To the restoration of the washed-out sea coast of the city Poti

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Introduction

Large-scale geomorphological changes in the coast area of the Poti city (the main port city on the Georgian Black Sea coast) started to occur after 1939 when the course of the Rioni river (with a maximum discharge up to 4000 m^3 /s) was completely diverted northwards from the city. Though this diversion protected the city from frequent floods, it at the same time created an irreversible deficit of beach-forming alluvia and, as a result, the sea coast of Poti was irreparably washed out by sea waves and its area diminished by hundreds of meters.

To restore the washed-out sea coast of Poti, in 1959, the dam with a regulator (sluice) was built across the Rioni river, at the 7th kilometer to the north-east of Poti. Its purpose was to divide the river flow so that a part (400 m^3/s) of the river discharge would flow back to the former river bed (the so-called city channel) in order to compensate for a sediment deficit (600 m^3 per year). However, for a variety of reasons, this measure did not lead to the desired result and the coast continued to be washed out.

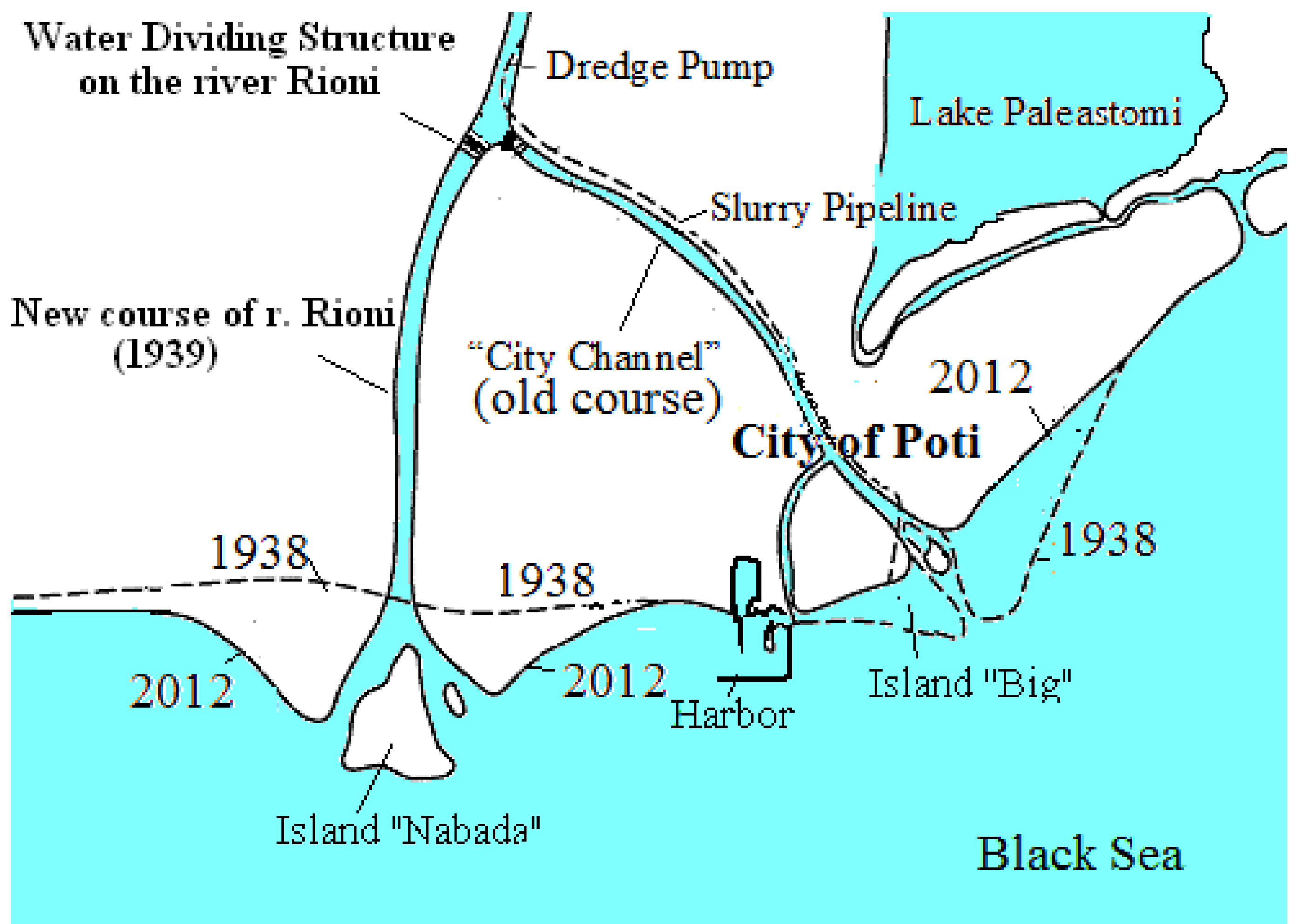

Fig.1 Schematic map of Poti sea region
- - - coastal line in 1938; — coastal line in 2012

