#### Epistemologies of Community-based groundwater recharge in semi-arid north Rajasthan: progress and lessons for groundwater-dependent areas

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#### Abstract

Increasingly relied upon, groundwater is nevertheless relatively underappreciated and understudied. Perhaps as a consequence of these facts, around the world unregulated exploitation is placing this resource under increasingly intense pressure, necessitating new governance systems if a negative spiral of ecological, social and economic decline is to be avoided. In this paper we examine, using Ostrom's well-known framework for common pool resource (CPR) systems, a community-based groundwater recharge scheme based on Gandhian principles in the Arvari River catchment in semi-arid north Rajasthan. Literature reviews, field visits and interviews with local experts confirm that local initiatives are reestablishing previously defunct traditional village community structures alongside traditional community-designed and maintained water harvesting structures. This new socio-technical complex is increasing groundwater recharge during monsoon rains and thereby regenerating aquatic, farmed and natural ecosystems. The previous negative downward trajectory has been replaced with a positive spiral of environmental, social and economic regeneration.

#### Keywords

Rajasthan, semi-arid, groundwater, recharge, governance, common pool resources

#### 1. Introductio

Groundwater is an especially important resource in arid and semi-arid regions, where surface water is scarce and subject to high evapotranspiration losses. Human dependence on groundwater has increased in many regions globally, including North America, the Middle East, East Africa and south Asia. However, the 'hidden' nature of groundwater means it is often the victim of administrative, and also sometimes scholarly, neglect rendering it relatively easy to unwitting overexploitation(Downing, 2002; Glennon, 2002; Staddon, 2010). Globally, groundwater is the most extracted natural resource, providing over half the world's fresh water for uses such as drinking, cooking and personal hygiene, as well as providing up to 20% of the need for irrigated agriculture (Aureli and Ganoulis, 2003; Eckstein and Eckstein, 2005; United Nations, 2003). Groundwater supplies 75–90% of drinking water supply in some European countries, and 95% of the rural population of the USA relies on groundwater for public water services (Eckstein and Eckstein, 2005; Glennon 2002; Mateljan, 2007; United Nations, 2003). Whilst groundwater is underexploited (and still being discovered) in some regions, other regions experience unsustainable extraction rates grossly exceeding natural replenishment. Lack of appropriate monitoring of abstraction, recharge rates and resource status contribute to a mounting groundwater crisis in many parts of the world. Qualitative challenges too abound: arsenic contamination of groundwater in developing nations such as Ethiopia and Bangladesh is becoming a serious public health issue (SOURCE). The global movement away from locally-embedded water governance systems towards centrally mandated and increasingly neo-liberalised systems also complicates our attempt to examine successful *local* responses to the above challenges (cf. Budds and McGranahan 2003; Staddon, 2010; Staddon, Langberg and Sarkozi, 2015).

Groundwater supports over 85% of India's rural domestic water requirements, 50% of urban and industrial water needs and nearly 55% of irrigation demand (Government of India, 2007). 92% of India's groundwater extraction is used for irrigation (Central Ground Water Board, 2006). The area of groundwater-irrigated agricultural land increased by nearly 105% in the two decades to 2009 (Jha and Sinha, 2009). The number of mechanized wells escalated in the last four decades of the twentieth century, from less than one million to more than 19 million in the year 2000 (Jha and Sinha, 2009). Across India, more than 22 million operational wells

support the rural economy (Wani et al., 2009). Groundwater exploitation has also contributed significantly to poverty reduction in rural India, and to wider socioeconomic development and the Indian economy in general. Small and marginal farmers comprise 20% of the total agricultural area, yet control 38% of the net area irrigated by wells (Jha and Sinha, 2009).

This chapter focuses on groundwater management in a semi-arid region of the Indian state of Rajasthan, the location of an ongoing "experiment" in community-led groundwater recharge which we argue constitutes nothing less than a new political epistemology of water. In particular, we use an empirical case study of local management of groundwater in the Arvari catchment of Rajasthan to argue that an Ostrom-type common pool resource (CPR) regime can not only operate effectively, but can constitute a model for adaptive management based not on a backwardlooking romanticism (cf. Gupta, 2011) but on advanced groundwater science and democratic decision-making combined with a restoration of "Ghandian" principles of interaction between competing users and with the natural world. Notwithstanding pressures to privatise and marketise water rights and allocation we argue that sustainable development's "triple bottom line" (social, environmental and economic) can sometimes be better served by locally embedded non-market governance regimes.

Our analysis is located at the junction between critical political ecology (Forsyth 2002; Staddon 2009) and institutionalist perspectives on common pool resource (CPR) management (Ostrom 1990; 1997). We suggest that the requirements outlined by Ostrom for a well-functioning CPR are present in Alwar District, including:

- Clearly defined boundaries to the commons
- Consistent appropriation and provision rules
- Participatory collective-choice arrangements
- Effective monitoring by accountable parties
- Graduated sanctions
- Accessible conflict resolution mechanisms
- Minimal recognition by the State of rights to organise
- Nested governance with local CPRs

However, whilst we do see the TBS programme for groundwater management as a sort of CPR, this insight is not in itself enough to explain either how the system came into being or how and why the Indian state (operating within a highly centralised Nehruvian epistemological frame) has come, very grudgingly, to accept it as the legitimate manager of water resources in Arvari. A political ecological perspective, focusing attention on the politics of relations between competing resource managers (e.g. the Indian state versus TBS), is indispensable for showing how the present situation of uneasy accommodation has shaped both sides of the rivalry. What's more, a political ecological perspective offers the prospect of, as Staddon (2009) notes, of seeing the epistemological shifts attendant on the hearing of often unheard (or ignored) voices; of women, ethnic minorities, the aged, etc – *and indeed of the 'environment' itself*. This sort of "critical political ecology" is more than mere stakeholder engagement as it is attuned to the ways in which previously marginalised voices can produce meaningful discourses about the natural world which subsequently result in material practices of management and exploitation of the natural world (cf. Forsyth, 2002).

