Geophysical Research Abstracts
Vol. 15, EGU2013-5212, 2013
EGU General Assembly 2013

Climate impact on groundwater systems: the past is the key to the future

Martine van der Ploeg (1), Dioni Cendón (2), Sylvi Haldorsen (3), Jinyao Chen (4), Jason Gurdak (5), Ofelia Tujchneider (6), Rein Vaikmäe (7), Roland Purtschert (8), and Najiba Chkir Ben Jemâa (9)

(1) Wageningen University, Environmental Sciences, Soil Physics and Land Management, the Netherlands (martine.vanderploeg@wur.nl), (2) Australian Nuclear Science and Technology Organization (ANSTO), Australia, (3) Norwegian University of Life Sciences, Department of Plants and Environmental Sciences, Norway, (4) Sun Yatsen University, Department of Water Resources and Environment, School of Geography and Planning, China, (5) San Francisco State University, Department of Geosciences, USA, (6) National University El Litoral, Faculty of Engineering and Water Sciences, Argentina, (7) Tallinn University of Technology, Institute of Geology, Estonia, (8) University of Bern, Physics Institute, Switzerland, (9) Sfax University, Fac des Lettres et Sciences Humaines de Sfax, Tunesia

Groundwater is a significant part of the global hydrological cycle and supplies fresh drinking water to almost half of the world's population. While groundwater supplies are buffered against short-term effects of climate variability, they can be impacted over longer time scales through changes in precipitation, ,evaporation, recharge rate, melting of glaciers or permafrost, vegetation, and land-use. Moreover, uncontrolled groundwater extraction has and will lead to irreversible depletion of fresh water resources in many areas. The impact of climate variability and groundwater extraction on the resilience of groundwater systems is still not fully understood (Green et al. 2011).

Groundwater stores environmental and climatic information acquired during the recharge process, which integrates different signals, like recharge temperature, origin of precipitation, and dissolved constituents. This information can be used to estimate palaeo recharge temperatures, palaeo atmospheric dynamics and residence time of groundwater within the aquifer (Stute et al. 1995, Clark and Fritz 1997, Collon et al. 2000, Edmunds et al. 2003, Cartwright et al. 2007, Kreuzer et al. 2009, Currell et al. 2010, Raidla et al. 2012, Salem et al. 2012). The climatic signals incorporated by groundwater during recharge have the potential to provide a regionally integrated proxy of climatic variations at the time of recharge. Groundwater palaeoclimate information is affected by diffusion-dispersion processes (Davison and Airey, 1982) and/or water-rock interaction (Clark and Fritz, 1997), making palaeoclimate information deduced from groundwater inherently a low resolution record. While the signal resolution can be limited, recharge follows major climatic events, and more importantly, shows how those aquifers and their associated recharge varies under climatic forcing.
While the characterization of groundwater resources, surface-groundwater interactions and their link to the global water cycle are an important focus, little attention has been given to groundwater as a potential record of past climate variations. A groundwater system's history is vital to forecast its vulnerability under future and potentially adverse climatic changes. By processing groundwater information from vast regions and different continents, recharge and palaeoclimate can be correlated at a global scale. To successfully evaluate the sustainability of groundwater resources, "the past is the key to the future".

To address the identified lack of palaeoclimatic data available from groundwater studies, a global collaboration has been set-up in 2011 called Groundwater@Global Palaeoclimate Signals (www.gw-gps.com), and has already more than 70 participants from 5 continents. Since 2012 G@GPS receives seed funding to support meetings by the International Geoscience Programme, the International Union for Quaternary Research and UNESCO-GRAPHIC International Hydrologic Project. This collaboration targets groundwater basins on five continents —Africa, America, Asia, Australia, Europe — containing vast groundwater resources with an estimated dependence of tens of millions of people. We will present G@GPS, show examples from groundwater basins, and discuss possibilities to integrate groundwater information from these basins.

References

Cartwright, I. et al. 2007. Consraining modern and historical recharge from bore hydrographs, 3H, 14C, and chloride concentrations: Applications to dual-porosity aquifers in dryland salinity areas, Murray Basin, Australia. J. Hydrol. 332: 69-92.
Clark, I. and P. Fritz. 1997. Environmental isotopes in hydrogeology, Lewis Publishers.

Collon, P. et al. 2000. 81Kr in the Great Artesian Basin, Australia: a new method for dating very old groundwater. Earth and Planetary Science Letters 182: 103-113.
Currell, M. J. et al. 2010. Recharge history and controls on groundwater quality in the Yuncheng Basin, north China, J. Hydrol. 385: 216-229.
Davison, M. R. and P. L. Airey. 1982. The effect of dispersion on the establishment of a paleoclimatic record from groundwater. J. Hydrol. 58: 131-147.
Edmunds, W. M. et al. 2003. Groundwater evolution in the Continental Intercalaire aquifer of southern Algeria and Tunisia: trace element and isotopic indicators, Applied Geochemistry 18: 805-822.
Green, T.R. et al. 2011. Beneath the surface of global change: Impacts of climate change on groundwater. J. Hydrol 405: 532-560.
Kreuzer, A. M. et al. 2009. A record of temperature and monsoon intensity over the past 40 kyr from groundwater in the North China Plain, Chemical Geology 259: 168-180.
Raidla, V., Kirsimäe, K., Vaikmäe, R., Kaup, E., and Martma, T., 2012, Carbon isotope systematics of the Cambrian–Vendian aquifer system in the northern Baltic Basin: Implications to the age and evolution of groundwater: Applied Geochemistry, v. 27(10), p. 2042-2052.
Salem, S.B.H., Chkir, N., Zouari, K., Cognard-Plancq , A. L., Valles, V, and Marc, V., 2012, Natural and artificial recharge investigation in the Ze′roud Basin,Central Tunisia: impact of Sidi Saad Dam storage. Environmental Earth Sciences, v., 66, p. 1099–1110.
Stute M., Forster M., Frischkorn H., Serejo A., Clark J. F., Schlosser P., Broecker W. S., and Bonani G. (1995) Cooling of tropical Brazil (5 °C) during the Last Glacial Maximum. Science 269, 379-383.