Participatory Groundwater Management: Lessons from Programmes Across India

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Abstract

With an annual extraction of 230 cubic kilometres, India is the largest user of groundwater in the world. The value derived from the use of groundwater for irrigation is estimated to be four times the annual investments in irrigation projects. However, unregulated abstraction of groundwater has led to more than 60 percent of districts being affected by scarcity or quality issues. To tackle this, an alternate paradigm that espouses resource understanding and community participation has been tested under the Participatory Groundwater Management (PGWM) programme. In practice areas, the PGWM programme has led to increase in groundwater levels and, in some cases, improved crop productivity through the evolution of protocols for better water use. Several principles enshrined in the PGWM approach are now finding place in governance frameworks for groundwater management.

Keywords

Resource understanding, participation, common pool resource, groundwater management

Introduction: Understanding the Groundwater Crisis in India

India is the largest user of groundwater in the world using around 230 cubic kilometres annually (World Bank, 2010, p. 1). It is also an important source of drinking water, perhaps the only source of drinking water in much of rural India, and a vital source of urban water supply. Groundwater is vital as a source of irrigation, contributing to 84 percent of the total irrigated agriculture areas (Planning Commission, 2012, p. 284). A study in 2007 by Shah estimated that the value derived from the use of groundwater in irrigation for agriculture is about four times the annual public investments in irrigation projects and is in fact greater than all expenditures incurred by the government on poverty reduction and rural development (Shah, 2007, p. 17).

One of the main reasons for such rampant use of groundwater is the nature of the resource that lends itself to decentralized abstraction. This, coupled with a lack of regulation, and a poor understanding of the characteristics of the resource has led to proliferation of structures that extract groundwater, such as wells and bore wells. A 2012 estimate pegs the number of such structures at around 30 million (Planning Commission, 2012, p. 108). In several states, this dependence on groundwater increased when unmetered/subsidized power was provided for agriculture during the rural electrification drive between the 1970s and 2000 (Mukherji, Shah & Giordano, 2012). This led to a sharp increase in the number of tube wells over time, for example, the number of mechanized wells and tube wells rose from less than 1 million to about 19 million in 2000 over a period of 40 years (Jha & Sinha, undated, p. 10).

The story of groundwater extraction follows the course of unsustainable use of any natural resource which fails to put in place governance principles to regulate rampant development with no concern for management. Thus, as

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more and more sources of groundwater across the country run dry, we continue to be inundated with daunting statistics of depletion in quantity and quality of the resource, across the country. For instance, a mid-term appraisal of the 11th Plan of the erstwhile Planning Commission, Government of India, suggests that almost 60 percent of districts have either a scarcity or quality issues with respect to groundwater India (Planning Commission, 2012, p. 101).

The inability to create a holistic management framework for groundwater is perhaps attributable to the complex nature of the resource. Groundwater is unevenly distributed across the country (Jha & Sinha, undated, p. 8) and even within a district or block; its use can be highly varied. Any attempt to create strategies for management would, therefore, have to take into account both the diverse hydrogeological settings and the complex socio-economic situations across the country. Thus, these strategies will have to comprise of both scientific management of the resource and working with communities to evolve more efficient use and promote demand management (Kulkarni, Shah & Shankar, 2015, p. 12).

Participatory Groundwater Management Programme: A Potential Solution to Groundwater Crisis

One such strategy for better groundwater management is the Participatory Groundwater Management (PGWM) programme. The programme that seeks to deal with both the rising and indiscriminate use of groundwater and diametrically opposite situations of flood where excess availability of water cuts off people from safe drinking water sources is supported by Arghyam, Bangalore and developed by resource centres—four premiere institutions in the country working on groundwater (Table 1) across the country. It seeks to provide a holistic management approach that involves two critical elements:

1. Improving resource understanding and management by use of science and appropriate technology.
2. Community participation and an understanding of traditional groundwater management practices.