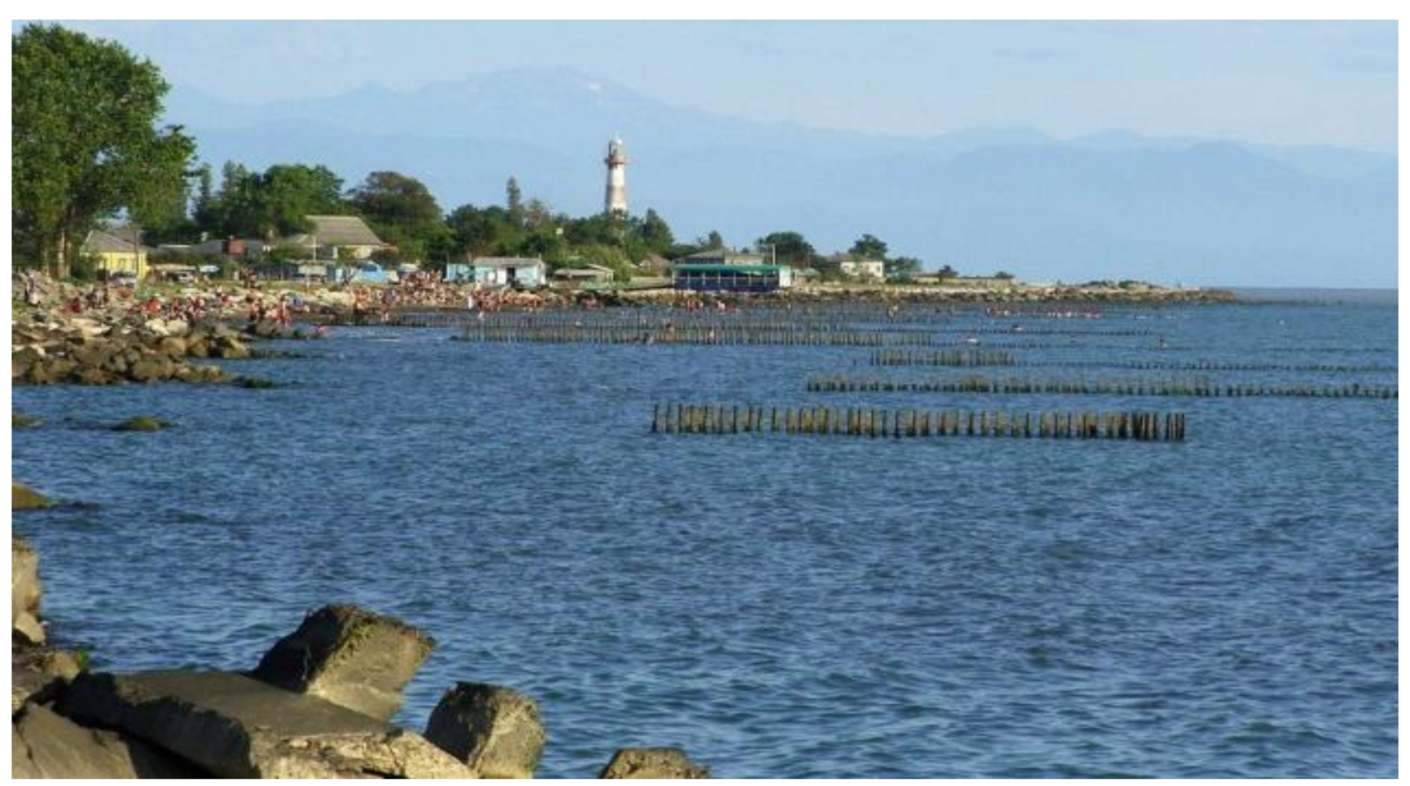

Fig.2. Washed-out beaches of Poti

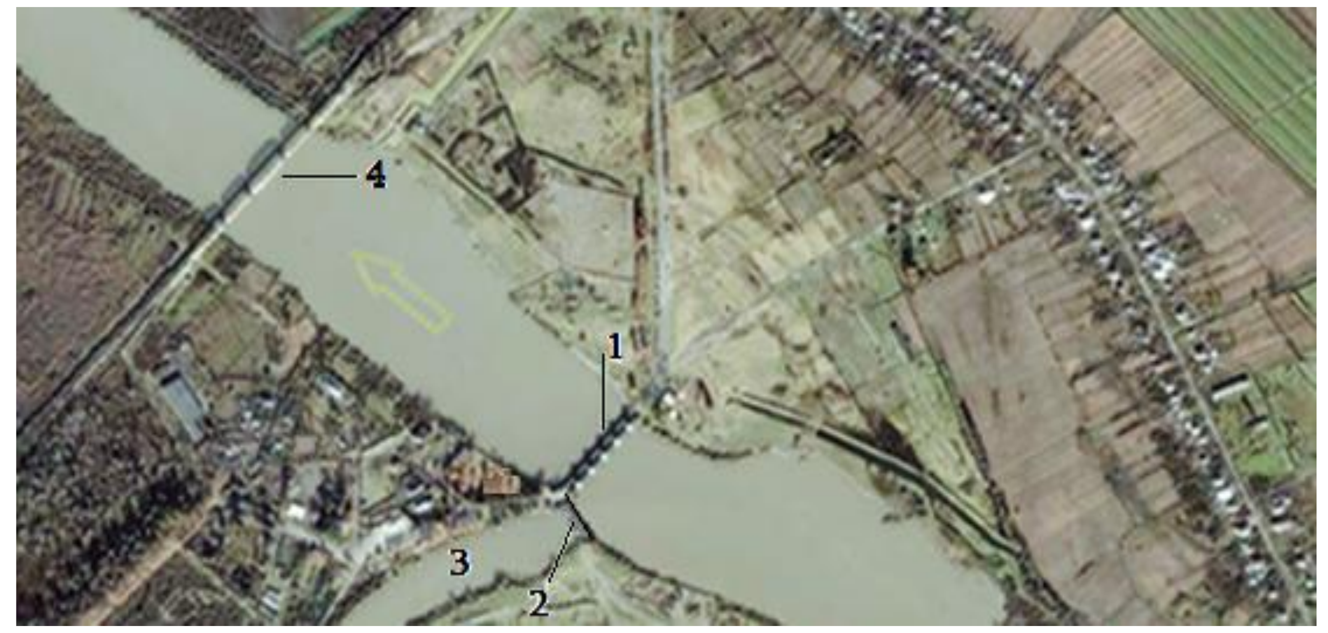

Fig.3. The water dividing dam on the river Rioni.
1. Dam; 2. Gateway regulating the water supply from the river Rioni to the City Channel. 3. City channel; 4. Railway bridge. The pointer indicates the main flow in the direction of the sea.

Fig. 4. Water regulating hydro complex from which solid sediments are transported to the Poti coast