For us the TBS case study is interesting not just because it involves a successful challenge to Nehruvian state-centric neo-liberalisation of water resource, but because it demonstrates that success often relies on a new ontological and epistemological politics of community-environment relations. For other critical scholars of groundwater management, "social capital" is a key aspect of local success (Lopez-Gunn, 2012), and this is where TBS has been particularly successful. Specifically TBS has sought to replace the centrally-mandated and highly bureaucratised groundwater management capacity (which we term here "Nehruvian" after Jawaharlal Nehru) with locally-rooted management structures more closely aligned with local structures of administration and legitimation (which we term "Gandhian" after Mahatma Ghandi).<sup>1</sup>

The analysis presented in this paper is part of a long-running engagement with the Arvari region initiated by one of the authors (Everard) in the 1990s. We have made considerable use of the large, but mostly "grey", literature on groundwater management in this part of Rajahstan (e.g. Agrawal, 1996; Jayanti, 2009; Rathore, 2003). This literature has been cross-referenced with other literatures on groundwater management in developing areas and/or community-based approaches to water management, in particular Birkenholtz (2009), Lopez-Gunn (2009) and

<sup>&</sup>lt;sup>1</sup> In our reading, Nehru sought to use the power of a strongly centralised and hierarchically organised Indian state to rapidly achieve development aims, albeit at the cost of bureaucratisation and effacement of traditional administrative systems. Conversely Gandhi sought to inject already existing local management systems with a stronger sense of equality (especially between castes and between men and women).

Subramaniam (2014). Desk-based research has been augmented by direct observation and data collected by Everard during field visits to the TBS ashram (headquarters) and neighbouring villages in the Arvari catchment in 2013 and 2015. Interviewees included TBS staff (Rajendra Singh, Abhinav Agrawal<sup>2</sup> and Kanhaiya Lal) as well as village elders (particularly Rooparam, the headman of Hameerpur village, and a number of other local decision-makers). Ad hoc discussions took place with other local people, for which TBS staff acted as translators. The catchment visit was augmented by telephone and other electronic discussions with various people with experience of ecosystem management in the district (Dharmendra Kandal, Director of the NGO Tigerwatch) as well as others with international expertise in wetland and catchment management. Additionally, we are separately attempting to appropriately classify and document the growing abundance of biodiversity (flora and fauna) created by successful groundwater recharge.

For convenience we have organised and presented data according to the "STEEP" (Social, Technological, Economic, Environmental, Political) model, developed initially to assess a range of global change issues (Morrison and Wilson, 1996) but also applied to analyse the interconnectedness of different domains of human activity and their interplay with regard to meeting the goals of sustainability (Steward and Kuska, 2011). Application of STEEP by Everard et al. (2012) and Everard (2013) has proved valuable for understanding the systemic relationships between the constituent parameters of the STEEP framework to support water and development issues in South Africa and Europe, particularly in relation to technology deployment and associated governance systems making water available to people and for economic uses. In the case explored here, the STEEP framework provides a platform for exploring the higher order analytical issues raised by applications of CPR and political ecological approaches. We conclude the paper with a few key lessons that are transferrable to water management in other arid and semi-arid, groundwater-dependent regions, with suggestions for follow-on research.

# 2. Groundwater Use and Dependence in Rajasthan's Alwar District

The Arvari (or Arwari) River Basin, a predominantly rural catchment with a rapidly growing population lying within the Alwar District of north-eastern Rajasthan, is the

<sup>&</sup>lt;sup>2</sup> not related to the author of Agrawal, 2009 cited elsewhere in this chapter

geographical focus of this study (Figure 1). The oldest of the historical Rajathani kingdoms, Alwar District has a land area of 7832 km<sup>2</sup>, representing about 2.5% of the total area of the contemporary state of Rajasthan. The 2011 Indian census put the total population of Alwar District at 3,671,999, a 23% increase since the 2001 census (http://www.census2011.co.in/census/district/429-alwar.html). The Beekampura Village, through which the Arvari passes, has a population of approximately 1000 people and is located 70 km from Alwar town via routes #248 and #55.

Located southwest of Sariska National Park, the Arvari River catchment is semi-arid, occupying an area of 476 km<sup>2</sup> and comprising 46 micro-watersheds (Glendenning and Vervoort, 2010; Rathore, 2003) through which the now-perennial 90 km river flows on its way to its confluence the Sarsa and Baghani Rivers, before joining with the much larger Bangangra River. Long-term average annual rainfall for the District is 657.3 mm, though this rainfall is unevenly distributed both spatially and temporally, strongly affecting agricultural potential. Available renewable surface water per person is under 1400 m<sup>3</sup>/year, making Alwar District "water stressed" according to the common metrics used by UNEP.

Agricultural production in Alwar district is significant within Rajasthan, with irrigation mainly supplied from wells and tube wells supporting about 83% of the cultivated area of 507,171 hectares. A considerable proportion of the irrigated area is double-cropped. An estimated 35,470 electric motors and 66,502 diesel pump sets are used for irrigation purposes (<u>http://alwar.nic.in/</u>, accessed 1<sup>st</sup> September 2014). This cultivated land is used for the production, in declining areal extent, of Bajra (pearl millet), jowar (sorghum), guar (cluster bean), maize, arhar (pigeon pea), cotton, ground nut, rice and pulses (<u>http://www.alwar.nic.in/Agriculture.html</u>, accessed 1<sup>st</sup> September 2014). Owing to the predominantly vegetarian diet of Alwar residents, rough grazing occurs but is not intensive.

Rathore (2003) reports that the valleys of the Aravali Hills were well-vegetated up to mid-1930s. At this point, timber rights were sold to private interests, and within ten years ecological decline and associated increased incidences of both seasonal flooding and drought ensured. Sale of forest rights and sub-lease of land for mining were reportedly instigated by a prince anticipating that a free India would take away his primacy (http://tarunbharatsangh.org/where%20we%20do.html, accessed 1<sup>st</sup>

September 2014). Around the same period, administrative reforms passed water management responsibilities from local to state and national government control. Ceding of water management responsibilities from local control led in turn to a shift in perception about the value of water, disengagement of local people with management of their own assets and responsibility for supply-side management, and hence widespread abandonment and consequent degradation of community water management structures (Rathore, 2003). The emphasis shifted instead to greater mechanical efficiency in resource exploitation, including a decline of bullock-operated wells with greater investment in energisation (diesel and electric pump sets) for extraction from ever-deeper wells and tube wells.

This led to substantial depletion of groundwater, prompting a range of adverse ecological, social and economic consequences. Government data reported by Rathore (2003) records that groundwater extraction in Alwar district was 66% of the available resource in 1984, 110% in 1988, 108% in 1999, 119% in 1995, 100% in 1998 and 118% in 2001. Continued overexploitation is clearly unsustainable, contributing to a cycle of linked adverse ecological and social eco-degeneration, leading people to migrate away from the villages of Alwar district to cities mirroring depopulation trends across considerable areas of rural India apparently subject to a similar cycle of groundwater overuse. Rathore (2003) stated that "Migration to urban and peri-urban areas is symptomatic of the deepening crisis in the farm and rural sectors", substantially driven by declining access to water.