The first step in rolling out the PGWM programme was to elucidate principles of work based on an understanding of the existing body of knowledge. Principles were evolved in a round-table discussion of groundwater experts—both partners to the work (from Table 1) and other experts such as those from the World Bank funded Andhra Pradesh Farmer-Managed Groundwater Systems Project (APFAMGS)/APWELLS project. They are (Arghyam, 2015, p. 16):

1. Groundwater is a common pool resource (CPR).
2. The groundwater problem should be clearly defined.
3. The principles and processes of groundwater management should cut across different uses such as drinking water, irrigation, etc.
4. The minimum unit of management can be the local aquifer (micro-watershed) and the maximum unit can be the regional aquifer.
5. Commitment of a long-term engagement of at least 8 years.
6. Planning, management and monitoring should be executed by the community with support from external agencies. Local knowledge and formal science should be prioritized. No overriding.

Table 1. Participatory Groundwater Management (PGDM) Programme Partners

Name of the Partner	About the Partner
Advanced Centre for Water Resources Development and Management (ACWADAM)	ACWADAM is a not-for-profit organization that aims to develop solutions to groundwater problems of today and tomorrow. It is a premier education and research Institution and facilitates work on groundwater management through action research programmes and trainings.
Arid Communities and Technologies (ACT)	ACT is a non-profit organization working in the Kachchh region of Gujarat. It aims to strengthen the livelihoods of communities in arid and semi-arid regions by resolving ecological constraints through facilitation or by providing access to technologies and by engendering technological and institutional solutions.
People's Science Institute (PSI)	PSI is a non-profit organization with a work focus in the Indian Himalayan region and the poverty-stricken Bundelkhand region, aims to eradicate poverty through the empowerment of the poor and the productive, sustainable and equitable use of natural and human resources.
Watershed Support Services and Activities Network (WASSAN)	WASSAN is a network that works towards bringing about a qualitative change in the watershed-based development programmes in India. It aims at providing capacity building and support services for development initiatives in natural resources management with a focus on promoting livelihoods of poor, economic and gender-discriminated citizens.

Source: Arghyam (2015).

Implementing Participatory Groundwater Management Approach

To test this approach and the ground truth of the principles, the PGWM programme was piloted by the resource centres initially in four of India's six hydrogeological settings (Kulkarni et al., 2015, p. 3; see also Figure 1 and Table 2). In the selection of the four hydrogeological settings for the programme, the Himalayan region that depends on springs was included to demystify the science of springshed management. As mentioned earlier, the implementation of the PGWM programme involved two important steps described in the following sections.

Improving Resource Understanding[1]

While resource understanding depends heavily on the local hydrogeological and socio-economic settings, some common approaches were evolved that helped take into account gaps in existing programmes for groundwater management programmes. These included:

1. Understanding aquifers or the resource base in the areas of practice through field work for hydrogeological mapping to help create better strategies for groundwater management.
2. Testing water quality to explore linkages between over-extraction and quality and arriving at methods to tackle this.
3. Demystifying the scientific knowledge to communities and understanding traditional practices of water management to create protocols, and understanding of wise use and demand management within the user community to formulate groundwater management plans that can be formally adopted by the community at the local self-government level.

In each of the pilot sites, these steps then led to understanding water availability (supply) and use (demand). This further led to the development of a water balance. Once communities understood availability versus use, they also participated in creating demand management solutions and protocols for groundwater management. Any technical assistance required for developing and managing groundwater for improved crop water management and drinking water security was also provided.

This exercise had the added benefit of helping hone the resource centres skills in measurement, monitoring and analysis. It also helped translate the science of hydrogeology into tools for decision support. Understanding aquifer characteristics helped create new groundwater management strategies or modify the existing ones. In some cases, it also helped reinforce the idea of groundwater as a CPR within communities.

Community Participation

To be able to create strategies for groundwater management that communities would implement, the PGWM programme adopted a participatory approach from initiation. To ensure that interactions with communities were a two-way street of information sharing, three practices were integrated in pilot sites:

1. Understanding traditional practices of groundwater management used by communities and incorporating these in groundwater management plans and protocols.
2. Capacity-building of communities to demystify science and help communities become joint owners of the knowledge from studies of resource understanding which will help them create appropriate decision support tools.
3. Wherever possible, the groundwater management plans were legitimized by the *gram sabha* (a village assembly comprising of adults in the village that has wide powers including the power to safeguard and preserve natural resources and ensure that they are used sustainably and equitably). When financial resources were required for implementation of infrastructure-based solutions, these were found from public funds; if management protocols were to be adopted, then the *gram sabhas* would formally adopt the protocols developed, thus, placing the intervention in the control of the local governance structures. Some important protocols evolved in the pilot sites include:

   a. Incorporation of hydrogeology in watershed programmes
   b. Recharge area protection (forest cover and community lands)
   c. Regulation of distance between wells (drinking water source protection)
   d. Regulation of agricultural water requirement (crop water requirement)
   e. Depth regulation (w.r.t. drinking well)
   f. Pump capacity regulation
   g. Drinking water quality monitoring
   h. Groundwater sharing through community participation

