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Changing Sea Conditions as a Threat to Our Underwater Cultural Heritage

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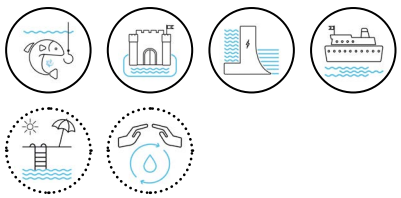
Changing sea conditions due to climate change will have an enormous effect on all sorts of processes in seas, oceans and coastal areas. Current patterns will change, as will sedimentation-erosion processes, acidity and salinity. Invasive species will be able to settle in places they could not before. Each of these changes will trigger other processes that can have a negative effect on underwater cultural heritage. Our need to try to mitigate climate change has us looking for green energy, which has led us to build large wind farms in the North Sea. We want to continue living in areas under threat and therefore we imagine building high walls, to keep the water out. This barrier approach affects current, erosion and sedimentation patterns. Consequently, such actions need to be investigated in a multi-disciplinary way to understand the complexities of changes that may result.

Keywords: *sea, oceans, underwater heritage, sedimentation, erosion, acidity, salinity*

KEY THEMES



< Fig. 1 Previously-strong, hard oak wood from a shipwreck in the Wadden Sea (the Netherlands) has crumbled and almost disappeared due to the attack of the shipworm (*Teredo navalis*) (Source: Cultural Heritage Agency of the Netherlands).

Sea-Level Rise and Underwater Heritage

The protection of underwater cultural heritage should be an important theme in the global management of oceans and seas. We are on the verge of drastic changes in our water systems worldwide. As a result of climate change, water levels in the ocean will rise an estimated 5 m by 2150 (European Environmental Agency 2024). This may sound not too bad for underwater heritage, because wet is wet. However, it may be more of a problem than might be imagined. This change in water level will have an effect on many different related processes.

First, it has to be said that the melting of ice – one of the main reasons water level is rising – exposes archaeological sites that have been well-preserved for centuries, like those in northern Norway with Viking finds and on Svalbard with the seventeenth-century graves of Dutch sailors near Smeerenburg. The melting of ice will also affect very well-preserved historic expeditionary huts in Antarctica, like the one from the 1899 expedition led by Anglo-Norwegian explorer Carsten Borchgrevink or Captain Robert F. Scott's hut from 1902 (Jacobs 2020; fig. 2). It has even led to the discovery of sites underwater that up until recently had been preserved by an ice shield, like the wrecks HMS Terror and HMS Erebus, which disappeared during the Franklin expedition (1845–1848) in northern Canada and Shackleton's ship Endurance, which was crushed in the ice in Antarctica in 1915 (fig. 3). A discovery means that the site is exposed to natural elements and often to human interference.

When ice melts, it feeds rivers from far inland that transport the excessive water toward the sea. Some (inner) seas depend heavily on this feeding of fresh water. The Baltic is such a sea. The influx of less fresh water in the future may lead to the influx of more salt water.