At this time, excessive withdrawals of groundwater for crop production in Rajasthan had depleted the shallow aquifers, with groundwater levels receding to below 100 metres below surface level in many places, substantially reducing the amount of land that could viably be cropped and with forest cover also declining to between 3% (Subramaniam, 2014) and 7% (Singh, 2009) of land area, with only 28.6% of the notified forest area on the Aravali hills showing up as green in remote sensing in 1984 (Down to Earth, 1999a). The combined effects of hydrological poverty, principally on the viability of stock and crop production and fuel wood availability, led many people to desert their villages. Water is clearly the critical resource as regards local sustainable livelihoods.

Groundwater depletion has serious potential social and economic implications, constituting the key nexus in the negative spiral of interlinked ecological, social and

economic degradation leading to community decline. Downing (2002), Seckler et al. (1999), Postel (1999), Vaidyanathan (1996) and others observe that the still largely unregulated pump irrigation revolution observed across much of South Asia, particularly since the 1970s, is leading to serious socio-ecological threats. Seckler et al. (1999) in particular warned that a quarter of India's food harvest was at risk if groundwater management was not improved, with Postel (1999) suggesting that 10% of the world's food production depends on overdraft of groundwater with 50% of this area located in Western India. Singh and Singh (2002) estimate that declining groundwater levels could reduce India's harvest by 25% or more. Failing water resources represent a major threat to food security in India (Kumar, 2003). There are also significant distributional impacts associated with groundwater over-extraction, as the relatively high costs of deepening the generally shallower wells owned by small and poorer farmers often excludes them from access to water long before wealthy farmers and other affluent users (Moench, 1994).

However, groundwater can also be responsive to positive management, providing a range of benefits to dependent communities. Wani et al. (2009) report significant groundwater rises in 'treated areas' where community-based participatory methods have been developed at benchmark sites in several Indian states/provinces, as well as in Thailand, Vietnam and China. These initiatives, which bring together institutions from scientific, non-government, government and farming sectors, have been found to improve productivity by up to 250%, as well as to restore groundwater levels and to reverse the degradation of natural resources (Wani and Ramakrishna, 2005; Wani et al., 2006). Community empowerment was also found substantially to improve the livelihoods of poor people in 368 experimental watersheds across Asia. In many of these experimental watersheds in India, including the Bundi watershed in Rajasthan, water levels in wells close to community-constructed and maintained WHSs were found to have better and more reliable yield both quantitatively and qualitatively compared to more remote wells (Wani et al., 2009). Groundwater levels in the Bundi watershed of Rajasthan within this wide trial were observed to rise by 5.7 metres, with a corresponding 66% increase in irrigated area (Wani et al., 2003). However, some of this enhancement is being offset by increases in numbers of boreholes dug to exploit the enhanced groundwater. So, despite (state and international NGO-mandated) collective action aimed at regenerating groundwater

levels, no corresponding concern or awareness was observed amongst villagers relating to sustainable use of groundwater. This highlights the need for community participation, supported by appropriate social and institutional mechanisms, to instigate and coordinate action at village level to monitor groundwater and its allocation to individuals. Integrated watershed management (IWM) approaches, emphasising in-situ conservation of rainwater at the farm level, including locally-appropriate WHSs that make water available for surface irrigation or aquifer recharge, recognise the interdependence of water resource stewardship with food production and human security (Wani et al., 2009).

# 3. The Taran Baharat Sangh Programme of Water Management in the Alwar Region of Rajasthan

Tarun Bharat Sangh (TBS, translating as 'Indian Youth Association') is an activist organisation inspired by Gandhian philosophical principles, particularly those related to non-violent resistance (in this case to the neoliberal "Nehruvian" Indian state) and self-reliance. It was established by Rajendra Singh (sometimes now referred to in the media as the "waterman" or "rivermaker") in 1985 against a backdrop of rural depopulation and economic and ecological decline initially following colonial exploitation and then, after 1947, successive waves of state-brokered "accumulation" by dispossession" (Harvey, 2003) with respect to water and land resources (Subramaniam, 2014). TBS has been active in the simultaneous restoration of the supportive natural resources of soil, water and ecology and of human livelihoods, understood from their Gandhian perspective as interdependent. The key educational emphasis of TBS changed in 1985 when Singh has told by a village elder that the primary issue in the region was not lack of education but lack of water (Jayanti, 2009; Singh, pers.comm.). Many rivers in the region, including the Arvari, had by then stopped flowing or flowed only intermittently, and agricultural land productivity was at an historic low and still declining. Reversing this trend became a priority for the fledgling organisation, located in an ashram near the town of Thanaghazi in the Alwar district of Rajasthan.

The principal work of TBS has therefore revolved around very locally and the practically-focussed measures. The approach of TBS is defined as "Community self-reliance through natural resource conservation", embedding the Gandhian ethos of

*Jal Swara* including participation, equity and decentralisation at the heart of water management (Jayanti, 2009). In particular, this revolves around restoration or creation of small, localised WHSs that can recharge groundwater, restoring greenery and soil moisture of villages and rejuvenating local rivers.

Taking heed of the counsel of village elders, Singh and colleagues took advice from a lower-caste older lady to build *talabs* (a kind of small pond created by shallow bunds) near the village of Mangu Meena to stop and store water during the concentrated monsoon period, allowing it time to subsequently percolate into the ground and recharge groundwater. The first such water capture structure was built by the villagers of Bhaonta-Koylala. Construction was considered risky, and results uncertain, but the dam functioned as anticipated, restoring soil moisture and ecology for improved food production, rejuvenating local grazing and other vegetation, and re-establishing some vitality to the local river (Singh, 2009). This initial innovation led to a widespread and rapid proliferation of interest from the many parched, depopulated villages in the vicinity. TBS activities correspondingly expanded to other villages as they attracted funds, mainly from international donors, for constructing WHSs. Construction of hundreds of johadi, talabs, etc. was to follow, with TBS contributing 50% of costs largely from international donor sources matching investment by beneficiaries in the villages of the Arvari watershed. Significant catchment-scale outcomes ensued, leading Singh to remark that "We never realised that we were recharging a river. Our effort was just to catch and allow water to percolate underground" (Down to Earth, 1999b). Demand for building WHSs remains high in villages; but TBS is only able to build or renovate around 300 structures annually due to funding limitations.

