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ASSESSMENT OF THE BALTIC SEA NEAR-SHORE WAVE ENERGY RESOURCES ALONG THE COAST OF KLAIPĖDA

Summary of the Doctoral Dissertation (Technological Sciences, Environmental Engineering)

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The Lithuanian coast is located at the eastern part of the Baltic Sea where the one of the highest waves in the Baltic Sea occur. Consequently, these are the waves with the highest energy potential, which in the future can be used to produce electricity.

The analysis of recent literature sources revealed that the amount of scientific work concerning wave energy topic in the European semi-enclosed seas, like the Black Sea and the Mediterranean Sea, increased rapidly in the last years, what leaves the Baltic Sea a blank spot on the European wave energy map. Therefore, the aim of this thesis was to assess wave energy resources in the Lithuanian near-shore area, taking into consideration their temporal and spatial distribution.

The scientific novelty of this dissertation was not only that the wave energy resources in the Lithuanian near-shore area were assessed for the first time, but also that for the latter only visual measurements of the wave heights were used. So far no established methodology exist how to base the assessment of the wave energy resources on the visual measurements.

The propagation of waves to the shore is the process that is mathematically difficult to describe with complex boundary conditions. In this thesis this scientific problem is solved combining statistical analysis and numerical modeling methods and using them to evaluate and assess the Baltic Sea near-shore wave energy resources along the coast of Klaipėda. The methodology which allows using the multi-year visual wave height observations to assess the wave energy resources was created.

Lack of knowledge about the Baltic Sea wave energy resources along the Lithuanian coast makes it difficult to develop and to properly adjust wave energy converter to produce electricity with maximum efficiency. Therefore, not only the most powerful sea states in the Lithuanian near-shore area were determined, but also the wave energy resources were assessed along the Klaipėda Seaport breakwaters, where in the future could be the viable site for wave energy converter in Lithuania.

The tasks of the dissertation were to evaluate and to assess: 1) the temporal distribution of the Baltic Sea near-shore wave energy resources along the coast of Klaipėda, 2) the spatial distribution of the Baltic Sea near-shore wave energy resources along the coast of Klaipėda, 3) the Baltic Sea wave energy resources alongside the Klaipėda Seaport breakwaters.

The Baltic Sea near-shore wave energy resources along the coast of Klaipėda, taking into consideration their temporal distribution, were assessed by carrying out the statistical analysis of the multi-year visual observations in the Lithuanian near-shore area along the coast of Klaipėda. The goal of this analysis was to find out the distribution of the average wave heights in the Lithuanian near-shore area in the selected design years. Selected design years were: high intensity (5 % probability), median intensity (50 % probability) and low intensity (95 % probability) wave years. The Baltic Sea near-shore wave energy resources along the coast of Klaipėda, considering their temporal distribution, were evaluated and assessed using the design years‘ average monthly, seasonal and annual wave height values.

Other method applied for the assessment of wave energy temporal distribution was use of scatter diagrams. The scatter diagrams were adapted to visual observations and calculated using monthly average wave heights. They show annual and seasonal probabilities of occurrence of sea states together with power flux distribution through these wave states.

The Baltic Sea near-shore wave energy resources along the coast of Klaipėda, taking into consideration their spatial distribution, were assessed using two dimensional hydrodynamic numerical wind-wave model *MIKE 21 NSW*. Model was calibrated using instrumental measurements of Klaipėda wave gauging station and European Centre for Medium-Range Weather Forecasts *ERA-Interim* reanalysis data. For *MIKE 21 NSW* model calibrating purposes bottom dissipation parameter, Nikuradse roughness coefficient, was used.

MIKE 21 NSW was used to model the dynamics of wave height loss, what consequently was the initial data to assess the decreasing amount of the wave energy of the waves that are propagating to the shore. The impacts of depth, wave propagation direction and wind on wave energy resources were examined. Same model was used to assess the wave energy resources alongside the Klaipėda Seaport breakwaters.

Both, for the assessment of temporal and spatial wave energy distribution of the Baltic Sea near-shore wave energy resources along the coast of Klaipėda, wave power fluxes were calculated from the JONSWAP wave spectrum adapted to the Baltic Sea conditions.

The dissertation was defended on 3 June 2015 at Aleksandras Stulginskis University.