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Natural Risk of Geochemical Transformation of the Caspian Coastal Zone due to the Rapid Sea Level Changes

Nikolay Kasimov (1), Mikhail Lychagin (1), Alexander Gennadiyev (1), Maria Kasatenkova (1), and Salomon Kroonenberg (2)

(1) Faculty of Geography, Moscow State University, Leninskie gory, 119991, Moscow, Russian Federation, e-mail: lychagin2008@gmail.com, (2) Department of Applied Earth Sciences, Delft University of Technology, Mijnbouwstraat 120, P.O. Box 5028, 2600 GA Delft, The Netherlands, e-mail: s.b.kroonenberg@citg.tudelft.nl

Global warming causes world-wide concern on the impact of sea-level rise on oceanic coasts. Predicting this impact is hampered by the slow pace of sea-level rise in the past (17 cm in the 20th century, 2.8 mm/year in the last 15 years; IPCC, 2007), and the complexity of coastal processes. The Caspian Sea, having experienced phases of sea-level rise of up to a hundred times the eustatic rate, offers accelerated real-world models of how soils behave under such conditions. These data can be used to calibrate and validate existing simulation models of the coastal zone behaviour within coastal areas of other seas. Long-term monitoring of the Caspian Sea shore zone allows revealing the changes due to the whole cycle of sea-level changes. The first part of the cycle lasted for 50 years (1929-1978) and was characterized by the retreat of the sea, lowering of the ground water table, and general decrease in the degree of hydromorphism of the territory. The second phase of the cycle (1978-1995) corresponded to the rise in the sea level and the depth of the ground water, and to increase in the degree of water-logging of the soil cover.

It is the transgressive stage of the sea-level fluctuations which determines significant geochemical transformation of the accumulative lagoon shores of the Caspian Sea. The changes are often related to the formation of the bar-lagoon system and its movement landwards. In opposite, the regressive stage is reflected in mainly passive drowning of the shore zone and relatively poor changes. The major trend of the ground water change during the sea retreat consisted in a desalinization of ground water of the higher levelled surfaces, as well as in a shift of a brackish ground water area seawards. The sea-level rise caused a reverse trend, leading to the fast salinization of the ground water at the modern terrace. The most diverse soil cover is presently characteristic for the lower surface of the present terrace partially inundated and water-logged by the lagoon. This surface shows a high variability of the soil organic matter content, Eh, pH and TDS values. Consequently, it has the most contrasting oxygen, sulfide and evaporative geochemical barriers accumulating a number of chemical elements. The leading geochemical processes caused by the sea-level rise are the salinization, organic matter accumulation and sulfidization. The latter is of a primary importance for the migration of iron and associated heavy metals (Co, Zn, Cu, Ni, Cr, Pb) in soils of the lagoon-marsh zone. The process of heavy metal accumulation in soils is typical for meadow and marsh soils and sediments of the Caspian accumulative lagoon shores. Generally it determines increase of natural risk of the coastal zone contamination with heavy metals and other pollutants.