Climate change: a challenge for future generations. Research and perspectives from early career hydrogeologists

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Abstract

The Topical Collection: Climate change research by early career hydrogeologists, was jointly developed by ECHN-IAH and UNESCO-GRAPHIC to foster the engagement of the new generation of hydrogeologists and groundwater scientists in the debate over groundwater and climate change. The contributions from early-career hydrogeologists to this topical collection include field datasets gathered over the past decades, advanced data analysis and numerical modeling.

Introduction

Climate change is likely to have a major role in the future careers of the next generation of hydrogeologists. Today's early career hydrogeologists are likely to be increasingly engaged in current planning activities and decisions that take place at the political and governance levels for mitigation and adaptation, but they will also be the ones experiencing the full effects of climate change in future years. This is why it is of paramount importance to engage with researchers from the earliest stage of their careers, promoting long-term strategies to cope with climate change issues.

To this end, the Early Career Hydrogeologists' Network (ECHN) of the International Association of Hydrogeologists (IAH) with the collaboration of the UNESCO International Hydrological Programme (IHP) scientific network on groundwater and climate change (Groundwater Resources Assessment under the Pressures of Humanity and Climate Change; GRAPHIC) promoted this Topical Collection on climate change research by early career hydrogeologists to showcase the valuable research carried out by early career researchers (i.e. researchers within 10 years after graduation and with a degree in hydrogeology or a related discipline) and young scholars in earth and environmental sciences. ECHN-IAH aims at supporting all hydrogeologists at the start of their professional careers irrespective of their age, by strengthening their involvement in international debate over groundwater assessment and protection. Moreover, ECHN-IAH is actively engaged in preserving hydrogeological competence and experience via productive exchanges between junior and senior hydrogeologists. GRAPHIC operates in the framework of the UNESCO-IHP, the intergovernmental program of the UN system devoted to water research, management, education and capacity building. GRAPHIC is an international network of scientists that promotes and advances sustainable groundwater management considering projected climate change and linked human effects. GRAPHIC provides an international platform for the exchange of information on groundwater and climate change through case studies, thematic working groups, scientific research, and communication. It serves the global community and Member States by providing scientifically based and policy-relevant recommendations. In addition, it closely works in collaboration with the IAH Commission on Groundwater and Climate Change (IAH-CGCC) to improve the understanding of the relationships among groundwater, human development, and climate change.

Climate change influences groundwater systems both directly, affecting in particular aquifer recharge, and indirectly, through changes in groundwater use, often associated with land-use changes (Green et al., 2011). In many regions, future impacts of climate change on groundwater resources will exacerbate existing stress, scarcity, quality, and security issues (Treidel et al., 2012). For example, increase in drought frequency may result in an increase in groundwater abstraction, especially to sustain agricultural production (Taylor et al., 2013). On the other hand, groundwater is the main perennial source of freshwater in many regions, especially the arid and semi-arid ones (Re and Zuppi, 2011), and thus can improve the resilience in coping with climate variability and change and could be fundamental in sustaining drinking water needs under changing climate.

Nevertheless, both the impacts of climate changes on groundwater resources and the potential role of groundwater to mitigate and adapt to the effects of climate changes require continued research by early career hydrogeologists and engagement with local resource managers. Even though the discussion of climate change has dominated some international scientific and political agendas, the international hydrogeologists' community must still advocate that groundwater receives the attention it deserves within the debate on water resources management priorities and climate change adaptation (Gurdak et al., 2015). For example, in the last IPCC report (IPCC, 2013), groundwater is barely mentioned in the context of groundwater mining and groundwater depletion, while in the report summary report for policy makers groundwater is not mentioned. In addition, although the formal negotiations under the United Nations Framework Convention on Climate Change (UNFCCC) did not include water as a leading subject, the Paris Agreement has created a momentum for water issues (Paris Pact on Water and Adaptation, 2015). The UNFCCC synthesis report (United Nations, 2016) on 161 Intended Nationally Determined Contributions (INDCs) shows that the three priority sectors are water (mentioned by around 75% of INDCs), agriculture (mentioned by around 65% of INDCs) and health (mentioned by around 55% of INDCs). However, only approximately 15% of countries have explicitly mentioned groundwater as a means of adaptation to climate change.

As a result, groundwater is marginally accounted for in climate models and policies, resulting in a poor assessment of the impacts of climate changes on aquifer reservoirs and in a limited understanding of the groundwater resource resilience to climate changes (Foster and MacDonald, 2014). Indeed, groundwater must be protected and carefully managed for both the health of natural ecosystems and the wellbeing of future generations. Awareness should also be raised in all relevant stakeholders (including the general public and water end-users) on the connections between climate change and global groundwater resources. Indeed, the future generation of hydrogeologists should be actively engaged in education and dissemination activities targeted to bridging the gap between science and society (e.g. via socio-hydrogeology; Re, 2015), and raising awareness on the impact of climate changes on global groundwater resources. Therefore, this Topical Collection on climate change research by early career hydrogeologists was launched with the overall goal of encouraging the discussion among Early Career Hydrogeologists on this issue that will likely dominate their career.

The Topical Collection: Climate-change research by early-career hydrogeologists

The contributions from early-career hydrogeologists to this topical collection on climate change include field datasets gathered over the past decades, advanced data analysis and numerical modeling. Garamhegyi et al. investigate the relationship between the behavior of shallow groundwater levels and climate indices derived from atmospheric pressure which could be used to adjust crop species cultivated in a Central-Eastern European. Scheihing et al. analyze chronicles of groundwater level and air temperature to discuss the effect of groundwater depletion on the local climate in the arid northern Chile. Switzman et al. assess the impact of water conservation strategies on groundwater resources in the Northern Egypt based on numerical modeling. These three papers showcase some of the work produced by early career hydrogeologists on climate change and groundwater.

The authors

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Konstantin W. Scheihing holds a Master of Science in Applied Geosciences and will graduate in 2017 as a Doctor of Engineering in Hydrogeology from the Technical University of Berlin (Germany). As a stipendiary of the National Commission for Scientific and Technological Research of Chile (CONICYT) and the German Academic Exchange Service (DAAD), his current research focuses on the functional understanding of groundwater systems in the arid environment of the Atacama Desert of northern Chile. He holds expertise in the fields of isotope hydrology, geophysics, geographical information systems and environmental statistics. Prior to his doctorate he gained experiences as a lecturer in hydrogeology at the Technical University of Berlin and in environmental consulting. Investigating water resources in their integrated nexus for assuring their sustainable management is what drives him as a hydrogeologist.

Harris Switzman is an environmental scientist with technical and policy expertise in the areas of hydrogeology, watershed hydrology and resiliency-based management. He holds a master's degree in water resource engineering (McMaster University), a graduate diploma in water, environment and health (United Nations University – Institute for Water, Environment and Health), and a bachelor's of science in earth and environmental science (McMaster University). Harris' work focuses on characterizing the effects of climate change and land development on watersheds, estimating water supply and demand, and managing community risks associated hydroclimatic hazards, such as floods and drought. He has worked on projects at the national-scale across Canada, throughout the Laurentian Great Lakes, in Egypt, Uganda, and on a local scale in Alberta and Ontario. Harris is currently working with WaterSMART Solutions and prior to this he was a project manager with the Toronto and Region Conservation Authority, responsible for a portfolio of projects focused on building community and watershed resilience to climate change and hydroclimatic risks.

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