Groundwater governance: backing CPR principles with a process-based approach

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Abstract

Access to groundwater is "open", and therefore difficult to control or restrict, despite its Common Pool nature. The fugitive character of groundwater is difficult to define uniquely, given the range of conditions controlling the accumulation and movement of groundwater resources. India is now the largest user of groundwater in the world. This has led to many problems, the foremost being the high degree of groundwater vulnerability – likely to affect at least 60% of India's population. This vulnerability has been a consequence of many factors, and therefore, poses multiple challenges in developing responses. The rapid shift from a community-based to individual "access" imposes hurdles in efforts relating to demand-side community management of groundwater. Complex issues surrounding the mismatch between administrative, hydrologic and aquifer boundaries have imposed limitations on clear-cut guidelines of groundwater governance. Further, India's water focus has been embedded in the management of surface-water systems, developed through public funding, leaving groundwater resources development in the hands of individuals and driven by private investment. Finally, the rigid separation in sectoral governance while looking at water - drinking water remains separate from irrigation, for 'institutional' convenience – widens the divide between 'uses'.

Notwithstanding limitations on managing groundwater as a 'common pool' resource, it has become imperative for India to develop a 'governance' process that will back efficient, equitable and sustainable management of groundwater on the ground. India's groundwater governance vision must combine efficiency in supply, ensures equitable access and resource management through demand-regulation and ensures a process of data gathering that is oriented towards enabling site and situation-specific decision support to ensure sustainability of groundwater availability and quality. Such governance requires a healthy combination of collaborations, law making, facilitation, piloting and space for evolving a separate policy on groundwater for the country. Some promising ongoing initiatives in India are currently looking into some of these factors and could form the basis of developing clearer CPR-based groundwater governance in India.

Key words: Groundwater, Common Pool Resource, Boundaries, Processes, Supply, Demand

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Background

Irrigation has been the prime mover of agricultural growth in India. The problem of slower growth of agriculture, particularly irrigated agriculture, is relatable to the emerging crisis of groundwater in India. Much of the recent expansion in irrigated area is because of groundwater. Of the addition to irrigated area of 25.7 million hectares (mha) between 1970 and 2000, groundwater accounted for over 85%. At present, about 61% of the irrigation in the country is from groundwater. Groundwater is also important as a source of drinking water in India, particularly rural India. According to the figures of the Department of Drinking Water Supply, Government of India (DDWS, 2009), nearly 90% of the rural water supply is sourced from groundwater. NSS surveys confirm this. According to the latest available data, 56% of the rural households get drinking water from hand-pumps or tube wells, 14% from open wells and 25% from piped water systems based on groundwater (NSSO, 2006). Though the share of drinking water in total water use is about 7% (whereas irrigation accounts for over 80%), rapid expansion of groundwater irrigation can threaten drinking water security in the end, since the resource for both uses is common. The mounting evidence for this is clearly shown by the statistics of several habitations “slipping back” from full coverage to partial coverage (DDWS, 2009).

Our experience in groundwater management from various regions of India helps draw a clear conclusion that given the complexity of India’s groundwater problems, only a ‘common pool perspective’ towards groundwater could be the way forward to a more robust form of groundwater governance in India. At the same time, we are able to recognize the challenge that one will face in trying to resolve India’s groundwater crises through a commons’ perspective. Millions of farmers use India’s groundwater resources. Groundwater usage is prevalent in the country from inside growing urban centres to the remotest of habitations in the interior hinterland, prompting a decentralized approach to the management of groundwater. A decentralized approach to managing groundwater is quite challenging, to say the least. The paradox of bringing together millions of *fragmented* groundwater users, across highly diverse physical and social settings in a system of *centralized* knowledge, information, institutions and governance makes the task more challenging. However, in the absence of robust alternatives to a centralized system of water governance and management, the principles of *commons* provide a platform on which to build such an alternative, while ensuring a seamless linkage to the inputs required for a groundwater management process. This paper attempts to explain the context in which one perceives the role of commons for managing groundwater resources in India and briefly describes a feasible process to convert CPR principles into an actionable agenda on groundwater management.