Construction and management of WHSs is central to TBS activities, in many cases resurrecting traditional technologies and knowledge and the social infrastructure necessary to operate them sustainably. The importance of social infrastructure cannot be overstated because without it the physical structures are vulnerable to neglect and abandonment. Therefore, TBS only responds to demand from village groups, and works to improve local management and decision-making processes along Gandhian principles. Consequently, the process of building and maintaining WHSs has been coincident with the resurrection of traditional village institutions in many villages (Kumar and Kandpal, 2003). Prominent among these are 'Gram

Sabha', traditional village decision-making bodies whose interests include discussion and decision-making about water management (Jayanti, 2009). Whilst some Gram Sabha became dormant after construction of johadi, many remained active where support from TBS continued, building social capital with some village institutions then progressing to tackle other related issues including protecting forests, building schools and other developmental works (Kumar and Kandpal, 2003). In considering ongoing wise stewardship of water resources, Gram Sabha are frequently also active in zoning of land-use and regulating uses of pastureland to avoid ecological degradation with broader social and economic consequences (Singh, pers.comm.)

WHS designs promoted by TBS build on this tradition of fitting with local needs, topography, microcatchment area, knowledge and budgets. Three generic principles are applied to technical design: convex dams bulging upstream to intercept water in high slope catchments; flat check dams (anicuts) on wider micro-catchments with low slope; and concave earth-banked johads in flatter topography. Each structure can serve multiple purposes, determined by local needs and knowledge. All have a primary purpose of promoting water infiltration to recharge groundwater, which is then far less vulnerable to evaporative loss than surface reservoirs. Trees are also used to promote hydrology, both in terms of reforesting denuded hillsides but also plantings on southern banks of some johadi for shading to reduce evaporation.

Some, though by no means all, johadi have additional capacity to store open surface water throughout the dry season for use by livestock (personal observation; Singh, pers. comm.; Rooparam, pers. comm.; Kanhaiya, pers comm.). Anicuts built across flat valleys to attenuate water flows can retain a significant body of surface water during monsoon rains that slowly percolates to ground to recharge wells but also to moisten and carry nutrients into soils that are then cropped intensively throughout the dry season, with mustard, channa (chick peas), bindi and wheat the predominant crops (personal observation; Singh, pers. comm.; Rooparam, pers. comm.; Kanhaiya, pers comm.).

Responding only to demand from villages (rather than individuals) has the potential weakness of fragmenting action across the landscape (Kumar and Kandpal, 2003). To achieve a more integrated approach, TBS promoted formation of an Arwari Water Parliament, or Pad Yatra which from its inception in December 1998 meets twice a year to determine water sharing and management issues, including dispute

resolution, across the catchment (Rathore, 2003). Across the Arvari catchment, an Arwari Council was established operating on the basis of seven principles and nine informal rules (Rathore, 2003, pp47-48). The Council has identified measures such as reforestation of the formerly forested but subsequently degraded Aravali Hill range to improve catchment hydrology (Jayanti, 2009). At local scale, village development committees (VDCs) have also been established throughout the catchment, instigated by village elders to promote local collaboration in water management.

By 2010, TBS was working with more than 700 villages in Rajasthan and had completed more than 200 johadi and related works (Subramaniam, 2014), although reported numbers of johadi constructed varies in different literature including, for example, published figures of 366 (Glendenning and Vervoort, 2010), 375 Jayanti (2009), 650 (Down to Earth, 1999a) and 3,200 (Kumar and Kandpal, 2003). In 1998, TBS also launched 'Jal Biradari' ('National Water Brotherhood'), comprising individuals from all walks of life – farmer groups, social groups, voluntary organizations, NGOs, research institutions, social scientists and water experts – concerned about water conservation, forest and soil management and promotion of water conservation work, as well as the re-establishment of community water rights through awareness programs and Jal Sammelans (conferences) aimed at developing people-oriented national and state water policy (http://www.tarunbharatsangh.org/programs/jalbiradari/about.htm, accessed 1<sup>st</sup>

# September 2014).

As we shall see however the experiences of TBS-brokered social-ecological infrastructure in Arvari has not been uniform, smooth or entirely free of challenge, particularly from the state and central governments, whose perspectives on water management are very different and whose departments wield far more institutional and legal power than TBS and local johadis.

# 4. Review of Outcomes in the Arvari Catchment

In this section, we present outcomes of our empirical work in Rajasthan. In the concluding section, we reflect on the political ecological dimensions of this emergent CPR system, using the STEEP framework to thematically structure our analysis.

#### Social outcomes

Ecological and hydrological recovery has reversed the trend of abandonment of villages in the Arvari catchment. Children and young people are now more likely to remain in their villages, and schools are thriving as people anticipate viable livelihoods. Also, johadi and other WHSs build on existing cultural traditions of the area, and are a 'seed crystal' for revitalisation of the traditional governance arrangements such as Gram Sabha that are central to their continued operation. These are fully social-ecological systems.

Significant amongst the successes of TBS and community initiatives around integrated water management is the empowerment of women who, freed from the drudgery of traditional roles foraging for water, fodder and fuel in a water-stressed environment, have more time to participate and learn following ecosystem restoration (Jayanti, 2009). In 1985, women would typically spend 6-7 hours daily searching for and carrying water but, as a result of rising water tables and access to water through installation of hand pumps and wells close to housing, this now takes much less time (Singh, pers. comm.) TBS has been further active in empowering women through enabling democratic engagement and in education including Ayurvedic (traditional herbal) medicine. TBS has also encouraged the formation of Women Self Help Groups (SHGs) to strengthen the role of women and share learning throughout the catchment (Rathore, 2003). Kumar and Kandpal (2003) confirmed that the revival and construction of water harvesting infrastructure made a significant reduction in drudgery of women in fetching water, fuel wood and fodder, with women's groups also becoming more active in tackling perceived 'social ills', including the education of girls and health services. Declining drudgery across all sectors of society, particularly women, contributes to greater potential for engagement in village-scale decision-making and other productive activities.