Hydrogeological typologies and aquifer types across India

The different hydrogeological typologies in India

Mountain systems
Found mainly in the Himalayan region, mountain systems are local aquifers found over a large region that feeds springs and streams. They demonstrate higher dependency for drinking water on springs and spring-fed streams than on wells. Land-use change and climate are factors of immediate concern around this resource's sensitivity.

Alluvial (unconsolidated) systems
Alluvial systems are unconsolidated river and aeolian sediments that deposit in vast plains, largely within the Indus and Ganga river basins typified by multiple regional aquifer systems. Groundwater quality in these regions is a major concern.

Sedimentary (soft) systems
Sedimentary (soft) systems are regional aquifers found over smaller regions in Central Indian drylands. They have a strong coherence with forests, mining areas and tribal dominant regions - regions that have higher dependency on groundwater for domestic usage.

Sedimentary (hard) systems
Found mainly in Central Indian drylands, sedimentary (hard) systems are local aquifers spread over smaller regions, again demonstrating a strong coherence with forests, mining areas and tribal dominant regions. Most of these regions have high dependency on groundwater for domestic usage and agriculture. Some areas in these regions have witnessed significant extraction of groundwater.

Volcanic systems
Volcanic systems are found over large regions and are the most heterogeneous of all aquifer systems. With limited amounts of storage, these aquifers often lead to some degree of self-regulating storage. Long term declines of these systems lead to constrained agricultural growth. Relatively better water quality levels can be found here.

Crystalline (basalt) systems
Crystalline systems are local to sub-regional aquifers found over large regions. These regions have a high dependency on groundwater for drinking water and agriculture. Groundwater markets arise primarily around rural to urban groundwater transfers. Fluoride tends to be a major contaminant in these systems.

Source : (2015) Kulkarni et al, Shaping the contours of groundwater governance in India, Journal of Hydrology : Regional Studies

Figure 1. Hydrogeological Typologies and Aquifer Types across India

Source: Arghyam (2015).

Table 2. Participatory Groundwater Management (PGDM) Programme Practice Sites

Organization	Action Research Site	District	State
Advanced Centre for Water Resources Development and Management (ACWADAM)	Muthalane	Pune	Maharashtra
Advanced Centre for Water Resources Development and Management (ACWADAM)	Randullabad	Satara	Maharashtra
Arid Communities and Technologies (ACT)	Kankavati sandstone area	Kachchh	Gujarat
Arid Communities and Technologies (ACT)	Kamaguna-Vatachchad	Kachchh	Gujarat
People's Science Institute (PSI)	Thanakasoga	Sirmour	Himachal Pradesh
Watershed Support Services and Activities Network (WASSAN)	Pargi	Rangareddy	Telangana

Source: ACWADAM (2014).

Across the different pilot sites, all the communities adopted certain basic principles:

1. Groundwater is a CPR irrespective of the nature of land ownership.
2. Groundwater shall first meet 100 percent drinking water (including cooking) needs of the community before its use is considered for other purposes.
3. In two of the four pilot sites, measures to enhance livelihoods through use of water-saving techniques such as drip irrigation; choice of crops that consume less water while not affecting profitability, etc., were undertaken with successful results.
4. While the ownership of groundwater structures can be held by individuals or user groups, the water will be shared with others in the water user group, along with operational costs.

Lessons from Participatory Groundwater Management Pilots and Efforts to Mainstream the Approach

Owing to robust community participation and decentralized application of hydrogeological knowledge, the PGWM approach saw several successes across all four pilot sites.

