summit co-coordinated by

7-8 December 2022

UN Paris HQ

Innovation

Innovations in Groundwater Technology, Communication, Education and Management

As a part of the United Nations Secretary-General's Decade of Action to deliver the Sustainable Development Goals (SDGs) by 2030, the SDG 6 Global Acceleration Framework provides governments with guidance to achieve it, though progress is slow . This Framework is intended to deliver accelerated results that mobilize UN agencies, governments, civil society, private sector, and other stakeholders around five cross-cutting and interdependent "accelerators". They include Innovation, i.e., new, smart practices and technologies that will improve water and sanitation resources management and service delivery. The scope of the Innovation accelerator is presented in this session of the Groundwater Summit.

Innovations can be both technical and non-technical, based on scientific research and certainly beyond the research into implementation phase; successful innovation is something that can be effectively translated into operational management and delivers improved groundwater governance outcomes. Innovation implies actions and priorities relevant to the local context (e.g., 'low technology' in one context can be an innovation in another region). Although aquifers occur in a regional to international dimension, often groundwater is used at the household level, giving groundwater resources a more local and personal dimension. Optimization of groundwater use and ensuring its quality is then, not only a question of applying the latest advances in technology, but involves ensuring equity and the active engagement of the community.

During the Innovation Session, an overview of currently available and accessible advancements related to groundwater will be presented, followed by a panel discussion where some specific innovations will be highlighted by international experts. General areas of innovation in groundwater resources include: 1. Technological innovation and discoveries, 2. Conceptual advancement such as improvements in problem solving, policy actions, and regulatory controls, 3. Upgrading educational approaches for students, professionals, young people, and society, and 4. Communication and social innovation.

Technological innovation: tools for solving practical problems in applied hydrogeology (field activities and monitoring)

Groundwater has benefited hugely from technological innovations over the past decades, with innovations in monitoring, surveying, drilling, pumping, distribution, and treatment. Properly applied many of them could accelerate the achievement of the SDG 6 targets. Examples include **targets 6.3** (*By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally)* and **6.4** *(By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity).*

The field of innovation is rapidly growing and benefits from increased international collaboration, interdisciplinary research, digital solutions, and involvement of end-users. The latter is crucial to ensure that innovations can be applied to a variety of socio-economic and cultural backgrounds.

A small sample of the current technological innovations of interest is discussed below.

- **Remote sensing techniques**, drones or satellite have proven to be useful to obtain spatial and temporal water distribution data, crucial for assessing groundwater availability and storage potential. Perhaps the best recent example is the GRACE satellites (Gravity Recovery and Climate Experiment), which have revolutionised our ability to identify decadal changes in groundwater storage.
- **Innovative *in situ* geophysics technology** to measure temporal changes in groundwater and the unsaturated zone is helping to identify recharge events, provide an early warning of contaminant plume migration, or land subsidence. The more widespread use and validation of magnetic resonance techniques is enabling aquifer parameters to be estimated indirectly.
- **Monitoring using novel loggers**. The widespread adoption of pressure transducers linked to telemetry over the past decade has given managers groundwater data at their fingertips, enabling near real time groundwater data to be delivered online. Technologies such as fiber optic water temperature loggers have helped understand heat flow, and the emerging technologies of quantum gravity sensors offer a whole new potential for monitoring groundwater storage changes at a field and catchment scale.
- **Smart Handpumps**. The Smart Handpumps project is an innovative solution that reduces the time required for fixing a broken pump, which would otherwise take long time to be repaired (leaving the local communities short of water). Converting a classical handpump into 'Smart' one, involves the installation of an accelerometer and transmitter into the handles, and machine learning mathematics to then notify mechanics of emerging faults.
- **Solar-powered groundwater pumping** rapidly gained popularity when second generation solar panels started to become more affordable. Both the decrease in price and technical improvements have resulted in increasing use of solar pumps; in India, for example, there were 5,000 solar pumps installed in 2012 and over 170,000 today (IGRAC). Solar-powered groundwater pumping represents a clean and low-cost alternative to fossil fuels and can improve the access to water and incomes of many farmers. Conversely if these systems are poorly operated they can lead to over-pumping of existing groundwater resources.

