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Strengthening the Science- Policy-Practice Interface

Rationale

Knowledge is widely considered a key ingredient for the effective and sustainable governance of groundwater resources. Policymakers and practitioners need to know about the availability and demands for groundwater, the quality of groundwater, and the effects of its management and use. They also need to understand current trends and changes, as well as potential emerging concerns. Such knowledge is needed to articulate visions and normative goals for governance; to identify and evaluate policy and management options to achieve those visions and goals; to monitor and determine whether groundwater management is following a desirable path; and to adapt to and respond to change.

Conversely, a lack of knowledge can be a barrier to action. Without awareness of potential problems and solutions, groundwater issues do not make it on the policy agenda. Further, uncertainty regarding the drivers of problems, potential future scenarios, and the likely impacts of policy and management actions can lead to a reluctance to act. Lastly, an absence of information on the actions of groundwater users and effects of those actions, can make it difficult to sanction or enforce policies.

In many countries around the world, weaknesses in the science-policy-practice interface are a barrier to the effective and sustainable governance of groundwater. In a recent survey of senior water officials and civil society leaders from 88 countries, 98% of respondents identified groundwater as very important or essential for their country, yet in over half of respondents also said groundwater is not integrated into laws, policies, and regulation in their nation¹. A primary reason for this deficiency is a lack of knowledge regarding the role of groundwater in complex environmental and societal issues including the drivers of and effects of groundwater problems within the country. Further, policymakers, water managers and practitioners do not always have a sufficient knowledge of the tools, measures, and instruments available to manage and solve interconnected groundwater issues.

Yet producing such knowledge and integrating it into policy and practice can be fraught with challenges. The science and information needed is not always available, and, when it is, it may not be produced in a timeframe that matches the needs of policymakers and practitioners, or it may not match the characteristics (scale, geographic scope, or details) those individuals need for decision-

¹ Water Policy Group, 2021. Global Water Policy Report 2021: Listening to National Water Leaders.



making. Further, there can be difficulties in translating key information in a way that is understandable and actionable by decision-makers. As a result, both policymaking and implementation may rely on informal, rather than scientific knowledge. Further, the knowledge used to inform policy may diverge from that used to inform practice.

Key Challenges for the Groundwater Science-Policy-Practice Interface

Several characteristics of groundwater system add to the complexity of the groundwater science-policy-practice interface. Groundwater flows underground, making it invisible and requiring advanced sensing and measuring techniques to monitor. Further, flows are slow and non-linear, thus the effects of pumping and recharge may manifest over time and in non-direct ways. In addition, the effects of groundwater depletion can be widespread, and experienced at distance from where the groundwater has been pumped. These physical science aspects interact with the social – as groundwater is widely used, by many dispersed users. Policymakers and practitioners are thus under pressure to balance across competing demands and interests. In doing so, they must grapple with the fact that groundwater science is often presented in terms of probabilities and uncertainties. Lastly, public acceptance of policies and management strategies is closely tied to social perceptions of the credibility and legitimacy of the science used to inform policymaking. However, due to the complexity of groundwater flows, the public and stakeholders may not have full understandings of the effects of groundwater use or groundwater management on the groundwater system.

Given this complexity, five challenges stand out as issues that must be addressed to strengthen the science-policy-practice interface for groundwater.

Challenge #1: A lack of data and information

In many areas of the world, data, information, and consequently knowledge of groundwater systems are lacking or incomplete. Determining groundwater flows requires extensive measurement and monitoring across both space and time. Aquifers extend both horizontally and geographically and the geologic conditions within them can be heterogeneous. This means that collecting the necessary groundwater data can be complex, time consuming and expensive. Often data on the conditions of the aquifer, as well as on water levels, pumping, and recharge rates have not been collected to the extent required to fully understand the system and its related pressures. Consequently, policy-makers and practitioners are left to make decisions and take actions without the full picture.

Challenge #2: Communicating knowledge

Groundwater systems are complex and understanding them requires knowledge that spans a variety of technical disciplines, including geology, soils, hydrology, and climate. In addition, groundwater flows are non-linear and variable over time. Due to the intrinsic variability in climate, hydrology, and groundwater use, characterizations of groundwater are often expressed using language of probability. Yet, policymakers and practitioners often seek concrete criteria and fixed values upon which to base their policies and management decisions. Consequently, scientists conducting studies and providing information on groundwater struggle with conveying the depth of knowledge they have in a manner that is understood by a wide audience and can be acted upon by both policymakers and practitioners.