The combination of PGWM and watershed development work in Maharashtra resulted in increase in groundwater recharge despite decrease in rainfall during the implementation duration in Randullabad, Maharashtra. This led to drinking water security even during the 2012–2013 drought. Following this approach increased crop diversity and productivity (Aslekar et al., 2013, pp. 67–72). Similar results were obtained in Andhra Pradesh where farmers came together to create a water grid, share bore wells using common pipelines to irrigate land (Arghyam & WASSAN, 2015). The work on springs in the Himalayas resulted in an increase in spring discharge and water quality despite rainfall variability (see Figures 2 and 3).

The encouraging results from the work led to an increased uptake of PGWM principles across the country. Figure 4 captures the spread of the PGWM approach through multiple stakeholders.

Arghyam is invested in building the capacities of multiple partners across the country with support from the resource centres to help spread and test the PGWM approach across the country. Several donors have collaborated with the resource centres to support the spreading of this work in other areas. The PGWM approach is also seeing traction with state governments, for example, it was adopted in technical trainings and implementation of Irrigation Schemes and Integrated Watershed Management Programme (IWMP) in Andhra and IWMP in Himachal Pradesh.

The need for groundwater management rather than development is also slowly finding traction in Government of India's documents and programmes. The 12th Five Year Plan perhaps for the first time acknowledged groundwater as a CPR, the need to understand aquifers by mapping them through a national aquifer mapping exercise and creating groundwater management plans based on this understanding (Planning Commission, 2012, p. 11). It also updated the Model Bill on Groundwater to include progressive provisions for protection and management of the resource.[2] States are encouraged to adopt the act and pass them in their legislatures. Springs, hitherto not acknowledged within policy-making, are also slowly making their way into policy, for example, as one of the activities sanctioned under the National Rural Employment Guarantee Act (Ministry of Rural Development, 2013),

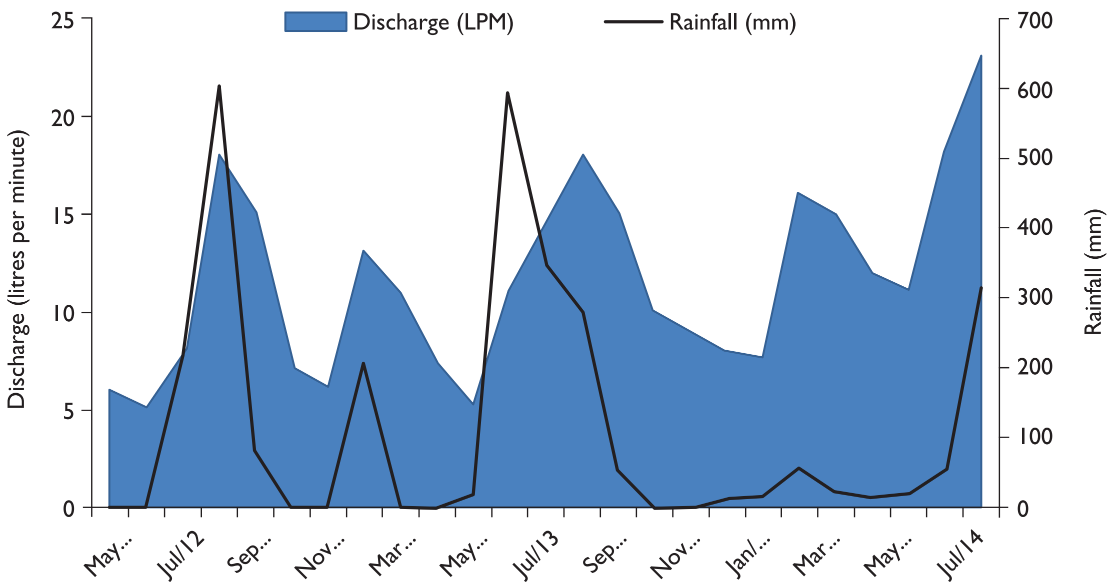

Figure 2. Spring Discharge and Rainfall, Dhalyi Spring

Source: PSI (2015).