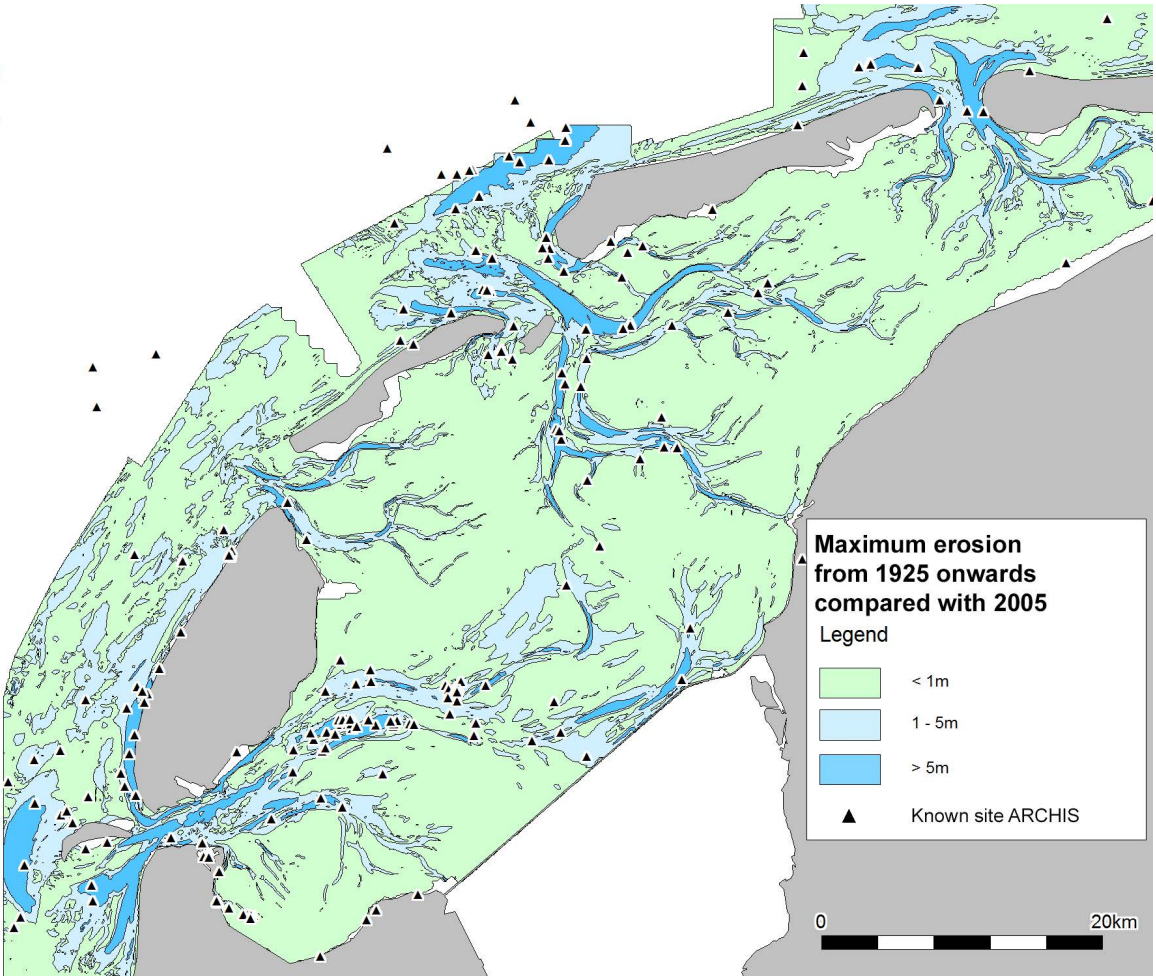
Sea level rise also means a different water distribution, which usually also means a change in currents. The effect is that water temperatures in the oceans will change, which will eventually lead to a temperature and season change in some parts of the world. The Gulf Stream circulation, for example, flattens out temperature peaks and valleys in Europe. Fortunately, this stream will not suddenly collapse or fail, but a slowdown can be expected and even this will cause an additional sea level rise and changes in ecosystems and fish populations. A change in current patterns also means a change in distribution of seabed material, like sand and silt. As a result, there will be areas of the seabed that are eroding and others that will receive more sediment. This changing sedimentation-erosion pattern, by the way, we also see on a more local scale – like in the western part of the Wadden Sea (fig. 4) – due to the introduction of hard protective measurements like dikes and (wave) breakers. The construction of these protective elements is also an (indirect) result of climate change. We want to remain safe against any sea level rise. Temperature changes also result in different weather patterns: more storms, for example. These influence wave action and therefore have a negative effect on maritime and underwater cultural heritage, especially near shorelines. Since maintaining an equilibrium in the environment is always important and change is usually bad, climate change will certainly bring about damage to underwater cultural heritage. Exposure will lead to more deterioration by human, mechanical, chemical and biological processes.

Invasive Species

If seawater temperatures are rising and salinity levels change as a result, this can affect life in the oceans. Invasive species will be able to

^ Fig. 2 This is Captain Robert F. Scott's hut that was built on Ross Island in February 1902 for his British Antarctic Expedition of 1901-1904 (Source: Sergey Tarasenko, CC BY 3.0, via Wikimedia Commons).

^ Fig. 3 Shackleton's ship HMS Endurance, trapped in Antarctic pack ice, February 1915 (Source: Frank Hurley).



^ Fig. 4 Erosion patterns of gulleys in the Wadden Sea. It shows the comparison between 1925 and 2005. Much of it is caused due to direct and indirect effects of climate change (Source: Cultural Heritage Agency of the Netherlands).

survive in places they couldn't before. There are still places, for example, where the shipworm, *Teredo navalis*, is not present yet. The Baltic Sea is such a place and – not surprisingly – this is where extremely well-preserved shipwrecks from centuries ago are found regularly, still standing with masts up on the seabed (fig. 5). Near the entrance to the North Sea, the shipworm has already demonstrated its destructive capability (fig. 1). Eventually the Baltic Sea may become more saline, which would immediately threaten the shipwrecks in this still brackish, almost freshwater environment (Gregory and Manders 2015).

Recently new shipworm species have been detected in the North Sea. In fresh waters of the Philippines, even more radically different new species have been discovered, which do not eat wood, but stone. Those shipworm species spreading out over the world may cause enormous environmental and economic problems.

^ Fig. 5 The "Ghost Ship," an extremely well-preserved shipwreck of a seventeenth-century flute ship at 110 m of depth, north of Gotland in Sweden (Source: Cultural Heritage Agency of the Netherlands / MMT).

What the invasion of these and multiple other new species means for the underwater cultural heritage, we can only imagine. Invasive species like the Zebra mussel and the Quagga mussel in freshwater environments seem to be primarily an environmental disaster, but mussels growing on wooden shipwreck constructions would make them more vulnerable to falling apart due to the weight of the shells and the pressure of the currents. Wood surfaces may become eroded because of the way the molluscs attach to the ship structure.

More Threats to Underwater Cultural Heritage

Climate change may also alter the acidity levels in water (acidification), which may have a strongly negative effect on underwater cultural heritage. Everything containing large amounts of calcium will be threatened and metal will corrode much faster.