India’s groundwater vulnerability

India’s groundwater situation is complex, to say the least. This situation is a function of aquifers, groundwater flow patterns, chemical profiles, patterns of use and more lately, the impact of Climate Change (Kulkarni et al, 2009i). Current perspectives on groundwater ‘governance’ in India are quite myopic. The assessment of groundwater resources with regard to aspects of ‘quantity’ and ‘quality’ is conducted by two different entities. Groundwater assessment including the status of ‘exploitation’ is determined periodically by State and Central agencies. India’s national organization working on groundwater, the Central Ground Water Board (CGWB), has provided to national level assessments – 1995 and 2004 (CGWB, 2006) – on the extent of groundwater exploitation in the country. Their basic unit of assessment is a 'block', a sub-district unit of administration, of the order of a few hundred km^2. Department of Drinking Water Supply (DDWS) of the Government of India (GoI) maintains information regarding water quality around public drinking water sources in different regions. According to DDWS, groundwater resources form the source for nearly 90% of the current rural water supply. Though the share of drinking water in total water use is about 7% while irrigation accounts for over 80%, rapid expansion of groundwater irrigation can threaten drinking water security in the long run, since the resource for both uses is common. The National Drinking Water Mission claimed in 1996 that India had only only 63 problem villages without access to safe drinking water. This figure was later revised and in 1999 a new target was set for universal coverage of 15 lakh habitations by the end of the 10^{th} Five Year Plan. According to the DDWS (DDWS, 2006), the number of "slipped-back habitations" to be recovered between 2005 and 2010 had grown to 419,034. The Eleventh Plan document reports that 2-3% of the habitations have slipped back, bringing down the coverage from 92% in 2003 to 89% in 2007 in rural areas (Planning Commission, 2008). The most important single reason for this slippage is the "drying up of the source", which is a reflection of the decline in water levels on account of increased groundwater extraction (Shankar and Shah, 2009).

India's groundwater problems have two clear dimensions. First, there is the question of water scarcity because of various degrees of groundwater exploitation. Second, there is the question of groundwater quality, of great relevance to rural India, which almost entirely depends upon groundwater for its domestic water supply. The compounded picture of groundwater scarcity and quality is frightening. Some 178 districts (30%) have "unsafe" levels of groundwater development. Many of these also have severe water quality problems. Among those districts considered "safe" in terms of quantitative availability, 169 districts have at least one of the three most serious water quality problems (arsenic or fluoride or salinity). Of these "safe" districts, 128 districts have high fluoride, 40 have arsenic problems, 80 have high salinity and 175 have high incidence of iron. Thus, 347 districts (59% of all districts in India) have problems related to either the quantitative availability or quality of groundwater (Table 1). This clearly indicates that the optimism often found in government documents that most habitations in India have achieved water security, is very misplaced.

Understanding India's groundwater management challenge

India's groundwater *story*, as Shah (2009) points out is unique; scripted by millions of farmers in its agricultural hinterland, India has at least some tens of millions of wells that are pumped indiscriminately leading to what Shah (2009) terms as 'groundwater anarchy'. There are certain specificities of groundwater that makes its sustainable management a unique and difficult challenge. Groundwater is a common pool resource access to which is hard to restrict. Each unit extracted by one user is no longer available to another. What makes management of groundwater especially tricky is its "fugitive" nature; it is a mobile resource, often *captured* by a few before allocation to a larger user-base. Surface water can be stored in a dam in order to allocate and distribute. Groundwater cannot be stored in a place, at least not in its natural state. This makes it difficult to establish and enforce private and exclusive rights to groundwater. Beyond a point, especially in times of increased scarcity, groundwater use transcends farm boundaries and generates negative externalities such as falling water tables, well interference and even sea-water ingress in coastal areas, following competitive pumping by groundwater abstractors. In fact, our observations in recent times also reveal that negative externalities also come into play in times of other 'extreme' situations such as droughts and earthquakes, when despite sufficient water-availability, restricted access (and sometimes even situations like *premium* water markets) comes into play.

Table 1: Drinking water vulnerability – an aggregate picture

(after Kulkarni et al, 2009)

Description	Number of Districts	Percentage to Total Districts	States where these Districts are Located
Districts with High Level of Groundwater Development (GD>70%) ("Unsafe" districts)	178	30%	Punjab, Haryana, Rajasthan, UP, Gujarat, Tamil Nadu
Districts with at least one of the 3 most serious quality problems (Arsenic or Fluoride or Salinity)	169	29%	Assam, Gujarat, Haryana, Karnataka, Maharashtra, Madhya Pradesh, Orissa, Rajasthan, Uttar Pradesh, West Bengal
TOTAL	347	59%	

Further, India's groundwater challenge is also about the disparity between the scales of information and action. The aggregated picture, including the kind of information presented in table 1, cannot form the basis for action. The need for a more 'appropriately' scale approach in developing actions on groundwater management requires information at different scales, including at a local scale, in some cases. First, understanding aquifers is important in understanding and managing groundwater; second, India's groundwater resources are used by millions of farmers, prompting a decentralized action agenda and three, there are stages of groundwater development that describe the physical, social and economic status of the groundwater resource and its dependents (Shah, 2009; Kulkarni et al, 2009i). All of these factors lead to what is called a 'groundwater typology' (Kulkarni et al, 2009ii). The strategic contours of groundwater management under a given groundwater typology can only evolve if the 'scale' factor is taken into consideration (Kulkarni, 2005).