Challenge #3: Incorporating advances in knowledge and technology into policy and practice

The science of groundwater is advancing rapidly, with new sensing and computer simulation models providing the potential for better data collection and analysis. Yet moving from pilot stages to widespread adoption and deployment of these innovations and bringing the information they create to bear on policymaking and practice remains slow. There is currently a disconnect between the science, the policy, and the practice community regarding these advances. This arises both due to differing mindsets and perspectives of each set of actors, as well as the societal pressures and expectations placed upon each.

Challenge #4 Incorporating the values, knowledge, and activities of local stakeholders into policy and practice

Groundwater users and those affected by groundwater use have a significant role to play in the science-policy interface for groundwater. However, their knowledge, values, and actions often are not part of the science-policy-action equation. Groundwater users are geographically dispersed and often unidentified. The effects of groundwater use can be widespread and multi-dimensional, including not just lowering of water levels, but impacts on surface water, ecosystems, water quality, and land subsidence. Consequently, identifying the full set of stakeholders and communicating with them can be difficult. Further, local users and stakeholders often interpret and express their knowledge and experience using laymen's terms, creating translational difficulties between them, scientists, and policymakers.

Challenge #5 Out of sight, out of mind

Groundwater by nature is invisible. As it is stored and flows underground, the quantity available, its quality, and the immediate effects of its use are not readily apparent. The result is groundwater is often out of sight and out of mind. An invisible resource is easily overlooked in increasingly competitive policy agendas. Policymakers take action on issues for which there is substantial public interest and/or pressure; yet the importance of groundwater and its effects of its use on the environment and society are often not well recognized by the public. Further, where groundwater does arise in the public interest, its invisibility can lead to contrasting opinions and dissent regarding potential policy actions. Generating awareness of and shared social understandings of an invisible resource is difficult, as humans tend to focus on what is salient to their everyday experiences.

Strengthening the Science – Policy – Practice interface

Strengthening the science-policy-practice interface and ensuring knowledge is produced and informs policy and practice requires a multi-faceted effort by governments, scientists, practitioners, and society. An essential step is recognizing the importance of groundwater as well as the challenges and benefits of managing it effectively.

Raising Awareness: The Year of Groundwater Campaign

Raising awareness of the role that groundwater plays in a range of environmental and societal themes, such as climate change adaptation, can elevate public perception of the importance of groundwater and strengthen the mandate for groundwater management in policy agendas. To increase awareness of groundwater at the global level, in March UNESCO and IGRAC led the World Water Day 2022 campaign "Groundwater: Making the invisible visible" on behalf of UN-Water.

The overarching message of the campaign was that exploring, protecting, and sustainably using groundwater will be central to surviving and adapting to climate change and meeting the needs of a growing population. Resources from this campaign are freely available and include factsheets, videos, links to webinars, case studies, and other information on groundwater. Anyone seeking to draw attention to and educate others on the importance of groundwater can access and use these materials, which are available for download at <https://www.worldwaterday.org/learn>

In conjunction with the World Water Day campaign, key events were organized throughout the rest of the year aimed at conveying a message about the importance of groundwater to the UN 2023 Water Conference. The success of the campaign was global with online mentions of World Water Day reaching over 800,000 across 204 countries and territories. The World Water Day campaign also became the centre of several political initiatives around the world targeting issues related to saving and valuing water. Politicians such as the Indian Prime Minister Narendra Modi actively promoted the World Water Day.

Another invaluable resource for raising awareness about groundwater is the 2022 the [World Water Development Report](#), the United Nation's flagship report on water. Launched at the 9th World Water Forum in Dakar, Senegal, the WWDR provides a first-stop trustworthy source of knowledge and information for regional, national and local-level decision-makers, water resource managers and practitioners to refer to when faced with groundwater knowledge gaps. The report presents the state and trends of groundwater resources globally, describes the challenges and opportunities associated with the development, management, and governance of groundwater across the world and explains groundwater's vital role in water and sanitation systems, agriculture, industry, ecosystems, and climate change adaptation.

Tools to Support the Interface: Groundwater Catalogue

Strengthening the science-policy-practice interface of groundwater requires the development of knowledge and capacity support tools. Recognising that it is often challenging to identify the role of groundwater and adequately incorporate it in the management process across a range environmental and societal problems, UN-affiliated water partners are developing the Groundwater Catalogue.

