts of the) dikes is only the beginning. Many dike building projects will follow in the years to come: recent resampling of meteorological data of the Rhine used in a new hydrological model to simulate long discharge series makes clear that the currently implemented and proposed dike building measures, seem inadequate to cope with the increased flooding probabilities (Te Linde *et al*., 2010).

Which aspects of old dikes are valuable?

Throughout the history, dikes have changed due to reinforcements that were made regularly. The actual dike projects will change the dikes as well. For the protection of the heritage value of old dikes it is necessary to define which aspects of these dikes are valuable. Is it solely the location, is it the archaeological information hidden within and under the dikes, is it the scarcity or the authenticity?

Dikes have an important information value. Especially for the older dikes almost no information can be retrieved from written sources. Through coring or trenching, archaeologists can collect data concerning age and construction of the current dike and its predecessors. In addition unique archaeobotanic remains can be found beneath the dike, which give information about the landscape and land use before dike building took place (Van Geel *et al*., 1983).

Scarcity is another heritage aspect of dikes. Scarcity has a relation with the Informational Value and typological aspects of dikes. In the Netherlands there are several thousand kilometres of dikes, yet a national overview is still lacking in order to classify dikes as elements of cultural heritage. The criterion of scarcity can therefore only be used on a local scale or for obvious cases such as a dike along the southern Oosterschelde which has a characteristic and unique saw tooth shape (Baas *et al*., 2001).

From a heritage point of view, authenticity can be of importance. One of the meanings of authenticity is originality, but after centuries of dike maintenance hardly any dike has its original form. Theoretically dikes which lost their dam-function long ago can be in an original condition but in practice it is almost always unclear how much of a dike disappeared over the centuries. After losing their primary function, many dikes were levelled (Nijhof, 1996; Mijnssen-Dutilh, 2011). The authenticity of a dike must therefore be found in the recognizability of the history and not in originality. Arc-like sections and numerous pools along the dike and characteristic elements like an historical cladding, old sluices and pump houses are reminders of the fact that every dike has its unique history.

Protecting dikes

In the Dutch policy on dikes there is consensus that the safety demand is the primary function but also that this always should be considered in relation with other aspects like cultural heritage and nature. Until the Nineteen Eighties, dike building in the Netherlands was dominated by civil engineers used to build dikes without taking into account cultural heritage values. Nowadays, things have changed and there are several instruments to ensure that the heritage aspect of the dikes is correctly handled. A limited number of dikes are listed monuments. The status of a listed monument does not freeze the situation but gives extra protection for information and authenticity values of a dike. In the Netherlands there are three administrative levels involved in listing monuments: state, province and municipality. Only one dike — the Leppedijk in the province of Friesland — is listed as a national monument. Several elements on, or in, dikes such as the Steenendijk — a 800 m long stone brick wall — at the outside of a dike between Zwartsluis and Wijhe and historical sluices like the Stevin- and Lorenzsluizen in the already mentioned Afsluitdijk are listed as national monuments, but not the dikes themselves. On the provincial level two out of the twelve Dutch provinces have listed their own monuments but only Noord Holland used the opportunity to protect dikes. The best known protected dike is the West Frisian Ring Dike. This 126 km long encircling dike is an important structuring element in the landscape. According to the monuments act of the province damaging the dike without permission is an offence. Furthermore the Province has developed a Beeldkwaliteitsplan (Visual Quality Plan) for the ring dike as an instrument to protect the dike in the spatial planning system and to preserve the openness of the landscape (Olthof *et al*., 2009). However, no clear definitions are given for what could be considered as damage to the dike and also openness can interpreted in a flexible way for in 2009 several wind turbines were build in the vicinity of the dike (Johnson, 2011).

In addition to a monument status protection the cultural heritage aspects of dikes can be guaranteed by defining requirements for design and execution of dike reinforcement projects. This can partly be done by an Environmental Impact Assessment (EIA), often combined with a benefit-cost analysis. In an EIA, strict regulations for noise, air quality and nature protection are leading but heritage aspects can also be included in the assessment. Usually a dike reinforcement project is initiated by a water board or by Rijkswaterstaat (Directorate-General for Public Works and Water Management). The appropriate authority is the Province. The Netherlands commission on EIA's inventories the available information. When there is not enough information available an assignment can be given for additional study and reporting. Until April 2011, an EIA in the Netherlands was only obliged for the larger dike projects, exceeding five kilometres. Smaller projects needed no EIA, which was not in accordance with EU Treaty principles. Therefore, the Dutch rules were changed. Now for every dike project the appropriate authority can decide if an EIA is mandatory or not.

Although the EIA was already practiced in the 1990s, almost no publications are available on the effectiveness of the assessments (Van Dijk, 2008). This effectiveness from a heritage point of view seems to vary greatly. Sometimes funds are lacking to bring back even the old cladding on a reinforced dike. In other cases it turns out to be possible to limit reinforcement measures to the waterside of the dike, resulting in the preservation of the original dike contours at the landside.

Some instruments can give protection to the heritage aspect of dikes indirectly (Van Veldhoven, 2009). Examples are dikes which are property of natural heritage organizations, National Landscapes or belong to listed town characters. The effectiveness of these instruments in the protection is not yet analyzed, although there are surely conflicting interests: for instance between the recognizability of historical dikes and the targeted biodiversity.

The first steps in the direction of preservation of historical dikes are to asses, identify, compile and map them. On a national level a limited set of historical dikes of supra-regional importance are defined and mapped out (Baas *et al*., 2001). A much larger set of dikes can be found on provincial heritage maps. Almost all the provinces have such a map. Combining these maps give a more detailed and complete overview of historical dikes. The problem is that comparison of the provincial maps and their impact is rather complicated, since there are significant differences in the used selection criteria, rating, accessibility, cartographic representation and use by the provincial policymakers.

Publicity and support

In recent years, several actions were taken to increase public support for the heritage aspect of the dikes. Dikes usually have a prominent position in regional and national canons. In the province of Noord-Holland, for example, lectures and excursions were organized on this topic. The results of archaeological fieldwork on dikes are regularly presented to the public on open days. These excursions, lectures and open days are usually well visited and widely reported in the media. Also the Internet is intensively used to inform the public about dikes and dike projects.

Another way to inform the general public of the cultural value of dikes is presenting reconstructions of long gone dike building techniques. Up to the 18th century, many dikes had a construction of wood and sea grass on the seaside for protecting the dike against the direct force of the waves. Because of a plague of the shipworm — a wood coring bivalved shellfish (*Teredo navalis*) — hundreds of kilometres of poles, wooden cladding and sea grass had to be replaced by a much more expensive cladding of stone which has changed the appearance of these dikes notably. To demonstrate to the public how the old dikes looked like, part of a sea grass dike along the former coast of Wieringen island was reconstructed in 2001. Another example is the reconstruction of part of the wooden pole clad-

Fig. 4. The Palendijk (pole dike) of Bunschoten, June 2011. Photo by the author

ding at the dike of Bunschoten in 2007 (Fig. 4). The reconstructions are explained with texts and illustrations on billboards.

Tasks for the future

In summary, we can conclude that dike building measures initiated by climate change can have a negative effect on the heritage aspects. Simultaneously the conclusion is that already much is done to improve the safety of dikes while conserving these aspects. A weak point remains: still not much is known of the effectiveness of the instruments used for protecting historic dikes. Another point is that a national overview is still lacking in order to classify the dikes as elements of cultural heritage. The Cultural Heritage Agency is currently working on this subject.

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