Ostrom (1993) identifies 8 factors that characterize long-enduring robust *Common Pool Resource (CPR)* institutions, though the absence or weaknesses in any one or more of which she also states leads to the weakening and collapse of a CPR-based resource management effort. Ostrom (1993) lists the following governing factors in

CPR institutions:

- Clearly defined boundaries
- Congruence between appropriation and provision rules and local conditions
- Appropriator participation in modifying operational rules
- Monitors actively audit CPR conditions and appropriator behaviour and are accountable to the appropriators
- Appropriators violating operational rules are subjected to graduated sanctions by other appropriators or officials accountable to the appropriators
- Rapid access for appropriators to local low-cost conflict-resolution mechanisms
- Rights of appropriators to devise their own institutions are not challenged by external government authorities
- Appropriation, provision, monitoring, enforcement, conflict resolution and governance activities are organized in multiple layers of nested institutions

Interestingly, the pioneering study by Ostrom (1990) suggests that differential capabilities among appropriators, especially differences in information and size are obstacles to agreement especially in the early stages of such initiatives. This is especially true for many attempts at community based groundwater management, where early challenges of such kind have led to such efforts being limited to *supply-side* interventions including resource augmentation, the *demand*-side remaining open ended. Moreover, the question of differential sizes of boundaries – administrative versus resource – have often led to serious externalities including free-riding when the size of the 'group' is quite small in comparison to the size of an 'aquifer'. Aquifer overexploitation has led to the erosion of an effort based on a 'commons' effort (COMMAN, 2005). At the same time, as the crisis deepens and the costs of not agreeing to collective action rise exponentially, greater possibilities of agreement have been recorded; also, for non-renewables, agreements happen faster (Libecap, 1995).

The factors listed above are an interesting set, especially with regard to groundwater resources. Given the complex nature of hydrogeological conditions that characterise groundwater resources, one the first factor attempts to capture this complexity through a reference to the resource boundaries. The rest are mainly factors dealing with the user-factor. The questions of scale and variability surrounding groundwater resources probably require a more detailed set of 'factors' that describe an enabling system of managing groundwater resources as a 'commons'. Wegerich (2005), while reviewing issues related to community-based management, evaluated literature on Common Pool Resources. In this review, he lists key factors in community based management as *number of resource users, wealth endowment, exit opportunities–time endowment, leadership, social heterogeneity, technological heterogeneity, de jure & de facto rights and emblematic events*. Again, here the factors are central to society, with resource characteristics being only secondary and implicit to each of the key elements listed.

In India, the problem of groundwater is quite serious. Some 60% of all districts in the country are reported to be in various states of vulnerability where groundwater resources and the communities dependent on them, are concerned. The question therefore is of whether the best alternatives regarding groundwater management are within the domain of a purely community based, participatory approach that includes a large degree of social mobilisation; or, whether a stringent and detailed groundwater legislation through a command-and-control approach that includes science, technology and legislation would be a better alternative. In a study conducted some 5 years ago, across different parts of India, a comparison between conventional command-control responses to groundwater overdraft and community-based management of groundwater in Rural India (COMMAN, 2005) was attempted. The study used more specific 'design principles' based on Ostrom's design principles, to arrive at a set of 'first' and 'second' order conditions which enable communities to perceive opportunities and constraints for groundwater "group" management (COMMAN, 2005). The design principles included the following:

First order conditions:

1. Interface between resource and management group (influences who receives benefits and who pays costs of group action).
2. Management group characteristics (affects ability to define groups of interest, management objectives and criteria for 'success')
3. Nested institutions (helps ensure large scale problems are addressed; also helps absorb some of the transaction costs of group organization)
4. External environment – policies, institutions and processes (defines the wider influences and constraints on group management)

The second order conditions are (applies only to *existing group management schemes)*:

1. Rules/norms defining groundwater access and/or use entitlements (defined and agreed)
2. Monitoring and sanction arrangements exist for checking and enforcing compliance
3. Mechanisms/arenas exist for modifying rules/norms

The study (COMMAN, 2005) concluded after comparing various 'community-based initiatives at managing groundwater resources across India by stating, "Developing effective strategies for responding to groundwater overdraft is challenging, due to a wide variety of problems, the scale of problems and responses and the pace of social and economic change." In other words, neither a purely community-based effort nor comprehensive command-and-control type of approaches are currently effective in providing sustainable solutions to meet groundwater management challenges. The report made clear reference to strategies that drew from interactive processes at the interface of research, policy development and implementation. In other words, integration of knowledge inputs, technological innovations, social arrangements and economic holds the key to a groundwater management strategy. The strategy itself, the report states, ought to be driven by appropriate research, with the implementation riding on the back of strong policy instruments like robust legislation and protection of basic water needs like drinking water.