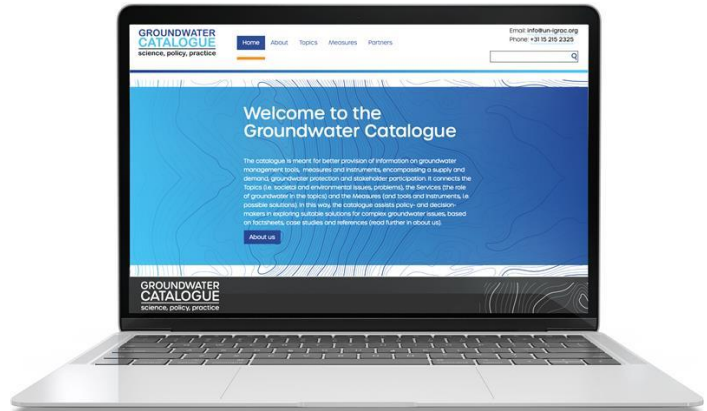
The Groundwater Catalogue is an online platform that assists decision-makers and practitioners in exploring suitable solutions for complex groundwater issues. It does this by linking resources for each of the 3 components of the science-policy-practice interface:

- *Science*: information on groundwater in relation to a range of societal and environmental issues such as Climate Change, Water Security, Industry, Ecosystems and Human Settlements
- *Policy*: a comprehensive collection of policy measures, instruments, and tools that can be used for groundwater governance and to manage groundwater



- *Practice:* case studies detailing the successful implementation of tools, measures and instruments for the better management of groundwater resources

The Groundwater Catalogue will continue to be further developed by partners, users and stakeholders, ensuring its constant update and a broad participation. Anyone can join this initiative by visiting the platform online at: <https://www.groundwatercatalogue.org>.



Key Messages and Call to Actions

Weaknesses in the science-policy-practice interface are a barrier to the effective and sustainable governance of groundwater. Challenges include but are not limited to: a lack of groundwater data and information upon which to base policy development; communicating complex information in digestible and actionable ways; incorporating advances in knowledge and technology into policy and practice; incorporating the values, knowledge, and activities of local stakeholders into policy and practice; and the invisible nature of groundwater often leading it to be 'out of sight and out of mind'. In order to strengthen the science-policy-practice interface, these challenges must continue to be addressed. Improving capacity, increasing awareness, and providing tools and resources are three key ways to strengthen interface. As such, the following actions are essential to improving the groundwater science-policy-practice interface:

Improve capacity

- Train more hydrogeologists who can produce and analyse information on groundwater resources (quantity, quality, and interactions with land).
- Provide tailor-made trainings on groundwater for people in other disciplines whose work links to groundwater (e.g. policymakers, economists, ecologists, social scientists). Ensure those trainings address the relationship between surface water and groundwater, temporal scales associated with groundwater, and future expected changes in the water cycle.
- Develop and implement best practices for transferring knowledge from research to decision-makers in a timely and effective manner. Create regular forums through which those who monitor and analyse groundwater can inform policy-makers and practitioners of the current state of and potential changes in the groundwater-system.
- Form peer-to-peer networks through which policymakers and practitioners can learn from and share expertise with one another. Use platforms such as the Groundwater Catalogue and IWRM Action Hub (GWP Toolbox) for case study exchange on best practices and lessons learnt.
- Step up the inclusion of local and indigenous knowledge into research, policy, and practice.

Increase awareness

- Build on the momentum from the Year of Groundwater by bringing key messages from the UN Water Summit on Groundwater to the UN 2023 Water Conference with the goal of convincing policymakers to commit to actions and protection of groundwater.
- Promote tailor-made outreach & education about groundwater in regular school programmes.

- Create networks that link policymakers, practitioners, and communities that use and are affected by groundwater use. The online global groundwater community that will be launched at the UN Groundwater Summit serves as a platform to connect such a network.

Provide tools and resources

- Promote sharing and diffusion of successful models i) of science-informed groundwater policy and ii) of policy innovations across countries and across regions.
- Continually update the Groundwater Catalogue and similar tools with new examples of successful science, policy, and practice so that users of those tools can learn from current and innovative examples.
- Promote the development and use of open-source tools for groundwater analysis and policy evaluation and strengthen the capacity of scientists, policymakers, and practitioners in using them.
- Develop decision support tools to support the dialogue between science and policy in order to develop strategies that balance across the needs and demands of diverse stakeholders as well as the multiple potential effects of groundwater use.