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Changes of the Groundwater Regime as a Manifestation of Global Warming (Evidence from the Southern Bug River Basin, Ukraine)

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The global and regional climate changes are manifested; in particular, in changes in the regime of the surface water and groundwater (the first form the aquifers surface). Analysis of a regime of groundwater levels (GL) within the basin of the Southern Bug over the past decades allows identifying the certain stages and a generalized forecast of changes in their reserves.

By 1988, there is a clear 10-11 year cyclicity of the level regime of groundwater within the basin due to the cyclical nature of precipitation. After 1988, a clear regular repeatability of level regimes changes into a protracted (1989-2012) high water phase, which can be regarded as a consequence of the influence of abnormal climatic factors. The cycle of the high GLs, which has begun after 1989, is well correlated with the first transition of the average monthly temperatures in February to positive values recorded in the same year. As a result, the thaw drainage contributed to the increase in the moisture content of the upper layer of soil and increase in the infiltration alimentation of groundwater. There was a significant increase in the average annual GL in the Southern Bug basin from 1989 to 2012. Without frozen layer, air penetration into the soil leads to a counterbalance of atmospheric and suction pressures in the unsaturated zone and a more rapid decrease in the GL after the melting of snow. The increase in the river dry weather flows, especially in winter, led to an increase in the average annual rate of discharge until 2007-2012 even in the river basins where there was a decrease in spring runoff.

Along with the accelerated operation of groundwater reserves in the winter and the subsequent rise in the temperature of the warm period, these processes created the preconditions for the transition to the next period - a decrease in GL. After 2010, the amount of precipitation in the warm period of the year decreased significantly. Under conditions of continuous rise of average annual temperatures and increase in the duration of hot, rainless periods with increasing volumes of evaporation the shortening of groundwater supply and reduction of their levels occurs. After 2012, these effects manifested most notably.

Conclusions: In the last decades, changes of the groundwater regime within the Southern Bug basin are determined by two phases associated with global climate changes. The first phase (1989-2012) was characterized by a significant increase in groundwater levels and water content of the river basins against the backdrop of an annual amount of precipitation. During the second phase (from 2013), there is a decrease in the levels and groundwater reserves, as well as a decrease in the river runoffs with a slight decrease in the amount of precipitation. Maintaining this trend will lead to a gradual decrease in the groundwater reserves. This may cause drying out of the small rivers with a slight erosion basis and predominantly ground-based feeding during the summertime.