Hence, managing India's groundwater requires an innate understanding of three basic components around the resource:

- The dynamics of the demand of groundwater.
- The history of supply (cycles of supply, as one of the components) created.
- The local availability, largely restricted to *aquifers (ideally),* but not extending beyond a microwatershed.
- The following points capture the rationale behind this argument:
- In India, the constant push for *decentralization* almost prompts a decentralized manner of looking at groundwater resources.
- Provision of drinking water in large parts of India has at least been attempted on a decentralized basis.
- The so-called *groundwater anarchy* (Shah, 2009) has also proceeded in a much more decentralized manner as compared to the centralized, irrigation-bureaucracy driven surface water development.
- And most significantly, a large part of India (some 63%) is underlain by hard-rocks and mountain systems (Kulkarni et al, 2009), which tap local aquifers – aquifers that operate at the scales comparable to those of typical Indian villages/habitations and microwatersheds.

Using conceptual diagrams to explain the relationship between availability, demand and supply in an aquifer, we attempt to highlight the complex nature of the groundwater management challenge. We also accept that the concept, as explained here, is limited to the problem of groundwater scarcity. For the sake of keeping it simple, we have not considered the problem of groundwater quality, a problem that is emerging in large regions of India, sometimes intricately woven into the problem of scarcity and exploitation of groundwater but in many areas, independent of these problems as well. Figures 3 and 4 provide a schematic view of the relationship between availability, demand and supply of groundwater in any region, to begin with. However, the concept gains further strength especially with regard to 'local hard-rock aquifers', the most common resource for decentralized groundwater supply in large parts of India.

The availability (within a hydrologic/ hydrogeologic unit) defines the upper limit for demand and supply, an aquifer in the case of groundwater resources. Availability is viewed here as the environmentally sustainable withdrawal of groundwater that the aquifer can support. In many rural areas of India, a single village usually has different episodes of supply augmentation - in other words, water supply schemes or well excavations that simply try to keep pace with the ever-increasing demand. Most supplies are engineering techno-fixes that cater to a certain "demand range". Hence, they work for a certain period in time, after which demand outstrips the supply range and a deficit is created (shown in red in the figure), for which another scheme (supply-step) is created. Each supply, as Figure 1 illustrates, has a fixed period, the deficits developing between a demand that outstrips the "designed" supply from time-to-time (details provided below the graph in Figure 1).

In drought-like situations, reduced quantities of recharge lead to such depletion that some of the later supply schemes actually run out of operation because there simply is not enough water left in the aquifer for that *design of supply* (and of course, to cater to the grown demand). Under a purely drought-driven situation, this is only a short-term concern restricted to the drought-period, as subsequent normal precipitation enables the aquifer to recover to provide water to the designed supply schemes (even under S3). However, if aquifer overexploitation has led to long-term depletion, then supply schemes like S3 are rendered useless as aquifer levels cannot fully recover to their full capacities. In fact, a similar situation arises under conditions where demand outstrips supply and water may have to be imported from outside, making a very strong case for exogenous water imports. In India, this means water is brought in either through tankers (which again generally feed on a local aquifer system elsewhere) or through piped-water schemes from long-distances (usually on rivers, which themselves have become sensitive to problems from overexploitation – reduced base flows – and the increased seasonality of river-flow hydrology on account of Climate Change.

The illustration of a *supply-driven* situation (Figure 1) is common to many parts of rural India. At the same time, although the context is somewhat different, many urban areas of the country are burdened with tremendous pressures to increase water supply. The foremost impact under such conditions is drawing water from longer distances, the sources often being part of rural settings wherein water resources are undergoing transition. Figure 2 illustrates the concept of sustainability through augmentation by appropriate *artificial recharge* programmes, so that depleted aquifer storage is restored (from S_{dep} to S_{rech}). In addition, conserving such storages on a sustainable basis would be possible only through some degree of *demand regulation*. Even a slight 'tweak' in the demand-line (Figure 2) illustrates the shift from the earlier situation (Figure 1).

The regulated demand makes a slight difference to the availability-supply situation in Stage 1, but as the demand increases, the regulated demand ensures a more effective supply, usually in the form of a *buffer*. In Stages 2 and 3, for instance, the area between the line of original demand (Figure 1) and the line of regulated demand increases, implying that water available (in the aquifer) will tend to last longer on the time-line. This, in essence, implies a more sustainable supply. Simply put, a water supply scheme in a village or a town tends to run over a longer period of time, through a regulated demand. The graph is a simple conceptualization of "sustainability". This conceptualization sets the theme for a strong articulation of demand management of groundwater in the current Indian context, an articulation already prophesied strongly enough (Planning Commission, 2007; Shah, 2009; Kulkarni et al, 2009). The concept explained in Figures 3 and 4 extends beyond demand-supply-availability and poses the question of "resource governance", groundwater governance in this case. We explore the question of groundwater governance, as an extension of this concept, in a subsequent section.