However, social challenges remain. Major disconnections remain in terms of resource ownership and capacity to access water. This is not helped by the established framework of top-down regulation and economic incentives emanating from the central Indian state. Cochran and Ray (2009) consider equity as central to community-based development efforts, in particular rainwater harvesting programmes as evidenced in two Rajasthani communities. The 'symbolic capital' of contributing to project design and development was observed to be central to

"...community understandings of equity as the distribution of benefits from the project", serving to retain community heterogeneity through a very open and broadminded approach to costs and benefits. Damle (2009) notes that there is a need for a water pricing policy that protects the rights of both small and large farmers and creates incentives for local groundwater recharge solutions whilst enabling industry to operate.

Rathore (2003) found that 58% of surveyed households in the Arvari catchment preferred community ownership of water resources in forest areas, but 42% feared capture of community governance and land assets by the richer members of their own communities. According to Subramaniam (2014), this is already happening in some villages, because larger landholders can better afford to drill wells, allowing them to exploit restored groundwater flows. Moreover, successive Five Year Economic Plans, a key management tool deployed by the central government, clearly sees water as "a commodity in exactly the same way as any other resource". Worse still, whilst local johadis clearly see systemic interconnections between water, forests and agriculture, the siloed government ministries see only univalent optimisation and maximisation logics. Many local people even reject proposals for "public-private partnerships" in resource management because past experience shows that the benefits of such are usually asymmetrically distributed.

# Technological outcomes

Kumar and Kandpal (2003) conducted a review of TBS projects between 1994/5 and 2003, cumulatively representing a total investment of 16.2 million Indian Rupees (approximately US\$4.7 million). Kumar and Kandpal (2003) found that "*The scale of work adopted by TBS is staggering*…" which had "…*shown that rejuvenation of traditional water harvesting structures on a wide scale is indeed possible*". Kumar and Kandpal (2003) observed that work promoted by TBS had a positive impact on water availability in the region, both in agriculture-dominant and animal husbandry-dominant villages, resulting in significant economic gains, greater protection against ill-effects of drought and a marked reduction in distress migration. Soil erosion was also reduced significantly by measures such as voluntary field bunding, and farmers

were also able to diversify into cash crops as well as livestock composition due to assured water availability.

A subsequent review by Jayanti (2009) found that 375 WHSs had been built over 25 years across the Arvari catchment, raising the water table and re-vegetating the landscape in a positively self-perpetuating dynamic. Furthermore, whereas the Arvari River had been dry outside of the monsoon season in the late 1980s, by 2009 it ran perennially as a result of successful groundwater rehabilitation. In the wider Alwar district, more than 10,000 WHSs had been constructed between 1994 and 2008, restoring perennial flows to five formerly seasonal rivers – the Bhagani-Teldehe, Arvari, Jahajwali, Sarsa and Ruparel – benefitting 250 villages and their local natural environments(Jayanti, 2009).

Glendenning and Vervoort (2010) recorded over 366 WHSs built in the Arvari catchment since 1985. They also estimated potential recharge from seven WHSs, across three different types and in six landscape positions based on monitoring of water level fluctuation in 29 dug wells. The average daily potential recharge from WHSs varied between 12 and 52 mm/day, while estimated actual recharge reaching the groundwater ranged from 3 to 7 mm/day. The large difference between recharge estimates could be explained through soil storage, local groundwater mounding beneath structures, and lateral transmissivity in the aquifer. Overall, approximately 7% of rainfall recharged groundwater via WHSs in the catchment during both the comparatively wet and dry years of field analyses, with key differences between WHSs due to engineering design and location. These results indicate that recharge from WHSs affects the local groundwater table, but also has the potential to move laterally and impact surrounding areas. However, the greatest weakness in such analysis is the lack of information available on aquifer characteristics, in addition to geology and soil type.

A further study testing the approach and outcomes achieved by TBS drew upon 'hard' physical science and engineering data as well as the narratives of local people from 500 families in 36 affected villages (Agrawal, 1996). 90% of the efforts and financial resources routed through TBS were observed to be directed at water harvesting and conservation, including linked soil and forest conservation. Agrawal (1996) noted that no hydrological calculations were completed to assess volumes of storm run-off, flood flow and the amount of water needed by local people, all of which would have been required as inputs to a more structured engineering approach to the design of WHSs. Selection and specification of design of WHSs was instead based on instinct, deliberation and consensus within village committees. Using rainfall data, addressing both amount and timing, and assuming run-off coefficient, Agrawal (1996) determined an ideal storage capacity of 1000 m<sup>3</sup> ha<sup>-1</sup> of catchment area to capture flow and promote infiltration, but that "The optimal Johad storage for these areas would be 1000-1500 m<sup>3</sup>/hectare which would raise annual average groundwater table by 20ft". Comparing this 'ideal' with 166 community-engineered johadi in the Arvari catchment, Agrawal (1996) considered that 35 were too small, 49 were small, 61 were optimal (800-1200 m<sup>3</sup> ha<sup>-1</sup>), 16 were superfluous and only five were excessive, providing strong evidence that traditional knowledge routed through traditional consensual processes, though not quantified in scientific or engineering terms, produced robust and appropriate designs.

#### Environmental outcomes

Increasing water tables have had profound implications for Arvari catchment ecosystems. Amongst the most visual successes during the field visit was restoration of perennial flows to the Arvari River which, as reported by Singh (2009) and Jayanti (2009), is one of several rivers now flowing perennially in Alwar district that had formerly run only during monsoon rains. During one late summer visit by one of the authors, the Arvari contained significant areas of open water supporting livestock watering and wetland biota. Below the village of Hameerpur (also Hamirpur), wildlife noted in Table 1 was observed (without the benefit of collecting equipment or local keys hence tentative identifications) in large bodies of water held back by check dams constructed for the dual purpose of promoting groundwater infiltration and providing watering of livestock. The extensive beds of hydrophytes and the presence of fish, frogs and odonata and other obligate aquatic organisms demonstrate the permanence of the water body. Singh (pers. comm.) and Rooparam (pers. comm.) report that the fish and other aquatic organisms were not stocked, but naturally colonised the pools. Lack of local knowledge about their taxonomy is in part due to local people being overwhelmingly vegetarian.

At a wider landscape scale, Rathore (2003) reports an increasing area under forest in Thanagazi Tahsil from 8.4% in 1989/90 to 14.37% by 1998/99, with the area under agriculture rising from 42% to 54.9%. The convergence of interests between TBS and the parallel process of emerging collective management of forest resources has been noted by Subramaniam (2014).