- **Rapid tests for microbial contamination** in drinking water have emerged over the past few years. One method for rapidly detecting microbial contamination uses the fluorescence of organic material. Testing in low economic and sanitary resource settings showed much promise for screening of groundwater sources at risk of contamination.
- **Managed Aquifer Recharge** is the purposeful recharge of water to aquifers for subsequent recovery or environmental benefit. It embraces methods such as riverbank filtration, stream bed weirs, infiltration ponds and injection wells, and uses natural water sources and appropriately treated urban stormwater, sewage and other waste waters to increase groundwater storage, protect and improve water quality, and secure drought and emergency supplies. https://recharge.iah.org/

Conceptual innovation: theory, guidelines, policy and governance actions able to innovate the hydrogeological approach and contribute to solve management and protection problems

Such innovation can promote all aspects of SDG 6. For example, these actions can accelerate the achievement of **target 6.6** *(By 2030, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes)*, and contribute to **target 6.5** (*By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate).*

The kinds of activities to protect and save groundwater resources include:

- **Regulatory agency actions and guidance** (e.g. U.S. Environmental Protection Agency, European Environment Agency, National Geological Surveys, etc.), adopting innovative strategies for monitoring, control, and planning groundwater uses, and using community approved management tools (such as Aquifer Contracts in Morocco) for sharing results
- **Agencies, academia, and professional associations and societies producing high-level reports** that can practically and constructively provide innovative opportunities to for groundwater resource management,
- **Effective regulatory enforcement** that transforms plans for groundwater management into implementation strategies, at regional, national and international levels (e.g. EU Common Implementation Strategy for Water Framework Directive, and Zero Pollution Action Plan)
- **Site-specific implementation of Managed Aquifer Recharge**,
- **Innovative dialogue and negotiations for transboundary aquifer management**, that can lead to measurable intercountry hydrodiplomatic and economic benefits
- **Innovative mathematical modelling** of groundwater flow, availability, and quality to inform decision makers and policy architects about proper resource management
- **Development of Decision Support Tools**, to be adopted at different scales (city planners, regional management, national plans) for ensuring a sustainable approach to groundwater resources, by regulating human pressures and by considering the nexus among natural resources and human needs.

There are few transboundary aquifer agreements presently, and this is an area of great potential. An example of an innovative transboundary aquifer agreement is the one signed by Jordan and Saudi Arabia in connection with their common Rum-Saq Transboundary Aquifer.

Educational innovation: innovation in educational activities for students, professionals, young people and society

The value of novel educational approaches and capacity development efforts in groundwater are an important segment of SDG 6 Innovation accelerator. These activities contribute to SDG **targets 6.4, and 6.2** *(By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations),* as well as several other SDG 6 goals.

Areas where groundwater education and capacity building are being transformed include:

- **The Online Learning Revolution**. The Covid epidemic forced many academic institutions and professional organizations into converting training and education that was traditionally taught face-to-face, into online and webinar internet modes. These practices are continuing to be exploited well beyond the deepest parts of the pandemic. While some important communities without reliable internet connection have not benefitted from these extensive internet opportunities, many instructional video recordings have been archived and can be made available as internet access becomes more widespread.
- Several groups have established **Youth field projects**. These are often interdisciplinary emphasizing the need for resource conservation and protection.
- The Groundwater Project provides accessible, engaging, high-quality, educational materials, free-of-charge online in many languages, to all who want to learn about groundwater and understand how groundwater relates to and sustains ecological systems and humanity. The current effort is focused on producing online books that have undergone rigorous reviews and editing, involving over 300 groundwater professionals from academia, industry, and government throughout the world.
- The Water Underground Talks are video interviews and short lecture series where groundwater experts from around the world share their passions and their latest research. From each video, undergraduate and PhD students can learn about passionate researchers, and their latest research on the connections between groundwater, climate, food and people. The project also aims to elevate diverse voices and perspectives by focusing on scientists who identify as women and Black, Indigenous and People of Colour.
- **Diversification of educational materials** can be a powerful, yet simple innovation to broaden the spectrum of information shared and provided in class and teaching at any level. The inclusion of non-western, traditional and indigenous knowledge contributes to an active engagement in decolonizing educational materials, and providing a broader, diverse, and more complete view of the knowledge spectrum that will result in the identification of efficient strategies more suited to the specificities of the individual local contexts for the long-term protection of groundwater.
- **Educational videos and archived webinars**. There are several examples of educational groundwater video projects. Groundwater U is a volunteer effort to put together curated videos on groundwater to be used for educational purposes. The U.S. Environmental Protection Agency TechDirect CLU-IN (Clean up information) series is another excellent source, geared toward groundwater remediation information. Jo.in Hydrocafe aims to encourage early career researchers to show and share their work in Spanish or English, increasing the visibility and impact of their contribution to science.
- **Gaming approaches**. Some computer games teach people about groundwater and groundwater pollution. This introduces an entirely new demographic to resources management. An example would be the upgrades made to recent versions of the game

