

Groundwater: From Research Challenges to Solutions

Open Space Workshop, 8th Water Research Horizon Conference, 19-20 Sep 2017, Hamburg

Outcome and future perspectives for groundwater research: Importance of integrated research approaches on groundwater resources and their relation between natural and engineering sciences, social and economic aspects for sustainable development

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This position paper summarizes the outcome of the [Open Space Workshop "Groundwater: From Research Challenges to Solutions"](#) that took place during the [8th Water Research Horizon Conference](#), 19-20 Sep 2017 in Hamburg, Germany organized by the [Water Science Alliance e.V.](#) Based on three input presentations participants discussed global, regional groundwater knowledge gaps, and according research needs concerning resource status, exploration, exploitation, utilization, management and governance of groundwater.

In the debate about suitable adaptation measures to increase resilience among others to impacts of climate change, groundwater resources are often seen as part of the solutions; either to overcome short-term, seasonal or multi-year droughts, as an intermediate buffer for water scarcities or just to "buy time" until other solutions become available. Often groundwater can offer sufficient quantities of clean and safe water for drinking water, domestic uses, agriculture and other industries. Subsurface space can also provide solutions for enhanced storage of groundwater through managed recharge.

To provide a solid science-based management system for groundwater, some basic knowledge requirements exist. These are related to the three dimensional nature of groundwater in the subsurface, time-dependent changes in quantities and qualities, questions about its "safe yield" or renewability through recharge and its interaction with the rock formations in which it is stored and flowing. Further challenges arise from the often uncontrolled -or controllable only under prohibitive high transaction costs- exploitation and utilization of groundwater. Groundwater can be classified as a common pool resource with high rivalry in consumption and low excludability of the resource users. These characteristics require adequate governance, complex stakeholder participation processes and decision making to ensure long-term sustainable development and utilization of these hidden assets.

Input presentations:

Dr. Karen Villholth³: *International Groundwater Challenges, Collaboration and Solutions*

Prof. Dr. Thomas Himmelsbach²: *Groundwater Resources in Southern Africa: From Occasional Findings Towards an Exploration Strategy*

Dr. Catalin Stefan⁴: *Can We Repair Damaged Hydrological Cycles to Ensure Longer-term Sustainable Development? Managed Aquifer Recharge: Solution for Sustainable Management of Water Resources*

The Open Space Workshop developed an understanding of knowledge gaps and research challenges related to groundwater globally, shared information about solutions that have been developed to counteract depletion and contamination and discussed possible contributions from and cooperation between research partners internationally and within the German water research community.

In the subsequent discussion, participants developed responses to three questions:

1. What are (research) challenges and knowledge gaps for better groundwater governance and management related to sustainable development and climate change from a global perspective?

- Role of groundwater at global level: Groundwater embedded in international trade products, esp. agricultural products, i.e. "embedded groundwater depletion", "virtual groundwater", "land / groundwater grabbing",
- Linkages between groundwater and climate (change): Better understanding of groundwater renewability, surface and groundwater interlinkages, environmental flow requirements,

- Long-term storage and resource availability of larger groundwater basins / reservoirs: Large intra-continental basins especially in Africa comprise still unveiled fossil or semi-fossil aquifers. Such deeper freshwater aquifers may represent strategic resources for fast growing populations and can contribute to climate change adaptation, but understanding of such resources in many areas is still limited,
- Need for better understanding of groundwater resources and their limits in space and time. Role and potential of suitable regulatory frameworks to build on and systematize this knowledge of the resource,
- Hydrogeochemical characterization of subsurface environments connected to hydraulic changes,
- Improving groundwater monitoring networks for basic data collection; development of smart monitoring / metering, incorporating technical innovations such as "smart pumps",
- Developing approaches to disentangle between different effects in complex hydrogeological settings (e.g. in urban areas),
- Better investigation of linkages between groundwater, energy and food,
- Quality of groundwater at risk from inadequate sanitation, non-point source pollution from agriculture, arsenic and other substances,
- Governance of groundwater: Need to link top-down and bottom-up approaches,
- Conceptual classification of groundwater as a common pool resource and corresponding challenges related to property regimes,
- Increasing understanding of linkages between groundwater use and land tenure, rights to the use of land and (ground-) water, lack of research on "societal behavior" in relation to stressed or closed groundwater basins and non-renewable groundwater,
- Exploring options for technological innovations as drivers for changes in management and societal perception of groundwater use,
- Value of groundwater for different purposes, including for ecosystem service functions,
- Transboundary aquifers: Improving the knowledge base of transboundary aquifers as basis for effective cooperation among riparians and aquifer states; exploring the role of benefit-sharing approaches for cooperation,
- Challenge of "how to best transfer" scientific understanding and new knowledge about groundwater as hidden resource to general public and decision makers.

2. What contributions are needed from the research community internationally?

What contributions can be offered from the German water sciences?

- Expanding networking and sharing at the international level, bridging existing knowledge gaps through global (research) initiatives,
- Groundwater - energy nexus: Optimizing energy use, increasing energy efficiency of groundwater abstractions and use,
- Groundwater valuation, economic scenarios based on hydrogeological concept or models,
- Interdisciplinary aspects and approaches to address the multi-dimensional challenges of groundwater management,
- Soil and groundwater quality assessment and management, also related to mining, fracking, sanitation, and salinization,
- Investing into integrated research and exploration strategies -comparable to oil and gas industry- for tectonic and sedimentary evolution, paleo-climate and hydrogeological conditions of deeper aquifer basins,
- Predictions on the possible role, outreach and impacts of groundwater irrigation in Germany,
- Developing and improving existing tools (free, web-based), case profiles, maps and frameworks for groundwater management; capacity development for groundwater management,
- Applying modern big data approaches to large data sets that are available today,
- Transboundary cooperation on groundwater assessments and joint management, moderating benefit-sharing approaches,
- Transferring experiences and scientific knowledge of various property regimes from other natural resources to the specificities of groundwater systems,
- Provide theoretical and conceptual knowledge suitable for interdisciplinary socio-ecological-technological research and communication.

German water sciences may also offer successful and transferable approaches in linking innovative technology development with practical research outcomes and adapted, suitable policy development.

3. What are enabling conditions to allow researchers to collaborate and develop the solutions needed for better groundwater governance and management in the future?

- Groundwater needs to be anchored higher on the global sustainable development agenda, e.g. through more visibility at international forums, such as e.g. UN-WATER, HLPW, WWF, etc.,
- Close and long-term cooperation with national and sub-national authorities and local stakeholders,
- Open discussions on groundwater governance,
- Success stories and groundwater best practices need to be shared openly and effectively,
- Close cooperation with national and international donors of research and development for the water sector,
- Looking for more cooperative research opportunities and linkages with the private sector,
- Harmonization of interdisciplinary research by focusing on interfaces.

The participants hope that the outcome of this Open Space Workshop may contribute to the debate about the future focus of water and groundwater research in Germany and internationally. This position paper is offered to the conference organizers for integration into the overall outcome document of the 8th Water Research Horizon Conference. It may also contribute to the discussions in the newly established Water Research Perspectives Commission (WRPC) in Germany as well as other water, research and development forums in Germany and abroad, e.g. GRIPP, a global network, which focusses on interdisciplinary, solution-oriented and stakeholder-engaged groundwater research for development.

¹ The content of this position paper summarizes the discussions of the Open Space Workshop. It does not necessarily represent the opinion of the individual contributors or their respective institutions.

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