Environmental outcomes beyond the rewetted catchment area comprise a balance of positive and negative observations. Jayanti (2009) observed enhancement in grazing in the buffer zone adjacent to Sariska National Park (a tiger reserve), reducing grazing pressure in the core zone of the Park. Kanhaiya (pers. comm.) reports that leopard regularly come down from the Park's mountainous perimeter to drink at johadi, with other wildlife also exploiting the open water. However, Kandal (pers. comm.) argues that reinstating moisture in a naturally dry location may work against tiger conservation through stock encroachment into the Reserve.

# Economic outcomes

Significant economic benefits are observed in terms of food sufficiency and overall wealth as villagers are able to engage in profitable farming, with economic uplift following improved soil moisture and catchment hydrology. TBS has worked with communities in over 1,068 villages in Alwar district, across an area of 6,500 square km, building over 8,600 WHSs by 2008, resulting in shallow aquifer recharge bringing the water table from about 100-120 metres deep to 3-13 metres at present (Singh, 2009). The area under single cropping and double cropping increased from 11% to 70% and from 3% to 50% respectively, improving significantly the livelihoods of farmers. Forest was also reported as increasing from 7% to 40% through agroforestry and social forestry, providing sufficient fuel wood and sequestering atmospheric carbon.

As well as brokering relationships between communities, TBS has also been successful in drawing upon wider funding sources although TBS insists upon a minimum of 30% funding from local communities as an assurance of communal ownership and continued maintenance. 'Sweat equity', in the form of volunteer labour, or *shramdan*, a form of collective labour for local good closely linked to Gandhian ideals of self-sufficiency and mutual aid, is generally at the centre of water structure construction and maintenance.

Agrawal (1996) also compared the costs of water conservation work with their benefits. Community-based collaboration in WHSs design and construction was cheap, assessed in over half of the villages in the Arvari catchment as 0.5-2 Rupees (0.01-0.04 US dollars) per m<sup>3</sup> storage area. Agrawal (1996) found a strong correlation between per capita increase in the value of the Gross Village Product and investment by villages in water conservation work, with a ratio around 4:1, and also between recharge capacity and groundwater rise. The correlation between village investment in integrated water management was stronger for economic uplift than for groundwater rise alone, as the regeneration of soil fertility and moisture, forests and grassland made further contributions. Agrawal (1996) concluded that the johadi stood the test of time and "...are, by and large, engineering-wise sound and appropriate", concluding that "There can be no better rural investment than on Johads".

At village scale, distribution of benefits and shares of costs of WHS construction and management are key issues. Whereas common lands are grazed, croplands are privately-owned. Greater investment in WHSs is required through Gram Sabha by those most directly benefitting from cropland downstream and upstream of anicuts and from the benefits of well recharge (Kanhaiya, pers.comm.).

# Political (governance) outcomes

Kumar and Kandpal (2003) observed that successes achieved by TBS had impacts on State and National level water policies including: formation of a national water network addressing issues of community ownership of water; influencing a refocus of state drought relief works on water harvesting structures; contributing to the Sariska Tiger Reserve's Soil Conservation works; spreading learning to other states; and educating officers within Government. Kumar and Kandpal (2003) also observed that TBS was active in policy advocacy for water management at Rajasthan State level, attempting to steer State Water Policy in a more equitable direction particularly through 'Jal Biradari' networks at nested scales from regional to state and national.

The hydrological recovery of the Arvari catchment has triggered conflict between local communities and the state. Singh (2009 and pers. comm.) reports that, as

fisheries fall under central government control, once fish had colonised the newly restored perennial open waters of the Arvari River, the government of Rajasthan issued a license permitting fishing rights to contractors from outside the region. Subramaniam (2014) reports that, in 1996, the government issued rights to the fish to a private contractor for Rupees 18,700 (US\$1=Rs.45 approximately), although TBS believed the market value to be over Rs 100,000. Hameerpur residents resisted this take-over of their resource, in part recognising that central control of fisheries could be followed by central control of surface waters, also technically subject to central government management, which they regarded as only likely to reignite the cycle of disempowerment, ecosystem degradation and socio-economic decline. Village residents protested and kept vigil so that the contractor would not have access to the river. This led to a conflict between the villagers, the government department of fisheries, and the contractor. The contractor then reportedly put the pesticide Aldrin into the river to kill the fish, creating a dangerous situation as the presence of fish may be partly responsible for the lack of incidences of malaria despite creation of new, substantial surface water resources (Singh, 2009). Pressure on the government led to the annulment of the contract, and no licence for fishing has since been granted in the Arvari.

Moreover, in strictly legal terms most of the concrete anicuts constructed by the TBS are illegal as regulations require prior consent for their construction from the state Irrigation Department. Johadi and similar structures are also implicitly illegal under the Rajasthan Drainage Act of 1956 in which "Water resources standing collected either on private or public land (including groundwater) belong to the Government of Rajasthan". However, recognition of successes at both village and higher political levels up to the President of India have ensured that notices issued by the Irrigation Department have not resulted in follow-up activities. Singh (pers. comm.) has also campaigned with success using India's public-interest litigation (PIL) process against water-intensive industries, such as distilleries, moving into water-sparse parts of Rajasthan, and the operation of mines where prohibited in designated forest areas.

Village-scale community governance has significantly restored the ecology of the Arvari River. However, it was recognised that all villages in the catchment share a common and connected groundwater and surface water resource, necessitating an appropriate form of governance to ensure cooperative and sustainable use. Under

the leadership and guidance of TBS, the 72 villages within the Arvari sub-catchment have formed an Arvari Sansad (Arvari Parliament) to frame rules of water use (Jayanti, 2009), including restrictions on some areas from growing more waterintensive crops such as paddy rice, instituting rotational pasture use, and limiting forest use to lopping tree branches for fuel or cutting poles for construction use but no felling of trees in order to preserve resources of common value. The Arvari Sansad is one of a number of river parliaments based on catchment boundaries established with TBS leadership.

The processes of commodification and privatization by the state as a form of economic neoliberalism have sparked a wide array of popular counter-movements often targeting corporate and state power, seeking to return power to local levels (Haugerud, 2010), in which citizens resist accumulation by dispossession by framing their struggles as efforts to 'reclaim the commons' from perceived constraints on livelihoods by the state or private agencies (Subramaniam, 2014). Indigenous people across India have been found commonly to oppose privatization and to support collective ownership of natural resources such as forests and water (Fenelon, 2012). NGOs have an important and influential role to play in mobilizing citizens and contributing to accumulative practices seeking to achieve local neoliberalism (Subramaniam, 2014).

