Artificial Underwater Object’s Protection Properties Study using Numerical Modeling

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The important part of the tsunami research is focused on studying the considerable influence of natural geographical objects, like islands and near-coastal bathymetry, on tsunami waves. Complementing the physical modeling, we are designing a system for computer simulations at crucial coastal areas. The Bathymetry and Tsunami Source Data Editor is a basic system tool for editing bathymetric and tsunami source data by including/removing artificial seawalls and submerged barriers having different shapes and sizes. Accordingly, an artificial object is specified by special features/parameters including latitude and longitude of the object central point, height and width of the object as well as its rotation angle relative to north, and elevation/depth. The user can also work with composite objects creating them as a combination of atomic shapes. It makes possible forming complicated shapes as well as designing many of artificial objects/barriers. Current version of the Editor uses the NOAA Bathymetry data format. The editor also allows to specify an initial water surface elevation ‘specified parameters. It operates with ellipsoidal source shapes having the smooth water height distribution along the ellipse axis. This approach gives the possibility of the numerical simulation of the tsunami waves generated by combination of such sources with a specified location and an initial height.
Results of numerical experiments are presented for the gridded hybrid bathymetry for several coastal areas of Japan. Calculations were provided with a hybrid bathymetry formed by barriers with a parallelepiped shape using the grid-switching algorithm for the tsunami propagation computation from the initial source to the coastline. Accordingly, the 2148x1074 knots gridded bathymetry was created for the Oppa Bay and the neighboring harbors. The grid resolution is approximately 17 m. These data cover the geographical area from 141.41659 o *E* to 141.75 o *E* and from 38.5 o *N* up to 38.6666 o *N*.
The new method for numerical modeling of partial reflection of the long wave off the submerged vertical barrier was developed and tested. This method is based on the inner boundary condition, which takes into account the wave energy loss due to such kind of reflection. This system can help to issue recommendations for better protection of some crucial objects on a coastline. A number of numerical experiments with submerged barrier located at the entrance of the Oppa harbor were carried out. Barrier size, placement and depth were changed during experiments. All along the barrier its height is equal to the half of the local depth. After analyzing results, we can resume that wave heights in the northern part of the Oppa harbor within half a depth high barrier were reduced (suppressed) by 0,8 as compared to the wave height distribution without any barrier. In case of the barrier height be equal to 0,75 of a local depth the tsunami height reduction ratio decreases down to approximately 0,65. In order to protect some crucial coastal objects we can vary the position, width or the height of virtual submerged barriers choosing the desired mitigation effect.

Keywords: Tsunami Modeling, Hybrid Bathymetry, Coastline Crucial Objects Protection