Figure 1: Conceptual Diagram Illustrating Demand, Supply and Availability with regard to A Resource

GW Demand & Supply Diagrams - for EPW - Oct10 - unregulated demand.jpg

Adapted significantly from Kakade, Kulkarni et al. (1998)

Figure 2: Conceptual Diagram Illustrating Demand, Supply and Availability with regard to A Resource

GW Demand & Supply Diagrams - for EPW - Oct10 - regulated demand.jpg

Modified significantly after Kakade, Kulkarni et al. (1998)

Why a "commons" agenda for India's groundwater

Groundwater resources have high economic and social value in many areas of India. Groundwater, as a resource, is shared for various purposes – drinking & domestic, agricultural and industrial. Emergent scenarios across India have indicated conflicts between various water uses, conflicts that severely affect the nature of the resource itself (*Macdonald et al, 1995; Batchelor et al, 2000; Planning Commission, 2007; Joy et al, 2009).* Two broad sets of responses are obvious when one is attempting to address not just the conflict of 'uses' around groundwater, but also the friction that comes with competitive access to a resource which in only partially visible. The first, set of responses are part of a formal 'command and control' legislation and the second set being a more socially driven, community-based approach of regulation.

The scale on which conflict and friction around groundwater resources is emerging almost pre-empts the case for comprehensive groundwater regulation. The second option is to attempt some order with regard to groundwater use through 'group' managed systems or groundwater user-groups. Despite efforts on both fronts, there are limitations to applying either of these two instruments. In the case of groundwater legislation, there are two major concerns. Firstly, the validity of broad-based norms on which many of the current groundwater 'Acts' are based almost foreclose effective application of such legislation, considering the hydrogeological complexity of aquifer and aquifer systems. Secondly, because of the broad basis of legislative norms, implementation of laws becomes difficult. This is also because groundwater access has become an important aspect of rapid socio-economic development; it has automatically also achieved political sensitivity, often limiting the implementation of the law even in resource-sensitive situations.

Community based autonomous efforts, on the other hand, are emerging from some regions of India. The Andhra Pradesh Farmers Managed Groundwater System (APFAMGS) is one such large-scale effort at purely community-driven efforts at managing groundwater resources. In this we also include co-operatives, user-groups and even water-markets, all of which tend to have reasonably well-executed institutional arrangements. The flip side, however, is the lack of scientific understanding especially with regard to the scale of the effort – mismatch between community and resource boundaries – and about the dynamics of the resource itself in space and time. Participatory approaches to managing village resources are also shaping up, although external drivers – individual social or political leaders and civil society organizations – play an important role in such initiatives.

Regulating or managing demand for water is a critical factor in India's quest for improved groundwater management. Formal regulation through 'legislation' seems an obvious choice to regulate demand, considering the degree of groundwater exploitation in India. Many States in India either have Groundwater Acts in place or are in various stages of drafting such Acts, based on the Model Bill of the Government of India (1972). However, the scale of groundwater exploitation, the absence of information support and the socio-economic milieu precludes effective implementation of water relate legislation in India, particularly the legislation on groundwater (Cullet, 2007; Planning Commission, 2007; Shah, 2009; Kulkarni et al, 2009i). Moreover, the paradox of 'scale' imposes certain limitations to legislation.

Therefore, recognising groundwater as a 'common' resource is the first step in restoring a semblance of order to what Shah (2009) aptly calls the *groundwater anarchy* of India. The fragmentation of the resource even at a micro-scale – 1000 odd wells in an area of 70 km^2 (Badarayani et al, 2009) - requires *aggregated* thinking about its management. This calls for a clear focus on a community-based plan of managing groundwater resources, especially significant when one considers that more than 90% of India's rural water supply is based on groundwater resources (DDWS, 2009). Tables 2 (A) and 2 (B) illustrate the framework of actions required to mitigate problems of groundwater overuse and quality respectively. The important consideration in developing the framework is that of different scales on which actions must evolve. The scale issue is important within a comprehensive groundwater management strategy. The current state of groundwater legislation seldom considers such a framework in the formal regulatory mechanisms on groundwater.

Table 2: Framework of actions as part of response strategy to combat groundwater over-use (A) and groundwater quality problems (B)

(A) Groundwater over-use scenario

Protocols	**Farm (Well)**	**Group**	**Aquifer / Watershed**	**Village / PRIs[4]**	**Comments**
Aquifer mapping and database			✓		Aquifer-based data at appropriate scales, backed by key datasets.
Well measurements	✓	✓			Water levels, groundwater quality, well-tests and other such measurements that enable decisions on 'efficient well use' and feed into groundwater / watershed planning at community-scales..
Aquifer monitoring		✓	✓	✓	These include pumping tests, groundwater flow analyses and groundwater quality patterns. *Monitoring attempts to plot spatial patterns and temporal trends* to enable aquifer-level management of groundwater.
Decision making on GW as CPR	✓	✓	✓	✓	For effective management of groundwater resources, decisions ought to be at all levels; integration of decisions from all scales to an appropriate aquifer / watershed scale.
Regulation				✓	PRIs would need to be empowered with more proactive regulatory instruments that are not 'authoritative' but are meant to facilitate principles of groundwater

[4] PRIs: Panchayati Raj Institutitions

					within a robust CPR framework.

