Geophysical Research Abstracts
Vol. 14, EGU2012-460, 2012
EGU General Assembly 2012

Dramatic water-level fluctuations in lakes under intense human impact: modelling the effect of vegetation, climate and hydrogeology

M. Vainu
Tallinn University, Institute of Mathematics and Natural Sciences, Estonia (markovainu@hotmail.com)

Lakes form a highly important ecosystem in the glacial terrain of northern Europe and America, but their hydrology remains understudied. When the water-level of a lake drops significantly and rises again in a time span of half a century and the widespread explanation of the fluctuations seems insufficient, then it raises a question: how do different anthropogenic and natural processes actually affect the formation of a lakes' water body.
The abovementioned scenario applies to three small closed-basin Estonian lakes (L. Ahnejärv, L. Kuradijärv and L. Martiska) analysed in the current study. These lakes suffered a major water-level drop (up to 3.8 m) between 1946 and 1987 and a major rise between 1987 and 2010, from 1 m (L. Ahnejärv) to 2.5 m (L. Kuradijärv). Decreasing and increasing groundwater abstraction near the lakes has been widely considered to be the only reason for the fluctuations. It is true that the most severe drop in the lake levels did occur after 1972 when groundwater abstraction for drinking water started in the vicinity of the lakes. However, the lake levels started to fall before the groundwater abstraction began and for the time being the lake levels have risen to a higher level than in the 1970s when the quantity of annually abstracted groundwater was similar to nowadays. Therefore the processes affecting the formation of the lakes' water body prove to be more complex than purely the hydrogeological change caused by groundwater abstraction. A new deterministic water balance model (where the evaporation from the lake surface was calculated by Penman equation and the catchment runoff by Thornthwaite-Mather soil-moisture model), compiled for the study, coupled with LiDAR-based GIS-modelling of the catchments was used to identify the different factors influencing the lakes' water level.
The modelling results reveal that the moderate drop in lake water levels before the beginning of groundwater abstraction was probably caused by the growth of a coniferous forest on the lake catchments, due to which evapotranspiration and subsequently runoff from the catchment decreased. The forest had been destroyed by wildfires during World War II.
The water-level rise that the lakes have gone through in the last 20 years has in the case of L. Ahnejärv been caused by changing meteorological conditions (precipitation, air temperature and wind speed). In the case of Lakes Kuradijärv and Martiska the change has been caused by both the raise of groundwater level (caused by the decreasing groundwater abstraction) and the change of meteorological conditions.
Therefore the vegetation change on the catchment and changes in meteorological conditions have played as important or, at times, even more important role in the water-level fluctuations than changes in the hydrogeological conditions.
Although concentrating on three specific lakes in a specific region, the result of the study indicate the complexity of factors influencing the amount of water stored in a lake at a certain moment. Therefore it manifests a need for improved models in order to improve lake management around the world.