



The Black Sea present eustasy, coastal vulnerability and basic information for adaptation projects

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On the Black Sea the Global Warming provoked present eustasy - sea level rise due to water thermal expansion and shift in the continental water budget toward the sea. At some time this phenomenon activated mountain glaciers melting, storm frequency increased about 50%, and annual precipitation and river's flow rose accordingly by 11 and 12 %. The Black Sea catchments' area covered 23 countries with population of 162 million people, among which ~50% lives on the subsiding coasts and rivers deltas. The Sea represents serious interest for them as source of recreation, food and other resources, convenient and cheap means of transport and climate forming factor. The Black sea is a unique reservoir, as it has a two-layer stratification of the water column with a thin layer (~120m) of fresher and lighter water overlying denser water (with ~22L salinity) at depth. The layers are separated by strong pycnocline-Interlayer Cold Water (ICW) with a thin ~20m, at a depth of 60-80m. The temperature of ICW permanently is 6-8 0C. The vertical circulation in upper layer is originated by the sea central divergence and peripheral convergence. Divergence and convergence dynamic of the sea together with wind-drift current stipulated the system of four-cycle water circulation, marginal cycles of which covered the coastal zone and the central cycles the rest of the sea. Due to that water exchange between ICW and upper layer was intensified. As a result, the layer of water located above ICW, heats up and provokes present eustasy. Investigation of the present eustasy, particularly the kinds of vulnerability caused by them, has been fulfilled by instrumental observation data of 15 tide gauges around the sea. Duration of the sea level series is about 125-135 years. An analysis of such series has been performed by method of "Sea Level Long Series".

According to the results, present eustasy started in 1923-1925. At the beginning of 2007 its absolute increment overrides 20 cm, and relative one, which is the elevation of sea surface relative to the Land, exceeds 0,6-0,8 m in some places caused by subsiding coasts. In delta's of river's Danube and Rioni relative eustasy is the highest - about 0,8-1,0 m. After 1970-th, the eustasy has accelerated from 2,5-2,6 mm/year to 2,8-3,0 (to within $\pm 0,1$). As appears from the above, absolute eustasy at nearest future (2030-2050) will increase by 6,0-12,0cm and relative one in deltas on subsiding coasts by 0,18-0,40m. This phenomenon provoked various kinds of vulnerability, caused serious fears. The present eustasy has activated three indicators of coast' vulnerability: a. the zone of wave's erosion is moved into Land; b. underground water horizon increased; c. river' bed capacity in delta' is permanently reduced. Due to these indicators has activated storm surges and probability of river catastrophic floods is essentially increased. Consequently, present eustasy provoked many dangerous kinds of vulnerability: human victims, flooding and waterlogging of farming areas, the drop in an efficiency of infrastructure and salinization of useful areas. Various kinds of vulnerability demand the different measures of mitigation in separate parts of the region. In areas on intensively submerging coasts and river' mouths with high population density, it is necessary to organize system of early alert and emergency evacuations of the population. The major adaptation measures are also the jointing in height and strength of protective dams in accordance with forecast parameters of relative eustasy (a), risk of catastrophic flood (b), rate of land secular subsidence (c) and rivers' delta sedimentation (d) on all length of penetration of storm surges and higher tides. Dramatic events and accidents last decades specify, that adaptation projects is necessary to work out immediately, especially in coastal segments with high risk of catastrophic floods and storm surges.

Keywords: adaptation, mitigation, vulnerability, climatic indicator, eustasy, redemption project