



# Climate Change Threatening Archaeological Heritage in (Former) Riverbeds

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*Water has always played an important part in societies. It has created and damaged, threatened and saved societies throughout their existence. Its absence has done the same. Our rivers and seas contain evidence of this history and contain important parts of our cultural heritage, including underwater cultural heritage. Changing water levels – whether they lead to flooding or drought – challenge people’s livelihoods and threaten our heritage in (former) riverbeds, lakes and seas. Hunger stones, drowned villages, waterworks and shipwrecks all provide insight into the long history of human settlement. However, their sudden appearance due to climate change does not always allow for careful exploration. Long-term strategies are needed to assess, investigate and preserve underwater heritage. This article explores the challenges and opportunities of underwater heritage that arise from climate change, with a focus on Dutch rivers.*

**Keywords:** rivers, riverbeds, underwater heritage, climate change, flooding, drought



< Fig. 1 The dynamite ship Elisabeth exploded in 1895 in the Rhine River, near Spijk and Tolkamer on the Dutch-German border. Due to extreme low water levels the wreck has surfaced (Source: Vincent Jannink / © ANP).

## Underwater Heritage and Rivers

In the summer of 2022 the drought in Europe revealed the vulnerability of human society. Rivers dried up, immediately constraining activities like agriculture and recreation and threatening drinking water supplies and the transport of goods, even the cooling of factories and nuclear installations (fig. 2).

Rivers have been used for shipping, farming, fighting and as a food source for millennia. Now these resources – for many – suddenly seem not so reliable as often thought. However, a temporary absence of water is not completely new. The “hunger stones” discovered in German (fig. 3), Czech and Hungarian rivers have shown us that a low water level has meant disaster and hunger in previous centuries (Henley 2022). We should be warned! The earliest known stones date from the early fifteenth century, like those found in the Elbe River in Děčín, the Czech Republic. Throughout the centuries, whenever the hunger stones have surfaced, people added up the years of low water marks. The name “hunger stone” refers to the famines that coincided with the extreme low water levels. To mark the drought of 2022, the climate action group Extinction Rebellion placed a new hunger stone in the Rhine near Lexkensveer in Wageningen (fig. 4). Will it be a warning that pops up every so many years, decades or centuries, or will this stone soon be visible every year or even the whole year round?

Rivers are important elements in the landscape. They serve an important function by transporting fresh water from the inland to the sea. In doing so they become the lifelines, the arteries, of the landscape and the communities within. Often, the small summer riverbeds are not enough to cope with the large amounts of water that appear in autumn, winter and spring.





^ Fig. 2 Low water levels in the river Waal in the east of the Netherlands (Source: Martin van Lokven / Rijkswaterstaat).



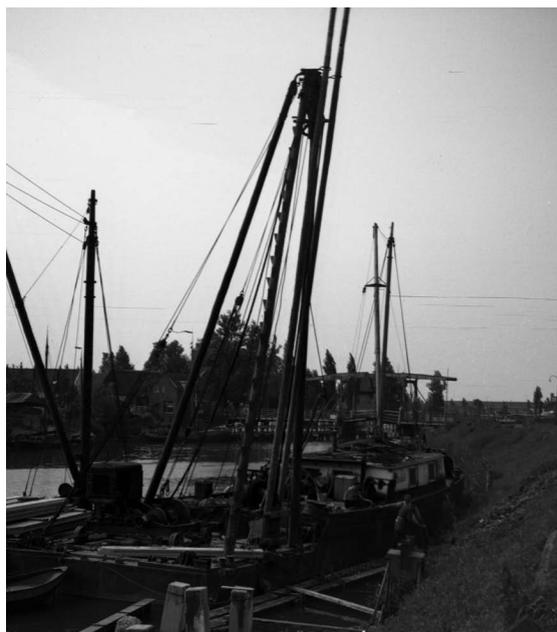
^ Fig. 3 The Wehlener Hungerstein, City of Wehlen, Germany (Source: Dr. Bernd Gross, CC BY 3.0, via Wikimedia Commons).



^ Fig. 4 Hunger stone placed by Extinction Rebellion in the river Rhine at Lexkesveer, Wageningen, the Netherlands (Source: Extinction Rebellion, CC BY 4.0, via Wikimedia Commons).

