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How do groundwater-dependent lakes react if the aquifer they rely on is being pumped?

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Groundwater is a valuable source of drinking water, but at the same time it is the primary contributor to the existence of many surface water bodies. If the latter truth is overlooked in water resources management, and ground- and surface water are not considered as a single resource, then the sustainability of groundwater-dependent ecosystems will become under threat. The necessity for implementing an integrated management of ground- and surface water has also been stressed in the EU Water Framework Directive.
This study aims to evaluate the effect of increased groundwater abstraction to groundwater and lake levels; and to evaluate the effect of increased groundwater abstraction to the seepage patterns in one example lake.
The Kurtna Lake District in northeastern Estonia contains almost 40 small lakes which are situated in and around the Kurtna Kame Field and constitute an EU Special Area of Conservation. The sands that form the kame field contain a Quaternary groundwater aquifer. Water has been pumped from the aquifer for household use with varying rates since the 1970s, but starting from the summer of 2012 the average pumping rate was increased by 51% compared to the year before.
During the current study the water levels of five lakes were monitored regularly from May 2012 to June 2013 – before and after the increase in the pumping rate. The water levels dropped 0.3 to 0.7 m during the year in three closed-basin lakes closest to the abstraction wells, but did not change neither in a flow-through lake nor in a closed-basin lake situated 1.6 km from the wells. Groundwater level in the aquifer (monitored by the Estonian Geological Survey) dropped up to 0.8 m near the abstraction wells in the course of the year, but did not change further from the wells. The estimates of average annual groundwater recharge were derived for the twelve months before both June 2012 and June 2013. Although the recharge rate was lower in the first year, the water-level drop was nevertheless caused by the higher pumping rate, because the effects of lower recharge would have affected the whole aquifer, not just a part of it. At the beginning of June 2012 and June 2013 also lake-bed seepage was directly measured in the bottom of one of the lakes (Lake Martiska). Seepage measurements in the first year showed that outseepage from L. Martiska occurred in the northern part of the lake, which is situated closest to the abstraction wells. For the second year the area of outseepage had widened towards the western shore of the lake. Therefore the increased abstraction rate had initiated the shrinking of these lakes near the abstraction wells that were hydraulically connected to the aquifer.
The results of the rare opportunity to analyse lake-groundwater interactions both before and after increased human intervention provide a cautionary example of what may happen to and in groundwater-dependent lakes if the surface water-groundwater interactions are not fully clarified before the intervention.