(B) Groundwater quality scenario

Protocols	**Individual**	**Household**	**Village / PRIs**	***Comments***
Water Quality Assessment/Monitoring		✓	✓	Frequency of measurement be decided based on the parameter(s) of concern.
Health Impacts	✓	✓	✓	Health impacts ought to be monitored at all three levels; the aim would have to ensure *attribution* of health indicators to a particular contaminant at the given location.
Water treatment		✓	✓	Water treatment options are required at two levels – at the household level and at the village-level (especially with regard to community drinking water sources). The latter become important, especially if groundwater is being managed through a CPR framework.
Improved water management at group level (especially when groundwater quality is impacted by groundwater over-use)		✓	✓	Co-managing two types of problem implies consideration of scale. Responses at aquifer / watershed scale using both supply and demand side interventions.
Mitigation of health impacts	✓	✓	✓	Integrated interventions on the *health* of individuals, households and the community are desired as a part of a comprehensive groundwater management strategy.

The tables above attempt to present the framework of crucial activities that form key elements of a groundwater management strategy at different scales. The tables above only provide a *starting point* of a more comprehensive strategy that will ensure a practical and sustainable process of managing groundwater resources in India. For instance, aquifer-based information is skewed – available for some areas, not for others – and often absent in identifying appropriate units for management. The question of boundary mismatch remains unresolved, as there is little information on (groundwater) resource boundaries even when information regarding administrative boundaries is quite clear. Mechanisms to collect information at the local-level seldom exist, and particularly in hard-rock systems, where aquifers are local, decision-support for community-backed systems of management does not exist currently. Hence, representative water level monitoring, understanding (even crudely so!) groundwater characteristics and an idea about the overall groundwater availability become imperative in designing local systems of groundwater management, including systems for equitable allocation. Further, it becomes important to protect such systems of management through formal legislation in order to overcome ‘free riding’ and other such externalities.

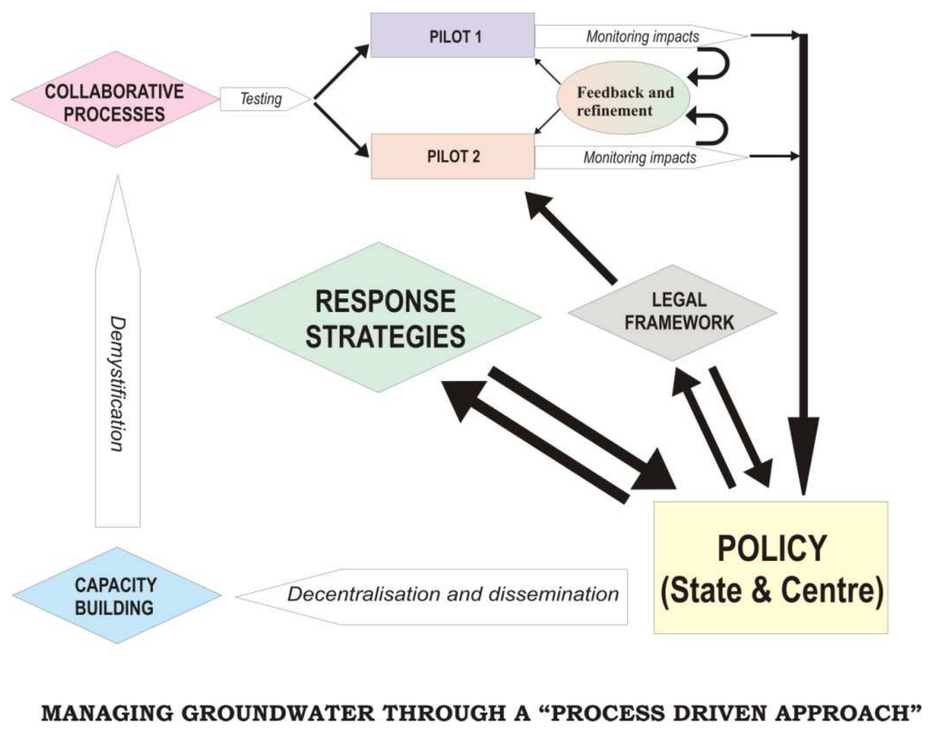
In the case of extending community efforts at water quality management, multiple strategies are important. Multiple strategies on the scientific (monitoring-testing), technical (treatment) and community-efforts (social) fronts would need interventions that deal with the resource as wells as the human element (health). Although it is beyond the scope of this paper, we acknowledge the consideration of finer points within such strategy. For instance, the frequency of monitoring in case of pathogenic vulnerability would be greater than that for fluoride vulnerability. However, for fluoride one might be interested in spatial and temporal patterns; hence monitoring at many points, say on a seasonal basis may prove more useful in areas that are prone to fluoride contamination. Similarly, in areas where co-managing issues of quantity and quality exist, one may be inclinded to simply regulate the ‘demand’ or say introduce ‘water efficiency technologies’; with such approaches, drinking water security still is at stake – because the water quality issue would remain unresolved. Hence, ensuring a certain quality of water is imperative for the groundwater management strategy in such areas.

