

Earth & Space

A prehistoric seawall to combat Mediterranean Sea-level rise

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ABSTRACT

We summarize a recently published study describing and discussing a now-submerged seawall constructed some 7000 years ago by Neolithic villagers on the Mediterranean coast of northern Israel. It was built to protect the village against the rising sea. Their attempt was unsuccessful, and eventually, they were forced to abandon their home.



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In November 2019, world media reported floods in Venice with the highest water levels in the region in more than 50 years (peaking at 1.87m above mean sea level). The mayor of Venice tweeted "These are the effects of climate change... the costs will be high." Floodgates that had been under construction for years (estimated cost of €5.6 billion) could, perhaps, have prevented the impact of the disaster on the historic city. However, their construction remained unfinished. If the predictions of the Intergovernmental Panel on Climate Change regarding current sea-level rise are realized, incidents of this kind will be more frequent and of greater magnitude.

The flooding of inhabited settlements by the rising sea is, however, not new. A study recently published

by us in the journal *PLOS One*, describes a now-submerged seawall constructed some 7000 years ago by Neolithic villagers on the Mediterranean coast of northern Israel, to combat the rising sea and save their village. Their attempt was unsuccessful, and eventually, they were forced to abandon their home. Our investigation indicates that between 9000 and 7000 BP, sea-level rose ca. 9m (4.5 mm a year), from 7000 to 4000 BP it rose ca. 7 m (2.5 mm a year), but, from 4000 BP onwards, it has been relatively stable. As a result of the sea-level rise, Neolithic settlements on the ancient coastline were inundated, and their submerged remains have been discovered offshore during underwater research.

One of the inundated Neolithic sites, called Tel Hreiz, dates to the late 8th millennium BP. It represents a

sedentary community of agro-pastoralists and fisherfolk that was occupied for several hundred years until it was inundated. Findings include rectangular structures, round installations, hearths, artefacts made of stone, bone, pottery and wood as well as several human burials, plant remains and animal bones. Following winter storms in 2012 and 2015, a continuous and straight, feature made of a single line of boulders was exposed on the seaward side of Tell Hreiz. The 100m long wall runs parallel to the modern coast and lies ca. 90m offshore between the Hreiz village and the Neolithic shore. The large boulders weighed 200–1000kg and were transported to the site from a distant location, requiring a concerted communal effort. Archaeological finds link the boulder wall and village including a small hearth adjacent to the wall containing charcoal and fragment of a wooden bowl and cattle bones. Radiocarbon dates from the village and those associated with the wall, gave matching ages.

Given its orientation, location, and method of construction, we have interpreted the boulder-built structure as a seawall intentionally built to protect the village of Tel Hreiz from the encroachment of storms. As the sea-level rose (ca. 0.5m during the lifetime of the village), it would have resulted in an inland shift of the swash zone (a beach area alternately covered and exposed by up-rush and backwash of waves), closer to the settlement. People must have noted that the frequency of storms damaging the village increased and decided to take action by building a seawall. Dating to ca. 7500 –

7000 BP, it is the oldest example of a seawall known to date. Unfortunately, it did not save the Tel Hreiz Neolithic village and eventually the community had to abandon their settlement.

Modern sea-level rise has already resulted in considerable destruction in low lying regions worldwide. Clearly, authorities around the world should prepare themselves to counter this potentially devastating phenomenon that may lead to loss of life, property and infrastructure. Supposing some of the predictions on the sea-level rise are verified. In this case, the cost of this struggle may become too high and economically unjustified, leading to population evacuation, as experienced by the Neolithic population.

Archaeologists interpret material remains and, as in the case of the Hreiz seawall, can infer the impact of environmental change and the resultant decision-making processes taken by people that reflects their resilience in the face of such threats. While the effects of past climate change are similar to today's threats, the root causes may be different. During the Neolithic, the post-glacial sea-level rise was a natural occurrence. The root cause of the current threat, however, may be affected by human actions. Nevertheless, modern people have experienced and may experience future sea-level rise. Regardless of the origin, there is a commonality that can be observed and lessons to be learned by the decisions taken, and ultimately of the fate of the Neolithic villages.