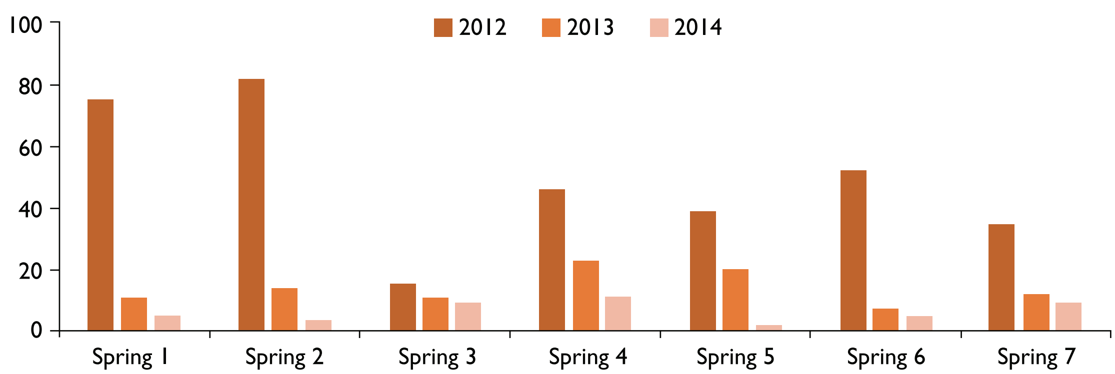

Figure 3. Reduction in Faecal Coliform Pre-2012 and Post-(2013–2014) Spring Protection

Source: PSI (2015).

and as a part of the Central Ground Water Board's (CGWB) aquifer mapping activities (CGWB).

Several other efforts by the Ministry of Water Resources, River Development and Ganga Rejuvenation (MoWR) also offer encouragement to practitioners; these include the recent announcement to restructure the two specialized organizations within the MoWR that manage surface and groundwater—the Central Water Commission and Central Groundwater Board to develop integrated water resources management and development and facilitate adoption of basin/sub-basin as a hydraulic unit.[3] MoWR has also been holding widespread consultations with sector experts to understand groundwater exploitation, and design better management protocols.

Another effort to mainstream groundwater management is happening through the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY). Launched this year with an outlay of INR 500 billion over the next 5 years, PMKSY seeks to provide assured irrigation to every farm[4] by creating implementation plans at the district level and collating these for the state (Ministry of Agriculture and Farmers Welfare, 2015). The National Watershed Management Project or Neeranchal which has an outlay of INR 21.43 billion will be implemented as a part of the PMKSY.[5] Neeranchal incorporates concepts from the PGWM approach. In fact, the resource centres of the PGWM programme and three other expert organizations have been approached to conduct trainings at the state, district and block levels.