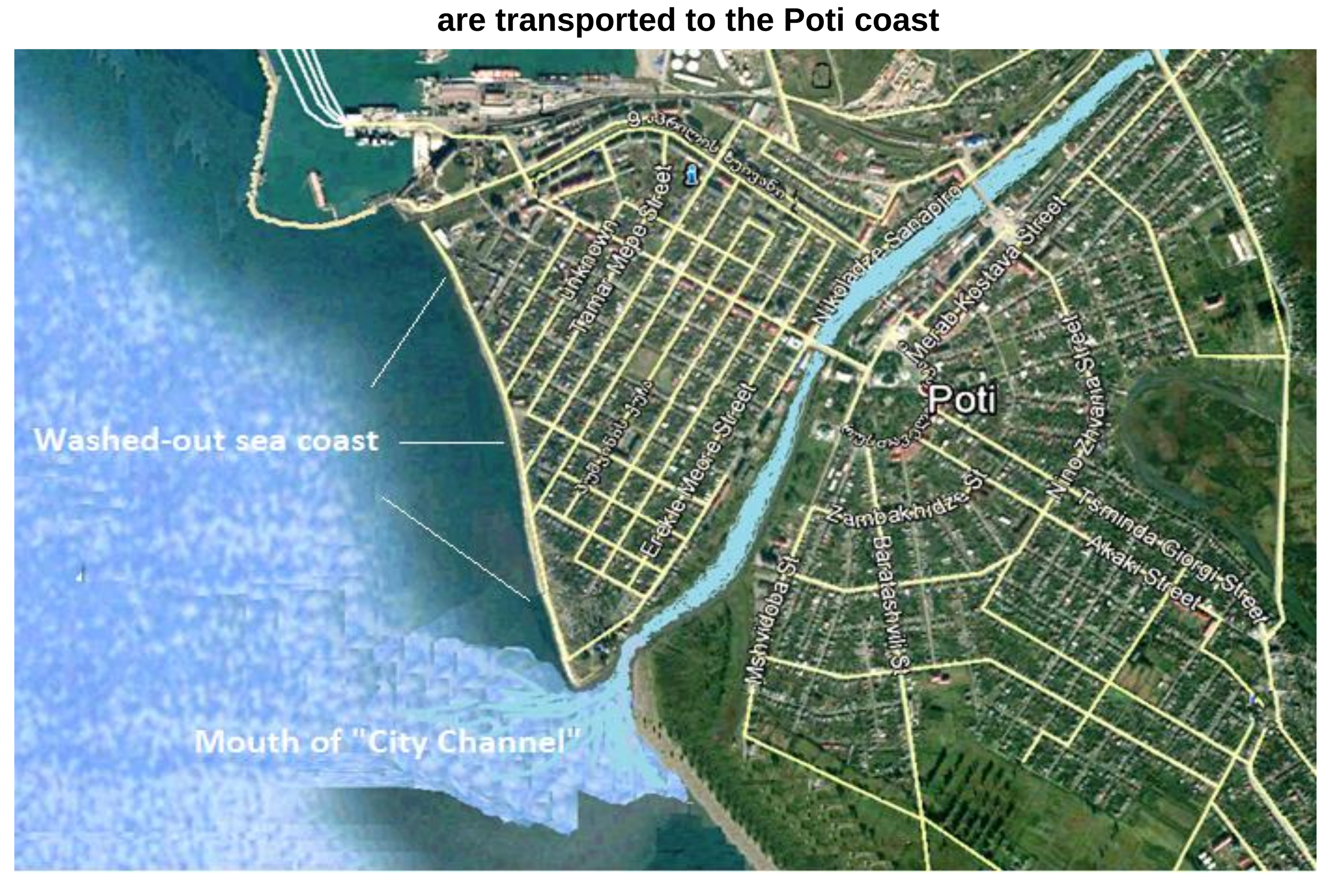

Fig. 5. Poti City Channel mouth.

The city channel width is $b_0 = 80m$; the depth is $H_0 = 4m$; a maximal discharge capacity $Q = 400m^3/sec$; the unit discharqe $q = 5m^2/sec$; the sea bottom slope $i_0 = 0.0067$; the velocity at which the motion of sediments starts is $U_{wash} = 0.8m/sec$

Justification of recommendations

In the river estuary areas, for the rough sea waves the motion velocity of water particles is calculated by Gagoshidze' s relation [1,2]

$$U = U_0(x) - a_0 \frac{\sigma}{\sqrt[4]{(k_0 H)^3}} \left(\frac{U_0}{\sqrt{gH}} \pm 1 \right) \sin\left(\sigma t - \frac{\sigma U_0}{g i_0} \pm 2\sqrt{\frac{k_0 x}{i_0}} \right), \qquad (1)$$

where $U_0(x)$ is a variable velocity of the river stationary flow; the x -axis coincides with the non-disturbed sea surface and is directed towards the open sea; a_0 and λ_0 are respectively the amplitude and the length of waves given at a large distance from the sea shore; σ is the wave oscillation frequency; $k_0 = \frac{2\pi}{\lambda_0}$ is the wave number; H is a variable water depth; i_0 is the bottom slope.

The distribution curves of maximal velocities of water particles in the estuary area of the Poti city channel are given in Fig. 6 for regular waves which arrive from the sea side and have the height $h_0 = 2m$ (amplitude $a_0 = 1m$), length $\lambda_0 = 108m$ m; (the wave number $k_0 = 0.058m^{-1}$), wave oscillation period $\tau = 8.26\,sec$ (frequency $\sigma = \frac{2\pi}{\tau} = 0.76\,sec^{-1}$).

