# Currents and waves in the northern Gulf of Riga: measurement and long-term hindcast*

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Ülo Suursaar*
Tiit Kullas
Robert Aps

Estonian Marine Institute,
University of Tartu,
Mäealuse 14, EE–12618 Tallinn, Estonia;

e-mail: ulo.suursaar@ut.ee

*corresponding author

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**Abstract**

Based on measurements of waves and currents obtained for a period of 302 days with a bottom-mounted RDCP (Recording Doppler Current Profiler) at two differently exposed locations, a model for significant wave height was calibrated separately for those locations; in addition, the Gulf of Riga-Väinameri 2D model was validated, and the hydrodynamic conditions were studied. Using wind forcing data from the Kihnu meteorological station, a set of current, water exchange and wave hindcasts were obtained for the period 1966–2011. Current patterns in the Gulf and in the straits were wind-dependent with characteristic wind switch directions. The Matsi coast was prone to upwelling in persistent northerly wind conditions. During the

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hindcast period, currents increased along the Kõiguste coast and in the Suur Strait, waves decreased noticeably off Kõiguste but fluctuated without a clear linear trend near Matsi. The spatially contrasting results for differently exposed coasts were related to the corresponding variations in local wind conditions and to changes in atmospheric circulation patterns over northern Europe.

## 1. Introduction

Hydrodynamic processes are the main agents that alter the concentrations and spatial distributions of biologically important nutrients and water column properties in nearshore marine areas. Causing direct physical disturbances, turbidity and resuspension of bottom sediments, orbital motions due to surface waves and other sea level fluctuations influence bottom life down to depths of approximately 10–20 m (Jönsson 2006, Kovtun et al. 2011). The impact is especially strong around the shoreline, where hydrodynamically forced geomorphic processes redistribute sediment and shape the coast (e.g. Tõnisson et al. 2008). In the regions of straits and estuaries, currents also have a special importance because of their association with matter exchange processes and frontal movements (e.g. Bowman & Esaias (eds.) 1978, Astok et al. 1999).

This study focuses on the northern Gulf of Riga and the adjoining small sub-basin called the West Estonian Archipelago Sea (or the Moonsund, Väinameri). Influenced by the large freshwater and nutrient inflow from rivers, these semi-enclosed, relatively productive and shallow waterbodies have attracted considerable attention, e.g. from marine biologists. A number of publications dealing both with basin-wide problems of the Gulf (e.g. Berzinsh et al. 1994, Ojaveer 1995), as well as some locally focused papers, call for a better understanding of the hydrodynamic variability in the changing climate and increasing anthropogenic pressure (Kotta et al. 2008). In terms of scientific effort and the number of publications, Kõiguste Bay (where a marine biology field station is located) on the south-eastern coast of Saaremaa Island and the Suur Strait (Figure 1) are prominent. Considered to be one of the key outlets in the exchange of matter between the Gulf of Riga and the relatively less polluted Baltic Proper, the Suur Strait is where the first extensive measurement series of currents were carried out in the 1990s (Suursaar et al. 1995, Astok et al. 1999). Based on hydrodynamic models, currents and matter exchange were modelled by Otsmann et al. (1997, 2001), Suursaar & Kullas (2006) and Raudsepp et al. (2011). Some of the studies were motivated by plans to build a fixed link (a series of bridges and road dams) across the strait from the Estonian mainland to Saaremaa Island. However, after more than ten years of