The rivers then overflow their banks and occupy a larger stretch of land. This process may cause inconvenience, but in the past was also seen as a way that land could be fertilized. A threat, but also helpful. Dikes were built to restrain the river: lower dikes along the summer riverbed and higher ones along the wider winter riverbed. Still, extreme amounts of water would occasionally cause flooding, destroying houses, sometimes killing thousands of people and animals. Over time, rivers have also been prone to meandering through the soft sediments of large delta areas like those found in the Netherlands, creating floods, demolishing road and railway infrastructure and the quays, bridges and the houses of people living nearby. Entire villages have been swallowed. Although devastating, these water changes have left a wealth of information in the soil about our past. This is the archaeological resource.

The role of rivers as arteries of mobilization and trade is reflected in the many wrecks that can be detected and investigated in existing and former riverbeds (fig. 5). Although most trained underwater archaeologists are focused on research in the sea, important shipwreck finds have been made. Dutch examples of magnificent finds in (former) riverbeds have been discovered in Zwammerdam (fig. 6), Woerden and Vleuten-De Meern concerning the Roman period and Utrecht, Wijk bij Duurstede, Tiel and Deventer for the early Medieval period. Archaeological evidence has been found for earlier and later periods, including prehistoric finds along the IJssel and World War II wrecks, for example a mini-submarine *biber* (beaver in German) in the Waal near Nijmegen. Most findings were made on dry land, in former riverbeds. They show the potential of former and current riverbeds in the Netherlands to reveal more about the long-term past of river shipping and historic trade networks.



^ Fig. 5 Mid-twentieth century work ships on the river Eem at Eemnes, the Netherlands (Source: Rene Keijzer).



^ Fig. 6 A Roman shipwreck found in a former riverbed in Zwammerdam, the Netherlands (Source: Cultural Heritage Agency of the Netherlands).

## Floodplains, Groundwater and Archaeology

The channelling of rivers, the construction of double dikes (dikes for summer and winter), and actions to regulate the flow of water have not only protected people from flooding, but also have created a sense of safety and extra space to develop, to let livestock graze or plant crops. The areas between the dikes are called *uiterwaarden* or floodplains and have been developed from temporary water storage (winter) locations in combination with seasonal areas of use (grazing in the summer), areas for building and for substantial agricultural uses. The construction of settlements requires lower groundwater tables than the original floodplains. This has had important effects: people started to live in areas that were meant as a buffer against disasters and as a result flooding once again became a major challenge and a serious threat. Also, these areas lost their other function, that of storing reserve water. This may have consequences for water storage overall at a time when we need to be resilient against severe drought. Drought may become a huge problem in the (near) future and a challenge to overcome when water levels in the rivers drop dramatically as in the summer of 2022. So far, the Netherlands has experienced only one serious summer of drought, but this experience should provide a foundation for future learning.

While climate change is transforming rivers, these arteries of past and present societies host archaeological heritage in the ground that is in immediate danger of deteriorating or even disappearing – without ever being discovered – at times of drought due to low groundwater tables. Still, these are places that offer the most amazing and well-preserved finds (fig. 6). The low oxygen levels, wet clay and peat environments preserve organic materials very well but river floors are delicate areas that need to be managed carefully.

For decades the banks and floodplains of rivers have been neglected as a possible source of information about our past. Some examples of this neglect are even quite recent. The Over de Maas [Over the Meuse] project produced an enormous number of finds that were made in an old riverbed that was rated by the government to be of low archaeological value because it was lying in the winter riverbed of the Meuse River. It is said that about 100,000 individual objects were recovered, from the prehistoric period to recent times, from building fragments to complete shipwrecks (*Historiek* 2017). However, new initiatives, such as the “Archeologische verwachtingskaart uiterwaarden rivierengebied” [“River Area Floodplain Forecast Map”] – put more emphasis on prediction, protection and management in these areas, which starts with understanding their characteristic features (Popta and Arnoldussen 2015).

Archaeologists at first may see low water levels as a great opportunity for new discoveries along shores and riverbanks (fig. 1). However, most archaeological sites do not benefit from being exposed to air. Wood dries out and iron corrodes at a fast rate. In fact, low water levels are devastating for the preservation of historic shipwrecks, which are a unique and non-renewable resource. If we add up the length of rivers, canals and ditches, we come to hundreds of thousands of kilometers of inland shores, not including the many lakes and the former river and lake beds. Potentially this fluvial resource and that of other maritime cultural heritage is very rich.

