

120. Overtopping at port breakwaters and navigation risk using long-term multi-model numerical simulations

Dr. Rui Capitão, Dr. Liliana Pinheiro, Dr. Conceição J.E.M. Fortes, Dr. Ana Catarina Zózimo, Michelle Kleinjan

ABSTRACT:

This study assesses wave overtopping and ship maneuvering risks at Aveiro and Figueira da Foz ports, driven by climate change, namely sea level rise. The analysis is based on offshore wave hindcast data from the ECMWF database, covering a period from 1979 to present. Wave regimes are identified through statistical analysis of significant wave height, period, and direction for the years 2030, 2050, 2070 and 2100. These conditions, together with sea level rise projections, are downscaled using numerical wave propagation model SWAN, forcing NN_OVERTOPPING2 neural network to estimate mean overtopping discharge based on the local wave conditions, sea level and structural parameters. Ship manoeuvring safety will be analysed using the radiation/diffraction panel numerical model WAMIT, for linear analysis of surface waves interaction with floating structures. Maximum ship motions amplitudes along the navigation channel of each port will be computed, for the predicted local wave conditions and sea levels, allowing to establish new operating conditions. Following existing thresholds for admissible risk (overtopping and ship motions), risk levels changes from present to 2100 will be assessed. These results will enable the development of adaptive design and warning strategies. The proposed methodology supports effective risk assessment and can be applied to other coastal infrastructures and navigating channels.

Keywords: Climate change / Wave overtopping / Ship maneuvering / Extreme wave conditions / Coastal Hazards

Rui Capitão is a researcher at the National Laboratory for Civil Engineering (LNEC) in Lisbon, Portugal, specializing in maritime hydraulics and coastal engineering. His work focuses on long-term statistical analysis, for the establishment of wave regimes of sea wave climates, and short-term analyses of wave records, for numerical and physical simulations in laboratory environments. He has developed and refined methodologies for wave regime transfer and applied numerical wave propagation models to real-world case studies, contributing to improved techniques and databases for coastal engineering applications.

Liliana Pinheiro is a researcher at the National Laboratory for Civil Engineering (LNEC) in Lisbon, Portugal, specializing in maritime hydraulics and coastal engineering. Her work focuses on: Coastal and harbour Engineering, Wave generation and propagation, Numerical methods, modelling and integrated systems, CFD, Moored ships behaviour, Physical modelling of floating structures and moored ships, for numerical modelling, Early Warning systems for met-oceanic parameters, overtopping, and navigation in harbours, Risk management in port and maritime infrastructures and navigation.

Conceição Fortes is a principal researcher at the National Laboratory for Civil Engineering (LNEC) in Lisbon, Portugal, specializing in maritime hydraulics and coastal engineering. She is also head of the Division of Ports and Maritime Structures of the Department of Hydraulics and Environmental pf LNEC. Her work focuses on: Coastal and harbour Engineering, Sea wave generation and propagation, Methodologies for coastal and harbour studies, Physical modelling of maritime structures, Navigation and moored ships, Integrated systems for numerical modelling, forecasting and Warning systems for sea waves, overtopping, flooding and navigation in coastal and harbour areas, Risk management in maritime infrastructures and navigation.

Ana Catarina Zózimo is a researcher at the National Laboratory for Civil Engineering (LNEC) in Lisbon, Portugal, specializing in maritime hydraulics and coastal engineering. Her work focuses on sea wave generation and propagation, methodologies for coastal and harbour studies, physical modelling of maritime structures, forecasting and warning systems for sea waves, overtopping, flooding in coastal and harbor areas, and risk management in maritime infrastructures.

Michelle Kleinjan was a research fellow performing internships studies at the National Laboratory for Civil Engineering (LNEC) in Lisbon. She worked on the subject of sea waves propagation, overtopping and flooding risk assessment in the port of Figueira da Foz.