The complexity in creating an overview of the effects of climate change on underwater cultural heritage is due not only to the fact that this heritage is often not visible. The combination of multiple processes creates a deteriorating environment: erosion may expose a wooden shipwreck that will be deteriorated by increased currents in the area and species like *Teredo navalis* (Manders and Gregory 2015). The construction will be weakened and when it is colonized by organisms like mussels, oysters, or anemones parts of the wreck will become more vulnerable to destruction by currents, leading the structure to fall apart.

Activities to prevent or mitigate climate change threats may also negatively affect underwater

^ Fig. 6 A windfarm on the North Sea, photographed during an inspection flight of the coastguard (Source: Joop van Houdt / Rijkswaterstaat).

cultural heritage. The placement of dikes, as mentioned, have caused huge erosion patterns in the Western Wadden Sea in the Netherlands. The same is happening in other countries. Old types of protection, like the (re)planting of mangrove forests along coasts in the Caribbean countries of Suriname and Jamaica have been shown to have a more positive effect. Sand needed to reinforce the Dutch North Sea coast is removed from areas further from the shore. The presence of many prehistoric objects is a proxy for the effect of sand and pebble abstraction (mining of sand and pebbles from the seabed) on the prehistoric underwater landscape. This hidden landscape is also heavily under threat by the multiple plans for wind farms in the North Sea (Ravilious 2022; fig. 6). These windmills are needed to attain the zero emission the Netherlands has promised to reach by 2050 in the Paris Climate Agreement. The wind farms are being built to mitigate against global warming, but they are threatening underwater cultural heritage. They immediately destroy the submerged landscape below them and in the long run may also cause severe erosion patterns over a much larger area. Sites are being destroyed without ever being investigated. Is this a catch-22? Or can we find solutions to address more than one problem at once? *Can we combine efforts and create an overall picture of the complex effects of climate change and sustainable energy, gaining knowledge about our past and preserving underwater cultural heritage where needed?*

Climate change certainly will have an effect on underwater cultural heritage. In the past, research has recognized some (potential) effects. The biggest problems arise when multiple threats combine. While individual threats have been explored, they have not been systematically researched. To mitigate the impact of climate change, we need to get a picture of what is threatening our underwater cultural heritage that is better than what we have today. Mitigation against the known threats may not be enough. Some threats we do not even envision; others are so complex and related to multiple other threats that we can only adapt. The threats to underwater cultural heritage are often threats that are also important to natural heritage management and environmental protection. It is therefore important to carry out more overarching research, not limiting research to one effect or one heritage field. Only then we can visualize the combined effects of climate change and arrive at real and effective solutions or adaptations. A common playing

field in which joint research could be set up is within the Decade of Ocean Science. We need to address concerns about cultural heritage, in addition to those about the economy and the environment, and increase budgets for both research and protection. Everything is connected in this world. What is expressed in the lyrics of the classic spiritual "Dem Bones" – "Leg bone connected to the knee bone" – is also true regarding the effects of climate change: everything is connected. So, let's make sure we focus a bit more on integral interdisciplinary research on this subject.

Policy Recommendations

- Everything is connected and the individual effects of climate change should be seen in a larger picture of action and reaction. Therefore, it is important to support overarching interdisciplinary research that considers multiple actions and reactions.
- We should not hesitate to include underwater cultural heritage in the discussion of blue growth, green energy, and large scientific and policy cooperations and network activities. Cultural heritage matters: it is an important part of our being, our identity. Due to our long relationship with water, the past can teach us about sustainable management. Only by looking back can we see what can be successful to apply and what not. The past is therefore important for our future.

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References

European Environmental Agency. 2024. "Global and European Sea Level Rise." Accessed March 28, 2024. https://www.eea.europa.eu/en/analysis/indicators/global-and-european-sea-level-rise.

Gregory, David, and Martijn Manders, eds. 2015. "Guideline Manual 2: Best Practices for Locating, Surveying, Assessing, Monitoring and Preserving Underwater Archaeological Sites." Amersfoort, the Netherlands: SASMAP Project. http://sasmap.eu/fileadmin/user_upload/temasites/sas_map/pdf/SASMAP_guideline_02_LR.pdf.

Jacobs, Emma. 2020. "Preserved Antarctic Huts Reveal the Isolated Existence of Early Explorers." *Atlas Obscura*. https://www.atlasobscura.com/articles/antarctic-huts.

Manders, Martijn, and David Gregory, eds. 2015. "Guideline Manual 1: Guidelines to the Process of Underwater Archaeological Research." Amersfoort, the Netherlands: SASMAP Project. https://www.cultureelerfgoed.nl/binaries/cultureelerfgoed/documenten/publicaties/2015/01/01/guidelines-to-the-process-of-underwater-archaeological-research-guideline-manual-1/sasmap_guideline_01_lr_pdfa.pdf

Ravilious, Kate. 2022. "Fears Dash for Wind Power Could Cut Off Lost World of Doggerland." *The Guardian* (March 19). Accessed on February 22, 2023. https://www.theguardian.com/science/2022/mar/19/fears-dash-for-wind-power-could-endanger-lost-world-of-doggerland.

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