# 5. TBS-brokered WHSs as Part of a New Political Epistemology of Water in the Arvari Catchment

This review of community-based water management in the Arvari catchment highlights close linkages between productive ecosystems, social and economic outcomes, and local and participatory governance in ensuing technology choice and management. This strong interdependence between livelihood choices, locally integrated governance structures and the capacity of ecosystems to provide the necessary suite of supportive services is, on our analysis more in line with Gandhian principles than Nehruvian ones. TBS is not the only organisation to have recognised the value of traditional, local-scale water management systems in semi-arid and arid regions of India. However, empirical evidence reviewed in this paper suggests that TBS has been extraordinarily successful in promoting practical outcomes of demonstrable long-term benefit to ecosystems and community structure, and the social and economic benefits that flow from them, sometimes in the face of central government direction. Successes result from the connected reconstruction of social and technological infrastructure appropriate to geography and socio-economic needs, creating a self-reinforcing cycle of ecosystem restoration and enhancement of socio-economic wellbeing. This approach identified the value of traditional technologies and devolved forms of consensual governance, including zoning of land-use, use of pastureland to avoid ecological degradation, and modification of crop production and other uses to better integrate with environmental 'carrying capacity' and the livelihoods of others in the community.

TBS has achieved this by addressing governance and the connection of local solutions at nested scales, from village level (Gram Sabha) to catchment scale (Arvari Sansad), and also influencing both State and National policy by positive example and more directly via Jal Biradari. This nesting is essential to ensure that the functioning of whole river ecosystems remains central, whilst empowering local communities and making use of their context-specific knowledge about environmental conditions and needs. Since the 1990s, the decline of traditional water harvesting systems based on indigenous knowledge and technology has been prominent in the development discourse (Agarwal and Narain, 1997), with technological changes, such as the introduction of electrified tube-wells, leading to individualism and the breakdown of community stewardship (Appadurai, 1990). Balancing rights and demands remains a challenge, which TBS most effectively addresses by consensual agreements within village-scale governance systems rather than centralised controls that appear historically to have contributed to a cycle of decline of the whole socio-ecological system. Difficulties remain in terms of divisions between private and communal landholdings and associated rights, compounded by access by the rich to increasingly powerful pumps and other technological means to appropriate water resources, but these too are factored into local governance and investment models.

TBS adopted a learning approach based on practical outcomes, developing from this a set of guiding principles. In Table 3 we show how, in effect, TBS has brokered development of an Ostrom-type common pool resource (CPR) management regime. Consideration of these principles in Table 3 highlights a high degree of congruence between CPR principles and observed factors behind the success of community-

based groundwater recharge in the Arvari basin. There is close concordance between practices found to be successful in the Arvari catchment and principles advanced by Ostrom, the absence of strong graduated sanctions perhaps representing the weakest area though conflicts are acknowledged and resolved by consensus in village and catchment-scale parliaments. Lopez-Gunn (2012) also found strong connections between successful community-based groundwater management initiatives and Ostrom's CPR principles, emphasising that positive social capital underpins the key factors identified by Ostrom (1990) in selfgovernance systems and the factors that bond and bridge social capital in two Spanish case studies.

Lessons learned from the Arvari catchment may be adapted appropriately to local geographic and socio-economic context in other semi-arid and arid landscapes, particularly where sustainable groundwater management is a priority to address a nexus of water, food and energy security challenges in the face of population growth and climate change. The guiding principles for outscaling include understanding the functioning of ecosystems and the livelihood needs of local people, exploration of technical means to enhance ecosystem functioning (particular water retention and recycling), balancing livelihoods with environmental carrying capacity, and innovation of governance mechanisms at appropriate nested scales to maintain the productive ecosystems and shape exploitative uses from which human wellbeing stems.

There have been attempts by some major industries, including for example breweries and print production facilities owned by large corporations such as SABMiller and Coca-Cola (Confederation of Indian Industry, n.d.), to replicate groundwater infiltration technologies at industrial scale to replenish groundwater in Rajasthan to the extent that it matches factory demand. Singh (pers. comm.) is uncomfortable with this approach, perceiving it as taking away from resources underpinning traditional livelihoods based on sufficiency and self-reliance. However, if we accept that industrialisation is inevitable and therefore the pursuit of a sustainable relationship with natural resources is necessary, the experiment of adapting traditional, local-scale groundwater regeneration techniques to industrial scale must be carefully monitored to see if it can become a viable and sustainable alternative to traditional 'dam and pipe' surface water management approaches within an overall mix of livelihoods.

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Figure 1: Location of Arvari and Adjacent Catchments in Alwar District, Rajasthan



**Table 1:** Characteristics of WHSs and associated water bodies in the Arvari, Sarsa and Baghani catchments visited by one of the authors