There is, due to the size of area, no way to survey underwater sites in rivers during sudden droughts – like the one in 2022 – let alone to follow up on the surveys made to assess and protect the exposed sites. Citizen science approaches may be a good solution: many eyes

and ears may lead to findings and volunteers may lend their hands to excavation work. A professional validation of that work is however always important. As soon as water levels rise again, the sites will be covered with water, but the damage due to their exposure will already be done, irreparable and with much information lost.

As mentioned, floodplain areas have been used for dwelling and agriculture. Consequently, more control of groundwater levels is important. Low groundwater levels may seem ideal for construction and agriculture. For farmers, less water means that they can grow the crop they want and for builders it means that they can build foundations for houses without water issues. Such uses however, are a challenge for other interest groups in the area, including nature conservators, historic house owners, preservationists and archaeologists. For these groups, a change in groundwater levels means less biodiversity and an oxidizing soil, leading to fast deterioration especially in peaty areas, and a huge threat for the invisible archaeological heritage that lies in that soil (Roorda et al. 2020). How many of the traces of our past will disappear before even being discovered? We do not know that precisely. Earlier research in the EU-funded BACPOLES project (2002–2005) on changing groundwater levels has clearly shown the devastating effects on wooden foundations of houses and buried archaeological resources (Klaassen 2005). Protected Late-Neolithic sites in the province of Noord Holland have heavily deteriorated as a result of agricultural use and changing groundwater levels.

In the 1990s, many efforts to tame the rivers and to take control of the precious areas alongside them proved to have been made in vain. The severe river flooding in 1993 and 1995

forced the Netherlands to think differently about their strategies and new plans were developed based on the centuries-old way people once lived with the water surrounding them: basically “go with the flow.” The project Room for the River (2000–2019) was born (Rijke et al. 2012). With respect for the force of nature, the existing floodplains were once again used the way they were intended and additional areas were appointed as overflow areas (fig. 7). Efforts to avert the dangers of uncontrolled flooding may also be part of the solution for the droughts we may be experiencing in coming decades. Too much water in winter, and not enough in summer: the large areas alongside rivers may be used as water storage for the dry months to come. This scenario, however, also means that we have to hold the winter surplus of water longer than we would now. The result may be that some areas cannot be used for anything else. A discussion of different values, priorities and aims needs to take place. We can do one thing, but not always do the other also. Choices must be made. Is this possible? Can we do this? Holding water longer for dry periods to come? Or is this an illusion?

Another issue with rivers and groundwater is access to fresh water. The battle for fresh and clean water has already started. Many areas in the world have trouble building up reserves for the future. Examples include the Aral Sea in Uzbekistan and Kazakhstan and the Colorado River in the US. Although climate change contributes to the problem, political and personal choices make the situation worse. Large river systems are not being managed as a whole, while each country, each municipality, and each farmer is taking actions independently, often contributing to the problems experienced by those downstream. Water is being measured through the need of individuals or small groups of people, hardly for a whole



^ Fig. 7 High water at Ooijpolder at Tiengeboden, the river Waal, the Netherlands (Source: Bart van Eyck / Rijkswaterstaat).

nation, let alone in relation to what is needed by the natural environment. Whole areas are transforming from swamps to arid areas and from arid areas to deserts. This lack of cooperation and the devastating results can be observed in the Donau-Black Sea Region, where unique swamps are under severe threats due to a lack of water, misuse of water and pollution. Pumping up water, lowering groundwater tables, sea-level rise and extreme drought also cause salinization, mainly in coastal areas. Land becomes unsuitable for agriculture, even as grazing land. We are starting to see these effects in the Netherlands, especially in the lower western parts of the country. What can we do about these problems? Can we only adapt to the changing situations? Or can we also do something to stop them from happening? And how does this relate to maritime and under-

water cultural heritage? As shown above, we can learn from our ancestors, from how they used water as an important element in their communities. We can protect against disaster, but also benefit. We can adapt to changes, but also prevent problems or even restore some of what we have lost. There are ways: some innovative, some hundreds of years old. The past can bring us solutions for the future.

### **Policy Recommendations**

- Water management should include the protection and management of (underwater) cultural heritage, which is a rich resource for understanding our past. Policies pertaining to rivers – arteries in the landscape – need to be all-inclusive to overcome the threats triggered by climate change.

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