Groundwater governance – *silos to processes*

The current framework of institutions working on groundwater responses in India, is highly ‘compartmentalised’. There is little integration in the functionalities of not just institutions within the Government, but also across the wider net involving Academia, Researchers and Civil Society (Figure 3). Stakeholder fragmentation not only exists at the scale of resource use, but at a multiple levels within the organisational structure dealing with groundwater resources in India. Bridging gaps between institutions is a challenge that has proved difficult to overcome in other, relatively simpler sectors. Groundwater resources pose many challenges, institutional integration being just one of them. The *silo-based* nature of the current framework results due to many reasons, the discussion of which is beyond the scope of this paper. What is important, though, is the fact that breaking down institutional silos and piloting of processes (on a large scale) hold the key to addressing groundwater management challenges in India.

Managing groundwater as a ‘commons’ becomes a precondition to good groundwater governance in India. And, good governance is about effective processes. A process-driven approach has the capacity to be effective and accommodative, two key elements to ‘beginning’ to manage groundwater resources. A robust legal framework that facilitates community efforts at management is also required, because such a framework would acknowledge and accord a ‘commons’ principle to groundwater resources before going into the nitty-gritty of groundwater law. The response strategies that could emerge through such a framework could be direct, indirect or even adaptive (as some global literature suggests). Primarily though, the way forward has to evolve on the basis of sound science and strong social skills in understanding the resource and developing community-action around its management. Institutions will need to work around such a strategic process rather than fitting processes to institutions. Figure 3 attempts to briefly explain the processes and the flow for such processes. The diagram is self-explanatory, with responses at the centre. The key foci of such processes are capacity building, collaboration, legal framework - policy. As a matter of fact, these three elements would be able to link up existing institutions – academia, research and governance – into a well-integrated programme on groundwater management based on a ‘commons’ agenda. We discuss each of these briefly as follows.

Figure 3: The Way Forward: Broad ‘Contours’ of a Process-Driven Approach (*after Kulkarni et al, 2009i*)



1. **<u>Capacity building</u>**

Unless assessed and considered within the basic framework in which groundwater occurs – *aquifers* – the basic understanding (at the right scale) of groundwater will continue to be fuzzy, despite degradation of the resource, legislation to counter degradation and efforts around community management of this fragile resource. The term “aquifers” figures prolifically in the report by the Planning Commission (2007) too. However, in reality, the biggest drawback in converting groundwater policy into good practice is the lack of “aquifer based” approaches to groundwater management. Groundwater, within the policy framework, still remains a ‘component’ of watersheds, river basins, irrigation projects and the environment, and one cannot deny that it is so. Understanding the problems (hydrogeological setting, stage of development, extent of water quality and the vulnerability to different stresses) in different types of aquifers must become the key starting point for education and capacity building. Shifting the focus from ‘exploratory’ approaches to managing ‘available groundwater’ in course curricula becomes a significant step in this direction. Capacity building modules need to be customized for different stakeholders, where each stakeholder is a *learner* and there are *no experts*. Hence, capacity building will also need to consider its primary objective, i.e. *demystification*. The subject of groundwater, as mentioned earlier, requires intense observation, perseverance and imagination. Hence, a certain degree of demystification to get across concepts of aquifers, common property, equitability and sustainability, particularly when working at the village and aquifer levels, are essential for strengthening the case for a participatory, community-driven groundwater management programme. Such demystification would need inputs from multiple experts and therefore, the process of collaboration becomes important. Efficient collaborative processes will also lead to appropriate pilots on groundwater management, some of which are already happening; lessons from such pilots would only help in positive policy reform.

