Hydro-engineering and environmental problems in Poti Black Sea region and ways of their solution

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Work is dedicated to the development of hydro-engineering and environmental protection measures in the Black Sea region, the main Georgian port of Poti at the mouth of the Rioni, which will minimize the region geomorphological changes caused by the influence of natural and anthropogenic factors, and will over a long period protect coastal areas of these regions from washouts and large scale slippage processes.

The serious environmental problems started in Poti after transfer of the main flow of the river Rioni to the north. As a result, the founding of the city stopped, but the reduction of water consumption in the city channel, caused a decrease of the sediments carried away by the river, what leads to coastal erosion. The coast changes are connected with the movement of the waves and currents in the coastal part of the sea.

The research objects are (Fig. 1):

1. Poti seashore, which has retreated for hundreds of meters, promoted with the existence of underwater canyons along the southern pier of the port;
2. Input Channel - The problem of protecting the port of Poti on the sediment deposits;
3. The Rioni river watershed dam, the balance of which in time was subjected to destruction and substantial washout. Currently the stability of the dam is endangered;
4. "City Canal", the Rioni River old bed, which is greatly uplifted and is virtually unable to perform its function — to lead Poti seashore with solid sediment.

model of wave motion

The basic equation of wave motion are of the form:

\[ \frac{\partial \eta}{\partial t} + \nabla \cdot \mathbf{q} = 0 \]

where \( \eta \) - water elevation; \( \mathbf{q} \) - vector fluid flow; \( \nabla \cdot \mathbf{q} \) - divergence of the free surface elevation of the sea near the coast (Fig. 2).

The numerical modeling was developed in three stages. In the first stage, the geometry of the coast and the initial geometry of the structures are considered as an input parameter. Then, coastal wave field is calculated for the conditions prescribed in the input model. In the second stage, the calculated wave field is used to estimate the spatial distribution of the radiation stresses near bottom velocity. In the third stage, the coastal wave fields and flow fields are used in the sub-models of sediment transport and changes in the topography of the coast.

In the numerical solution of basic equations of motion of the waves, coastal currents and changes in sea bottom topography we use: finite element, finite difference methods, and the method of upper relaxation, Crank-Nicolson scheme. As an example of research, we are giving the results of the wave regime in the coastal area of the city of Poti (700000m²) adjacent to the port of Poti. The bottom profile, in this area is rather complicated. During the calculations of the average range of sea level, 0.1m was taken as the initial value, which corresponds to the actual conditions.

model of sediment transport and changes in bottom topography

\[ q_x = v_x + \nabla \cdot q_x \]

where \( q_x \) - sediment transport caused by the averaged currents; \( v_x \) - sediment transport caused by the waves.

The calculations have found that in the excitement, the sediment transport rates at a depth of 10-15m are almost zero. The maximum value of the velocity of sediment transport change within 0.006-0.0065m/s.

In the coastal area of the city of Poti, in the bank, the sediment transport changes, which varies in the range 0.0015-0.0022m/s. The rate of sediment transport changes in the bank in this case is relevant, and their maximum values in the range 0.0001-0.000171m/s. Changes in the water velocity varies from 0.25 to 0.23m. The role of coastal erosion south of the port of 8-10m/year.

To protect the coastal zone is essential consumption beach forming sediments that are distributed as follows:

1. 160000m³/year in the northern channel.
2. 650000m³/year in the southern channel.

Differences in the rate of beach forming sediments in the southern channel is 200000 m³/year. Mathematical modeling gave approximately the same results.

A conceptual design of bank protection measures, which uses a new idea of bottom diversion of river Rioni from the northern channel of the river Rioni in the southern channel. The basic design and operating parameters of hydraulic equipment for filling of bottom sediment. It is proposed a feasibility study of the proposed bank protection measures in the region of Poti. According to economic indicators and the reliability of the proposed project exceed the previously proposed projects to protect the shore from erosion near the town of Poti.

The results obtained using these models will be put as a base of development of such engineering measures and design proposals which:

a) will provide sustained increase of Poti coastal line on the basis of working out all exploitation regimes of the Rioni watershed hydro complex and as a result of performing additional engineering measures in "City Canal";

b) will thoroughly protect the Rioni watershed hydro complex dam tail-water from destruction and washouts;

c) will fulfill additional measures to improve potential solutions to the problems of sediment transport in the coastal area of Poti.

Bibliography


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