SIMCITY, (an open-ended city-building video game series), to consider the hydrologic cycle, groundwater, and groundwater pollution.

Communication & Social innovation

Communication and social innovation will be key in the achievement of targets 6.A (By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies) and 6.B (Support and strengthen the participation of local communities in improving water and sanitation management). Paying attention to the social context and fostering communication is essential to ensure the success of any groundwater management action and to reduce the risk associated to any top-down action.

- **Informing decision-makers and the general public of groundwater science, supporting policy and community decisions**. Because groundwater is hidden, it is not well understood by the general public and officials who represent those communities. One critical part of communication is the direct application of groundwater science to pressing challenges. The Strategic Overview Series (SOS) of the International Association of Hydrogeologists is a group of very short, descriptive, and illustrated papers that describe the relationship of groundwater to specific industries, communities, and world challenges. The SOS has been translated into many languages. Another example is the DOWN2EARTH Project that translates climate information into multilevel decision support for social adaptation, policy development, and resistance to water scarcity in the Horn of Africa drylands.
- **Socio-hydrogeological assessment**, that considers people (i.e. groundwater users) not only as a driver of pollution and water scarcity, but also the driver for a change in long-term groundwater protection. The engagement of water end-users, well owners and, more broadly, civil society in transdisciplinary assessments, can permit to unveil the invisible connections between people and groundwater, and to propose solutions that are tailored on the real needs and local features (e.g. economic availability, energy requirement, cultural traditions, customary laws, and potential for local stewardship).
- **Successful dissemination activities** include work to circulate and discuss the role of groundwater in society. This can include local radio programs, television documentaries, news media reporting and interviews with scientists and policy makers. The "inform me initiative" https://www.un-igrac.org/stories/amplifying-voices-rural-communities-tanzania-improve-groundwater-management with radio broadcasts and planned cartoons in east Africa and "Professor Água" animations in Brazil are examples of successful new communication programs.
- **Other Social media engagement** and **podcast** shows. These other forms of social interaction with the public help stress the importance of wise management and protection of groundwater, making the "invisible, visible". Projects like "What About Water" (Global Institute for Water Security and The Walrus Lab) connects water science with the stories that bring about solutions, adaptations and actions for the world's water realities.

Key Messages for Groundwater Innovation

To conclude, the key messages of this session are the following:

A very wide range of innovative solutions are already available in both the technical and non-technical areas, and there is an urgency for their financing, adoption, and implementation if the SDG's are to be achieved on target by 2030. Application of these innovations and new, cutting-edge practices is a cost-effective way to achieve SDG6 and its target 6.1 *(By 2030, achieve universal and equitable access to safe and affordable drinking water for all)*, where groundwater plays an essential role worldwide.

The current challenges for implementation of ground-breaking actions include: a. promoting the widespread trial, adoption and review of novel and practical actions to maximise benefits, b. ensuring that that groundwater innovations are accessible and appropriate for local conditions, and c. enlisting agencies and governments to ensure a timely investment of resources to adequately support innovations and implement innovative actions.

All new innovations need to be sustainable in the longer term and be accompanied with/followed by excellent communication, education/training, community involvement, and maintenance. Innovations need the opportunity to be robustly trialled and evaluated to build evidence of sustainable success.