Arvar	Arvari catchment					
JS	Jabar Sagar (27.207373°N,76.202331°E, 386 metres altitude) is an anicut on the Arvari river serving farmland around Harmeerpur. It was one of the earliest installed with support from TBS, in the latter half of 1980s. The anicut is the third between the source of the Arvari and Harmeerpur village, but is one of around 100 anicuts and johads within the catchment and 49 in the vicinity of the village. Wheat and gram crops, including a variety of ruderal weeds, are grown right up to the water's edge, which is at its maximum after monsoon rains in July-September after which water level retreats seasonally.					
KA	Anicut near Kalid (Kaler) village (27.155427°N, 76.224163°E, 386 metres altitude), downstream of Harmeerpur. The large concrete anicut holds water in the Arvari river perennially. It is heavily used for grazing with consequently barren banks and bare drawdown zones. Fish of different species were clearly visible, and in 1996 were the subject of a conflict over fishing rights, discussed elsewhere in this paper.					
Sarsa	catchment					
BE	Beechkharaga (27.249158°N,76.30568°E, 403 metres altitude), a newly-completed johad (constructed 10 <sup>th</sup> December 2014 to 27 <sup>th</sup> February 2015) where mountain slope drops to valley edge, serving to retain run-off and recharge aquifer and adjacent open well. The johad is located at the head of a monsoon nala (drainage channel) near Jaitpur village, upper Sarsa catchment, serving land owned by 9 families. The cost of the scheme was 1.8 lakh Rupees, with 67% of costs routed by TBS from the 'Wells for India' fund and 33% provided by the village.					
GP1	Gopalpura (27.268606°N, 76.30753°E, 407 metres altitude), a johad built in 1985 (the first constructed under the guidance of TBS) in the upper Sarsa catchment. The johad holds water all year, recharging groundwater and it is also extensively used for stock watering. There are now 17 water-harvesting structures in the vicinity of Gopalpura, serving 80 families (including the three Chabutra Wala anicuts in the adjacent shallow valley).					
CW	Chabutra Wala (27.270369°N, 76.310328°E, 408 metres altitude) is a series of three anicuts with water level control sluices built across a shallow valley in the upper Sarsa catchment in 1985 by TBS. The anicut surveyed was the highest upstream of three anicuts. The three anicuts retain surface water until the land is ready for sowing, when water is released downstream by removing wooden stoppers from holes in the water control sluice. Farmed land upstream of the anicuts supports crops of wheat, gram, mustard, bindi, brinjal, potato and carrot. Chabutra Wala is one of 17 WHS in the vicinity of Gopalpura, serving 80 families.					
GP2	Johad by road north of Gopalpura (27.276656°N, 76.302532°E, 411 metres altitude). The johad was at the time holding water, but appears to dry down in full summer once all water has seeped into aquifers or evaporated. There was evidence of extensive watering of and trampling by animals.					
GK	Golakabass (27.10133°N, 76.321519°E, 339 metres altitude), a relatively new anicut across the Sarsa River, north-west of a road crossing downstream from which is a broken former dam. The Golakabass check dam spans the river approximately 10km upstream from its confluence with the Sawa River.					
Bagha	nni catchment					
ТІ	Tilda (27.188411°N, 76.414071°E, 329 metres altitude) is a check-dam constructed across the Tilda River, upstream of its confluence with the Baghani River, forming a deep, clear-water pool ringed by patera (the local name for <i>Typha angustata</i> ). A temple is located at the head of the impoundment with ghats (steps to the water's edge) around which fish shoal and swim with bathing children. At the downstream end, women were washing clothes on the concrete check dam, which is also used as a crossing place.					
TE	Tehela (27.249588°N, 76.441471°E, 344 metres altitude), a check dam on the Jalumbragarh river (a tributary of the Baghani system). The Tehela check dam was installed around 2000,					

	near the town of Tehela (population 5-6,000). It constitutes a shallow impoundment					
	supporting extensive stock watering (water buffalo, sheep, goats) with wallowing buffalo					
	present, activities which eliminate much marginal vegetation (except stands of invasive, tall					
	and woody Ipomea carnea growing as an emergent close to the dam wall)					
MAu	Au Mandalwass, upper impoundment (27.277571°N, 76.33273°E, 496 metres altitude), a large					
	dam on the headwaters of the Baghani River built in 1993 immediately above smaller dam on					
	the top of a high mountain ridge. The upper Mandalwass dam is deep (estimated at 18-20 feet					
	in low summer weather) with the head heavily grazed, resulting in little vegetation and dense,					
	greenish (assumed algal) water. This water condition is exacerbated by high fish stocks					
	(reported but unknown species) in the impoundment, for which the village people allot					
	contracts to commercial fishermen providing an annual income used to refurbish the upper					
	and lower Mandalwass dams. The rocky margin of the impoundment was being used during					
	the survey period for washing clothes.					
MAI	Mandalwass, lower impoundment (27.279707°N, 76.333966°E, 496 metres altitude), the lower					
	of two impoundments repaired at the time the larger, upper dam was built in 1993, the					
	impounded water much shallower, clearer and well-established and densely vegetated, located					
	on the top of a high mountain ridge. There are some houses adjacent to the slope to the south					
	of the impoundment, with extensive grazing by buffalo in the riparian zone.					



Table 2: Wetland species observed during site visit near dammed Arvari riverdownstream of Harmeerpur, with generic description and tentativeidentification					
Hydrophytes					
	٠	Potamogeton crispus ? (curly-leaved submerged)			
	٠	Potamogeton spp. (floating-leaved)			
	٠	Potamogeton pectinatus ? (filiform-leaved submerged)			
	٠	Cyperus spp. (emergent marginal)			
	٠	Extensive beds of submerged, rooted Elodea-like plants			
	٠	Oxalis spp. (floating-leaved and emergent forms)			
Wetland birds					
	٠	Red-wattled lapwing (Vanellus indicus)			
	٠	Geese (flock of five unidentified small black and white geese)			
	٠	Moorhens (Gallinula chloropus)			
	٠	Common sandpiper (Tringa hypoleucos)			
	٠	Little egret ( <i>Egretta garzetta</i> )			
	٠	Little cormorant			

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	•	Black-winged stilt (Himantopus himantopus)
Odonata		
	٠	Damselflies (unidentified, small with black body and blue tip to tail)
	٠	Darter (unidentified, small with ruddy colour)
Other aquatic taxa		
	•	Frog (unidentified)
	•	Cyprinid fish (abundant but not identified)

Table 3: Congruence between Ostrom's CPR principles and observations in the Arvari catchment					
Key CPR principles (summarised) from Ostrom (1990 and 1997)	Experience in the Arvari catchment				
Clearly defined boundaries to the common	The focus is on linked surface and groundwater and associated terrestrial systems bounded at village scale, but also at catchment scale				
Consistent appropriation and provision rules	<ul> <li>Gram Sabha set rules allocating shares of water and also designs of WHSs for water capture through a process of village consensus</li> </ul>				
Participatory collective-choice arrangements	<ul> <li>Gram Sabha and Water Councils make decisions on the basis of participation and consensus, guided by elders</li> </ul>				
Effective monitoring by accountable parties	<ul> <li>Gram Sabha and Water Councils also monitor practices and outcomes through consensus</li> </ul>				
Graduated sanctions	<ul> <li>There are no formal sanctions other than the potential opprobrium of the village community; evidence in the Avari is that this is effective</li> <li>Shared investment in WHSs also leads to potential exclusion from benefits, including failing to build structures near the land holding of defaulters</li> <li>However, the absence of formal sanctions may mean that this CPR principle is less strongly observed than other principles</li> </ul>				
Accessible conflict resolution mechanisms	<ul> <li>The Gram Sabha and Water Councils serve as a forum for discussion and resolution of disagreements</li> </ul>				
Minimal recognition by the state of rights to organise	• The social structures have not received the recognition of the state, and the physical structures are also technically illegal given centralisation of legislation				
Nested governance with local CPRs as their base	<ul> <li>Gram Sabha and Water Councils operate respectively at nested village and catchment scales, with TBS also actively influencing State and National scales through mechanisms such as Jal Biradari</li> </ul>				