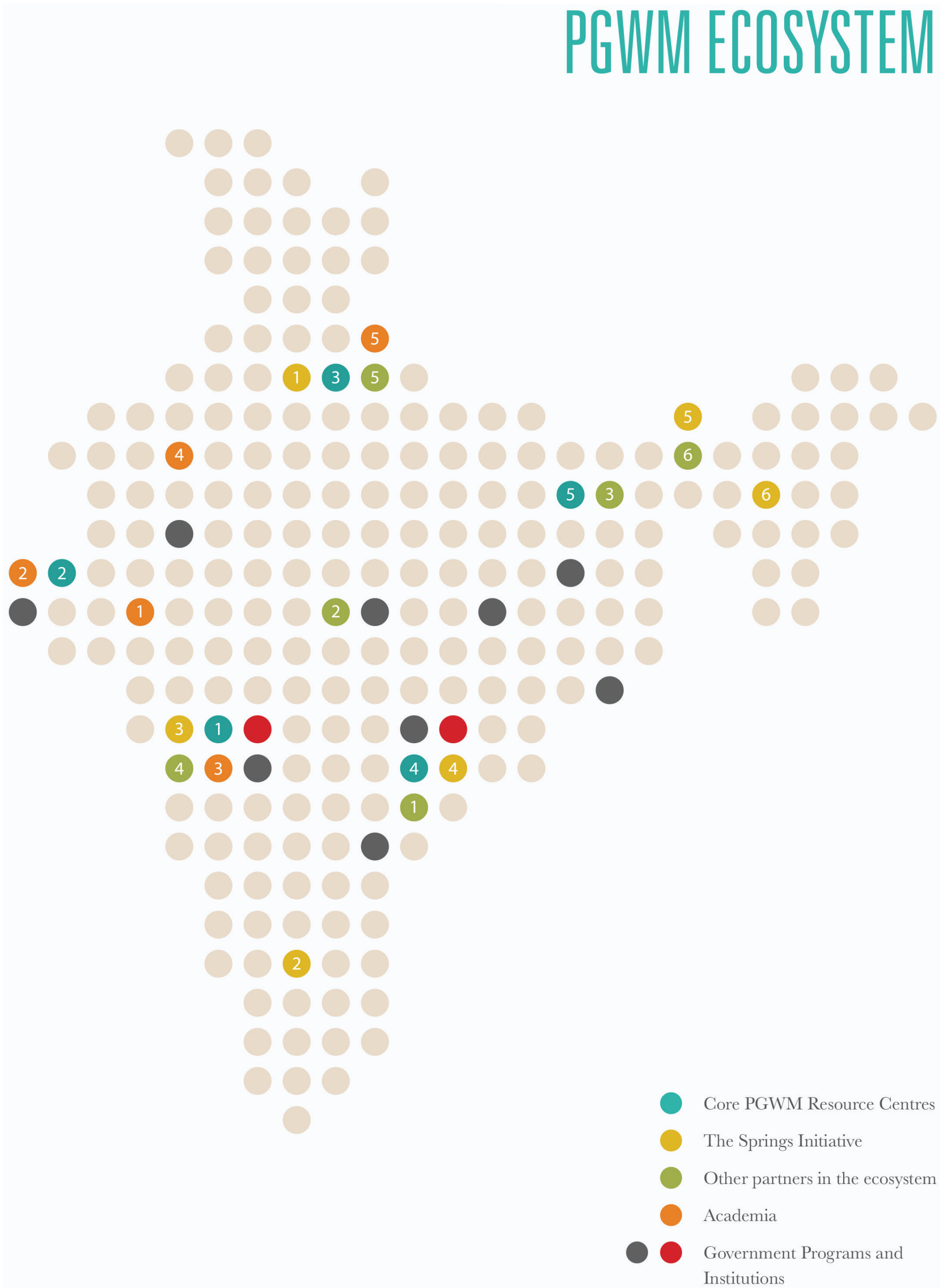

Figure 4. Spread of PGWM Programme

Source: Arghyam (2015).

Conclusion

The inclusion of groundwater management and aquifer mapping as a part of the 12th Five Year Plan, the subsequent creation of a National Project on Aquifer Management and revisions to Model Bill on Groundwater at the Government of India level, and inclusion of aspects of PGWM in implementation of government programmes in various states have happened with inputs from partners to the PGWM programme. The PGWM approach, therefore, has reached a good balance between testing solutions on the ground and theorizing this practice into solutions that can be embedded into a governance framework. However, if these solutions have to succeed on scale, there are some unresolved issues that need to be tackled on priority.

The first and perhaps the most important is the nature of groundwater ownership. For protocols for groundwater management to succeed, it is important to embed the idea that groundwater is not a privately owned resource, to be exploited by owners of the land as is common practice today, but a CPR that is to be shared and managed by across stakeholders. This assumes special significance in the context of the landless and more marginalized sections accessing water resources in an equitable manner.

Reconciling the myriad uses of groundwater to ensure a common understanding of the resource and, therefore, its use is another challenge. This will involve not only conversations between the multiple users of groundwater but also convergence between the various institutions that govern them. Investments in groundwater, therefore, have to take cognizance of the institutional mechanisms for regulating supply and demand in the context of all the users of groundwater. Prioritization, for instance, of water for life and basic needs (drinking, cooking, hygiene and, some argue, subsistence livelihoods) will be critical to evolve basic frameworks to regulate and manage groundwater use.

Notes

1. Lessons for this section have been drawn from a detailed Action Research Report—ACWADAM (2014). The authors can be contacted for the full report if required.
2. The Bill is accessible at http://www.planningcommission.nic.in/aboutus/committee/wrkgrp12/wr/wg_model_bill.pdf (accessed on 12 November 2015).
3. Ministry of Water Resources, River Development and Ganga Rejuvenation (MoWR). Order Dated 11 September 2015. Constitution of Committee on Restructuring CWC and CGWB for optimal development of water resources in the country in the background of integrated water resources management.
4. Available in a press release from Government of India, accessible at http://pib.nic.in/newsite/PrintRelease.aspx?relid=122935 (accessed on 12 November 2015).
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