Analysis of 50-year wind data of the southern Baltic Sea for modelling coastal morphological evolution – a case study from the Darss-Zingst Peninsula

OCEANOLOGIA, 53 (1-TI), 2011.
pp. 489–518.

KEYWORDS
Representative wind series
Statistical analysis
Morphodynamic model
Southern Baltic Sea

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Received 6 October 2010, revised 1 March 2011, accepted 2 March 2011.

Abstract

High-resolution wind series in the southern Baltic Sea for the period of 1958–2007 are analysed to generate representative climate input conditions for a multi-scale morphodynamic model to simulate decadal-to-centennial coastline change. Four seasonal wind classes, each characterized by a predominant distribution of wind direction and speed, are derived from statistical analysis. Further calibration of this statistical description is done by sensitivity studies of the model to generate similar coastline changes of the Darss-Zingst peninsula as the measured data for the last century. The coastline change of this area is then projected for the next 300 years based on four different climate scenarios, through which impacts of accelerated sea level rise and storm frequency on the long-term coastline change are quantified.

1. Introduction

Following the onset of the Littorina transgression (approximately 8000 cal BP), the sea level in the southern Baltic Sea has reached a relatively stable

level with minor fluctuations in the range of only a few metres in the last 6000 years (Kliewe 1995, Schumacher & Bayerl 1999). The rate of sea level change (in this study, the term 'sea level change' refers only to eustatic change) has generally been between -1 mm year^{-1} and 1 mm year^{-1} in the southern Baltic Sea in the last 4000 years according to the results of Lampe (2005), which is of the same order of magnitude as the neotectonic movements in this area (Harff et al. 2007). Along with the stable sea level and neotectonic conditions, other processes such as climate change, hydrodynamics and sediment transport have become increasingly important for coastline evolution (Schwarzer & Diesing 2003).

In contrast to other waters, the Baltic Sea is distinguished by its great variety of coastal types. In general, till material predominates along the southern and south-eastern coasts, while hard-bottom and rocky shores are typical on northern coasts (Schiewer 2008). The Baltic Sea can be described as a tideless semi-enclosed marginal sea. The hydrodynamics of the Baltic is characterized mainly by complicated meso-to-large scale wind-driven currents and local-scale wind-induced waves. Tides coming from the North Sea attenuate quickly after entering the Baltic Sea through a series of narrow channels. The tidal range in the southern Baltic area is no more than 15 cm, while large-scale meteorological situations can excite a storm surge with

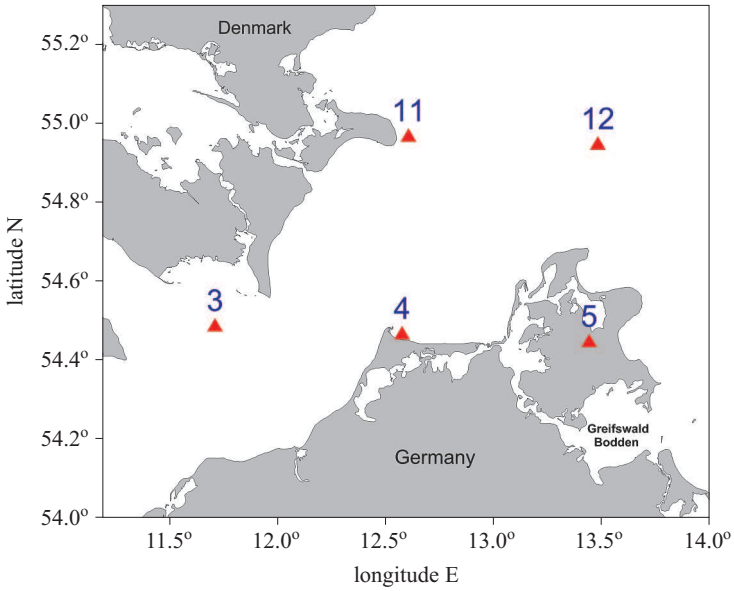

Figure 1. General features and location of the Darss-Zingst peninsula. Hindcasted wind series at five points (triangles) are analysed to generate the representative wind inputs for the long-term model