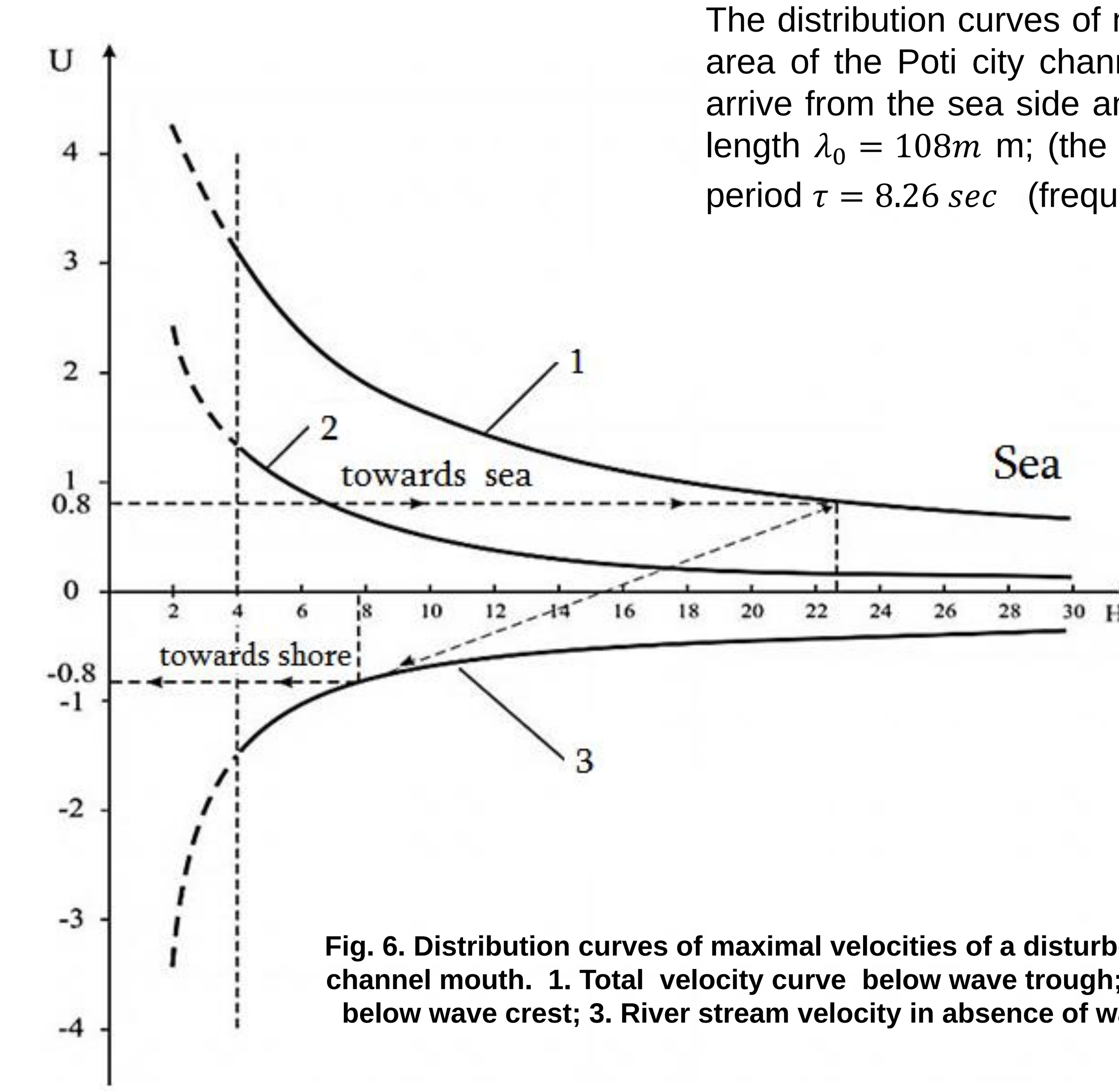

Fig. 6. Distribution curves of maximal velocities of a disturbed stream near the city channel mouth. 1. Total velocity curve below wave trough; 2. Total velocity curve below wave crest; 3. River stream velocity in absence of waves.to the Poti coast

For the above-given wave parameters, the intersection of the velocity distribution curves with the horizontal lines of non-washing-out velocities ($0.8m/sec$) takes place for the depth $H = 22m$ which is at a distance of $2.7km$ from the sea shore. However, for the calm sea the intersection is observed at $H = q/0.8 = 6.25m$ m which is much nearer the shore (about 335 m). In the latter case, the sediments will indeed promote the build-up of the sea shore.

Recommendation

As shown by our theoretical studies based on the asymptotic solution of the problem of long wave invasion in river estuaries, one of the principal reasons for persistent washouts of the coast of Poti is the absence of the operation modes of spillway gates of the city channel: they should not be opened during sea storms, that is higher than 3(H), since in that case the alluvia transported by the city channel are completely lost in the deep sea canyon located far from the coast and do not serve for the coast restoration. Therefore, in stormy weather it is necessary to close the spillway gates of the city channel. Besides, it is necessary to clean the channel bed in order to increase its transportation capacity.

Bibliography:

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