2. Collaborative processes

Protecting rural livelihoods, especially in a country like India, and ensuring groundwater management at the same time, can be a challenging exercise. However, the sustainability of such livelihoods remains questioned without proper strategies on natural resource management, groundwater being one of them. *The need to integrate science, technology, sociology and economics is the fundamental rationale for collaborative processes that form the backbone for groundwater management pilots*. Given the diverse nature of the processes, it becomes important to involve multiple types of institutions / expertise in developing groundwater management plans for an area. Therefore, rather than specifying institutions, which would be the obvious way forward, if one considers Figure 1 in such planning, the roles required to run the above processes are important. These roles (which also indicate the corresponding process) should broadly include:

- *Aquifer mapping* and *groundwater characterization*
- *Social surveys*
- *Defining the typology of groundwater conditions in the project area / region*
- *Community dialogue and mobilization*
- *Conduct of 'key' meetings like Gram Sabhas, wherein communities lay down some consensus on management of groundwater resources. The PRI framework provides an alternative framework to formal legislative processes, the latter currently not tuned to looking at the specific nuts-and-bolts of managing groundwater at the panchayat level.*
- *Co-ordinating roles of formal agencies such as the State Groundwater Boards, Electricity Boards, Soil and Water Conservation Department, Drinking Water and Sanitation Department etc.*

3. Legal framework - policy

A process driven approach will also enable a more robust legal framework! Current groundwater law enactments have stagnated, primarily because of their command and control approach. The focus of a robust legal framework should be to provide the *legal cover* for a community-based approach to groundwater management. Hence, the priority within the legislative framework will change from a *licensing, command-control* type to one where *there is protection to efforts of conservation, demand management and drinking water sources.* It is very likely that the successful running of *pilots* may also require some *legal cover*. For instance, when a *Gram*

Sabha passes a resolution that all groundwater use in a village will be through a community effort, such a resolution needs to be strengthened through a legislative norm imposing heavy sanction against *free riders*.

The revised National Water Policy (2002) has three basic points pertaining to groundwater resources.

- The need to regulate exploitation of groundwater
- The need to integrate surface and ground waters through a conjunctive management
- The need to avoid overexploitation especially in the coastal zone

As a policy statement on groundwater, these very bullets can be expanded through the process outlined above. Once aquifers are mapped, for instance, it would be clear to policy makers as to *where to do what*. For instance, it would be useful to regulate exploitation of groundwater in areas that are *vulnerable* to groundwater depletion and deterioration. *Aquifer mapping through collaborative processes would make such vulnerability mapping possible.* Moreover, the coastal zones themselves will be *typologised* through an aquifer mapping effort, leading to more concrete policy statements on such zones. Similarly, lessons from pilots will feed into policy, enabling expansion of the policy mandate on groundwater. The development of the overall legislative framework ought to evolve based on such lessons and be derived from *legal guiding principles* in the reformed policy environment on groundwater.

It will be difficult to make a separation between Central and State Policies on groundwater immediately. Questions such as, “do we need a separate policy on groundwater” is bound to lead to plenty of debate and discussion. In the process-based groundwater management structure (Figure 3), policy will have three major roles:

1. Take *learnings* from the ground and convert them into robust policy statements
2. Help drive more concrete ‘legislative’ frameworks
3. Provide guidelines (to States and various Departments) for scaling up response strategies for different groundwater problems and situations.
4. Develop a skeleton for decentralizing the process of groundwater management and disseminate the learnings that flow to it from pilots and from the broader response domain to improve capacity building efforts.

Conclusion

Developing groundwater management strategies becomes imperative, considering the magnitude of groundwater problems in India. Not only is the problem extensive, but it is also intensive, compounded by threats that come from a rapidly transitioning society and a changing climate. Recognising that groundwater resources are an integral component of a ‘commons’ base, such as forests and wetlands, holds the key in modifying the current approach to looking at mitigating problems of groundwater scarcity and quality. As mentioned earlier, this paper only proposes a framework of key processes to relook into a groundwater management agenda, with a ‘commons’ perspective. We end with a list of bullets that emerges as a consequence of the rationale put forth in this paper – factors that are not only important in managing groundwater resources, but imperative as a part of both, a piloting effort at *participatory groundwater management* and *policy & legal frameworks on groundwater management* in India. We end the discussion with a set of points that summarise the framework for groundwater governance in India, a governance based on the 'commons' perspective. The list below is clearly not exhaustive, but we believe, these are key action points of a completely reformed agenda on groundwater management and governance. Each point states the objective with a set of key actions.

1. To understand groundwater resources in all their dynamics
    a. Hydrogeological mapping leading to aquifer understanding
    b. Community dialogue including traditional wisdom on groundwater
2. To understand the present state of groundwater resources and reasons for depletion
    a. Primary and secondary data collection
    b. Exploring past and present patterns of use
    c. Developing a time-line that charts the history of groundwater resources and their usage
3. To understand the status of groundwater quality and its impact on living beings
    a. Water quality investigation, including past data (even if qualitative)
    b. Health data surveys
4. To study the availability, demand and supply
    a. Patterns of water use, estimate demand and analyse supply
    b. Estimate groundwater resources availability under various scenarios (particularly under the Climate Change challenge)
5. To facilitate the community in the process of decision making for the sustainable and equitable management of groundwater resources
    a. Institutional framework development (including linkages to PRIs)
    b. Demystification, capacity building and communication
    c. Exposure visits
    d. Participatory decision making system

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