Geophysical Research Abstracts
Vol. 17, EGU2015-5718, 2015
EGU General Assembly 2015

The role of the uncertainty in assessing future scenarios of water shortage in alluvial aquifers

Emanuele Romano (1), Stefania Camici (2), Luca Brocca (2), Tommaso Moramarco (2), Nicolas Guyennon (1), and Elisabetta Preziosi (1)

(1) National Research Council, Water Research Institute, Rome, Italy (romano@irsa.cnr.it), (2) National Research Council, Research Institute for Geo-Hydrological Protection, Perugia, Italy

There are many evidences that the combined effects of variations in precipitation and temperature due to climate change can result in a significant change of the recharge to groundwater at different time scales. A possible reduction of effective infiltration can result in a significant decrease, temporary or permanent, of the availability of the resource and, consequently, the sustainable pumping rate should be reassessed. In addition to this, one should also consider the so called indirect impacts of climate change, resulting from human intervention (e.g. augmentation of abstractions) which are feared to be even more important than the direct ones in the medium term: thus, a possible increase of episodes of shortage (i.e. the inability of the groundwater system to completely supply the water demand) can result both from change in the climate forcing and change in the demand.

In order to assess future scenarios of water shortage a modelling chain is often used. It includes: 1) the use of General Circulation Models to estimate changes in temperature and precipitation; 2) downscaling procedures to match modeling scenarios to the observed meteorological time series; 3) soil-atmosphere modelling to estimate the time variation of the recharge to the aquifer; 4) groundwater flow models to simulate the water budget and piezometric head evolution; 5) future scenarios of groundwater quantitative status that include scenarios of demand variation. It is well known that each of these processing steps is affected by an intrinsic uncertainty that propagates through the whole chain leading to a final uncertainty on the piezometric head scenarios. The estimate of such an uncertainty is a key point for a correct management of groundwater resources, in case of water shortage due to prolonged droughts as well as for planning purposes.

This study analyzes the uncertainty of the processing chain from GCM scenarios to its impact on an alluvial aquifer in terms of exploitation sustainability. To this goal, three GCMs (ECHAM5, PCM and CCSM3) and two downscaling methods (Linear Rescaling and Quantile Mapping) are used to generate future scenarios of precipitation and temperature; the Thornthwaite-Mather soil water balance model is used to estimate the recharge to the aquifer; the evolution in time of the piezometric heads is estimated through a numerical model developed using the MODFLOW2005 code. Finally, different scenarios of water demand are applied.

Final results show that the uncertainty due to the groundwater flow model calibration/validation in steady-state conditions is comparable to that arising from the whole processing chain from the GCM choice to the effective infiltration estimates. Simulations in transient conditions show the high impact of the uncertainty related to the calibration of the storage coefficient, that significantly drives the resilience of the system, thus the ability of the aquifer to sustain the demand during the periods of prolonged drought.