Geophysical Research Abstracts
Vol. 14, EGU2012-4671, 2012
EGU General Assembly 2012

Groundwater Flooding: Practical Methods for the Estimation of Extreme Groundwater Levels

A. Bichler (1,2) and J. Fürst (1)

(1) Institute of Water Management, Hydrology and Hydraulic Engineering, University of Natural Resources and Life Sciences, Vienna, Austria (josef.fuerst@boku.ac.at), (2) Department of Environmental Geosciences, University of Vienna, Austria (andrea.bichler@univie.ac.at)

Floods are in general recognized as a consequence of high flows in surface waters. Only recently awareness has been raised for potential flooding and flood risk from groundwater sources. In particular, information about high groundwater levels is relevant where basements of buildings or vulnerable installations might be affected. Also, the EU Floods Directive addresses the potential flood risk arising from groundwater sources. While the statistical analysis of extreme values is widely used in surface hydrology, there are currently only few studies that consider the specific properties of extreme groundwater levels.

The main objective of this investigation is the application of at-site and regional frequency analysis in the field of hydrogeology. Extreme groundwater levels with a given return period (e.g. 100 years) are estimated with the method of L-moments and their uncertainty is quantified. Moreover, software tools are developed in order to make extreme value analysis a feasible technique for practical application by the Austrian Hydrological Service. These tools address demand for user-friendly handling as well as integration and an update of existing and readily derivable data. Lastly, the estimates are regionalized, thus information of extreme groundwater levels and accuracy of estimation can be retrieved at any point of the investigation area.

The analysis is applied in four shallow, porous aquifers in Austria, with a total of more than 1000 time series records of groundwater levels, covering 10 – 50 years of observation. Firstly, local frequency analysis (LFA) is performed on a series of annual maximum peaks. The analysis of annual maxima allows for easy handling, but comes with the drawback of requiring 20-30 years of observation as minimum sample size. Due to anthropogenic impacts, natural changes of the hydrologic system, etc. this requirement cannot be met in numerous cases. Hence, the peaks over threshold (POT) approach and regional frequency analysis (RFA) is implemented. Thus, sufficiently large sample size can be derived from shorter time series either by selecting exceedances over a variable threshold (POT), or accounting for data from related observations (RFA, “trading space for time”).

The results show, that at-site frequency analysis is applicable at 63% of the records, at which the peaks over threshold method yields more accurate estimates compared to the annual maxima. Regional frequency analysis can be applied at 51% of the samples and results in even further reduction of uncertainty. In the four case studies 12 – 45 % of the investigated area is susceptible to groundwater flood risk, i.e. an event with a return period of 100 years is likely to reach the terrain surface. As one of the outcomes, maps of depth to the groundwater table make it possible to identify areas prone to groundwater flooding or suitable for development at a glance.