

## **Modelling changes in the coastal geomorphology of Unst, Shetland and the implications for understanding High to Late Medieval harbour changes in the Norse North Atlantic**

John Preston, Andrew Dugmore, Anthony Newton, and Simon Mudd  
School of Geosciences, University of Edinburgh, Edinburgh, UK

The Norse settlement of the North Atlantic islands relied upon a network of harbours that also played a key role in the development of North European economies through the late Middle Ages. However, many of these harbours fell into disuse, their locations are uncertain and the reasons for this are unclear. A crucial geomorphological characteristic of a successful harbour is structural equilibrium. A harbour must have physical stability (or a dynamic equilibrium in the case of a beach) for boats to use it safely season to season, year on year. In the absence of a major civil engineering effort, something that was not possible in the pre-modern Atlantic islands, the geomorphology of a harbour is a key indicator of its physical equilibrium (or otherwise). Should the harbour be located on a changeable coastline (or one that becomes changeable) it may become unviable. Conversely, a harbour may be located on a coastline stable over centennial timescales, where little geomorphological change occurs, infrastructure can endure and many aspects of the physical environment remain predictable.

The geomorphological setting of Norse harbours in the Atlantic is variable, with contrasting landform stability over short, medium and long time scales. We assess geomorphological change on the island of Unst, the most northerly of the British Isles, a coastline used by the Norse as well as earlier and later societies. This island offers a complex coastline of deep fjords and arcuate embayments and thus significant differences in forces acting upon the coastline. There is also evidence for instability in the beaches used by the Norse that could have been driven by the changes in climate conditions from the Medieval Climatic Anomaly to the Little Age and the present day. We model coastlines using the sediment dynamics model MIKE21. Model results agree well with the location of extant sandy beaches on Unst, but model runs with modern environmental drivers also build sandy beaches where none currently exist. Blown sand deposits were formed in the 12th-13th century, consistent with High Medieval settlement times and the onset of the Little Ice Age, suggesting that some of the Norse landing sites began to destabilise at this time.

This research shows how beach instability can be modelled to determine the likely circumstances under which beaches formed, changed or disappeared and thus the potential geomorphological drivers of coastal change, harbour use and our ability to identify past harbour sites.