ESSAY

From Groundwater Management to Groundwater Governance: Aquifers at the Intersection of Science, Praxis and Policy

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A long history of community access enabled through sustainable, steady-state technologies had defined the evolving usage of groundwater across the world for many millennia before we arrived into the modern era! The decentralised, often organic expansion of groundwater access, the rapid progression from rainfed agriculture to irrigated cropping, the urban sprawl, and the need for coping with climate vagaries have contributed to an ever-increasing dependency on groundwater in many regions of the world. Technology enabled individual access to groundwater, an invisible CPR. In the trade-off between food and income security, water security not only became complex, but now has serious implications in furthering various Sustainable Development Goals, particularly SDG6 - sustainable water and sanitation for all. The last hundred years have witnessed a groundwater story unlike anything before, leading to a paradox of solving problems while creating some more.

In this light, India's groundwater narrative is particularly interesting because of its ever-increasing reliance on groundwater on one hand and the compounding crises surrounding groundwater resources on the other. The problem is further complicated by the sheer numbers – of people, of sources, of the dimensions of socio-economic and socio-ecological consequences and by the lack of an integrated approach to groundwater management and governance. Aquifer depletion, groundwater contamination and the tension created between aquifers and ecosystems, especially rivers, often go together. The shrinking size of landholdings, the decentralised nature of governance required to address the largely atomistic nature of groundwater extraction and the diverse socio-hydrological aquifer settings makes it difficult to implement top-down approaches to groundwater management, including the often-obvious instrument of groundwater legislation. Local participatory groundwater management and governance involves a paradigm shift on many fronts. While we need to deal with the dichotomous nature of groundwater management and governance – which one of these is a subset of the other? – the paradigm attempts to move the focus from sourcing of groundwater to that of resource (aquifer) management using the principles of managing groundwater as a common pool resource through a protocol that is based on social hydrogeology, a concept that is gaining importance across the globe.

The commonality, across many local efforts, lies in the strength of community members participating in the process of developing local knowledge, arriving at decisions, and building actions around such community-based decisions. In most cases, they include mechanisms of decentralised groundwater governance as part of the larger groundwater management strategy. At the core of all these attempts lies a combination of 'a transdisciplinary approach and the

micromanagement of groundwater problems', a combination that holds promise in the pursuit of not just the SDGs, wherein the aspect of groundwater remains implicit but crucial to their achievement, but also in otherwise unseen dimensions such as building disaster resilience.

Such efforts also hold promise for an improved dialogue between groundwater science, praxis, and policy. Participatory aquifer management requires a strategic combination of demystified science, participatory practices, and robust policies, all of which embrace the process of ensuring a seamless integration of efficient and equitable groundwater management with sustainable groundwater governance. The process must, to begin with, include demystified science leading to the development of knowledge, data, skills and understanding of groundwater resources at any given location. Based on such understanding, community-level decision-making, co-operation between stakeholders must be supported through robust systems of governance that include socially normative regulation backed by formal legislation, which together will define the institutional structure of groundwater governance in India. Participatory processes of management and governance of groundwater can lead to a socially normative protocol where community decisions are documented and accepted through institutional instruments such as resolutions of the village gram-sabhas (local instruments of governance under the gram panchayats—village levels elected democratic institutions of governance vested under the Constitution of India). Combining social norms and formal legislation is challenging but holds the key to bring policies closer to the ground and enable sustainable practices to outstay many different externalities. The concept of decentralized governance, given that the actual decision-making on groundwater will be vested at the village or sub-district levels, becomes quite relevant to India's atomistic groundwater problem. Reconciling legislation to the nuances of a decentralized normative framework will be challenging. Hence, a new approach to developing legislation on groundwater could actually include protecting the social processes developed under a participatory, decentralized normative frame. Moreover, it could further link up to protecting not just aquifers but also the larger ecosystem, thereby also demanding a strong overlap with other legislation such as legislation in agriculture, urban development and even on forests and the environment.

While the process is easy to frame, experiential learning from different parts of India (and possibly from other regions of the world) provides opportunities to understand the flexibility of the process vis-à-vis how it has been adapted, strategized and accepted through various forms, providing a healthy plurality of approaches and strategies to groundwater management and governance.

Uttar Pradesh: enabling robust groundwater governance

The misplaced perception of Uttar Pradesh being underlain by thick, extensive alluvial aquifers has driven a certain kind of groundwater resources development that has had little focus on the science of aquifers, particularly at micro-scales. While a large part of the State of UP is underlain by sediments of alluvial original brought forth by Himalayan and Sub-Himalayan rivers, the sediments themselves show a great diversity, leading to complex hydrogeological settings and aquifer systems. While the degree if groundwater development inches towards serious levels of exploitation, there is evidence that criticalities around groundwater depletion and contamination are moving eastward, encompassing newer areas into groundwater crises. One must also note that UP is not just about a vast alluvial plain; it includes parts of the 'tarai' or 'terrai', a unique aquifer setting that is near the Himalayan foothills. Adding to this are the transboundary conditions of the region,

providing the aquifers a very different socio-ecological dimension, which is so different from the central alluvial plain. Further south is the Bundelkhand region, with its uniquely diverse set of hydrogeological settings, further compounded by dry, semi-arid climes. The growing dependencies, including a large urban groundwater footprint, challenges in groundwater quality and rising vulnerabilities require a reform in the planning, management and governance of groundwater resources, with a stronger focus on the science – community interface. Bringing in collaboration and participative experiences from other regions of India will be a crucial baby step in enabling sustainable and equitable management of groundwater from the aquifers of Uttar Pradesh.

REVIEW

Citizen's Science or Science for people
The Understanding of Science Through "WORDS"

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The science at every level starts with a strict definition or a group of words clarifying the meaning of the process, phenomenon or technique understood or explained through science. At all academic levels these words or definitions are of utmost significance but need a proper vision to follow. Any subject or sub-stream of science has been brought forwards numerous times through words specific to the idea, objective, and outcome of the same.

Now these words were particularly laid down to express the meaning of the unknown to make it known to the person partaking the knowledge of the particular science. But through the passage of time and advancement of knowledge these words instead of simplifying the meaning of science complicated the very essence of it. The subject became the liking of the elites and the knowledge given to the so called 'brilliant' group of students. This is when it began to complicate the whole essence of the learning of any and every science.

The whole meaning of learning science became a part of a system which was restricted and objectively presented as explainable and understood by a few. So now the knowledge of higher level of science became limited to tough words and definitions learned by the elite scholars. Though originally it was meant to educate people about the environmental and physical or chemical process occurring around them and the reasons and changes involved in those processes.

But words have their own power. Through time immemorial ('though time itself being a separate science') specific scientific words are commonly known to all humans. In a lifetime we are not even aware of how many scientific jargons we apply in our verbal communication on a daily basis. So the question remains that are words important or definitions important towards the knowledge of science. The social system today has made us aware of many such process or scientific terms such as "Greenhouse gasses", 'Climate change', "ozone", "Nuclear energy", "Tsunami", "Earthquake", "Dinosaur", popularly known to everyman or for that matter little children in elementary school. It is only a matter of awareness. So to make any science available or understood by citizens it is important to select words and elaborate them through simpler collection of words. The scientific community, local and national governments, international bodies, all are trying to spread awareness of various scientific processes and consequences involved. Now to alert any set of population and group for any natural or manmade phenomenon is much easier through various digital platforms. But to spread the correct "WORD" is now the responsibility of the scientist or knowledgeable personnel. To make science more understood and citizen's science we need to find the correct words and explain the meanings more clearly.