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Community-based groundwater and ecosystem restoration in semi-arid north Rajasthan (1): Socio-economic progress and lessons for groundwater-dependent areas

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ABSTRACT

Groundwater is a vital resource in arid and semi-arid regions, increasingly relied upon for year-round access, though lack of both study and regulation contribute to unsustainable pressures potentially contributing to a negative spiral of ecological, social and economic decline. Using field visits, interviews with locals and experts, and literature reviews, we explored a successful programme of community-based groundwater recharge in three adjacent catchments (the Arvari, Sarsa and Baghani) in semi-arid north Rajasthan, India, led by the NGO Tarun Bharat Sangh (TBS) in order to determine how successes were achieved and could be replicated. TBS-led initiatives rebuilt traditional village governance structures and participation in community-designed and maintained water harvesting structures (WHSs), which were efficient both economically and in technical design using indigenous knowledge. Enhanced seasonal groundwater recharge enabled by WHSs regenerated aquatic, farmed and natural ecosystems, underpinning a positive cycle of interdependent social and economic regeneration. Locally appropriate, integrated social and technical solutions maintaining this positive cycle have increased the quality of ecosystems and the wellbeing of local people. We used the STEEP (Social, Technological, Economic, Environmental, Political) framework to stratify outcomes, exploring principles underpinning successful local and catchment-scale regeneration and drawing out lessons transferrable to similarly water-stressed regions.

1. Introduction

Groundwater is a vital resource in arid and semi-arid regions where surface water is scarce and subject to high evapotranspirative losses. Human dependence on groundwater has increased globally, with groundwater suppling over half the world's fresh water withdrawals including up to 20% of irrigated agriculture, 75–90% of drinking water in some European countries, and 95% of public supply to rural US populations (Aureli and Ganoulis, 2005; United Nations, 2003; Eckstein and Eckstein, 2005; Mateljan, 2007). However, the 'hidden' nature of groundwater subjects it to administrative and scholarly neglect, and vulnerability to unwitting overexploitation (Downing, 2002; Glennon, 2002; Staddon, 2010). Whilst underexploited in some localities, groundwater extractions elsewhere exceed 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 (Famiglietti, 2014). Global transition towards centrally mandated, neoliberalised systems complicates examination of successful local water governance arrangements (Budds and McGranahan 2003; Staddon, 2010).

This paper addresses community-led groundwater recharge led by the NGO Tarun Bharat Sangh (TBS) in a semi-arid region of Rajasthan state, India. This region had previously experienced a cycle of groundwater depletion and linked ecological and socio-economic decline, TBS-led initiatives since the mid-1980s contributing to reversing this cycle. We draw upon pertinent issues of local governance of groundwater management from the extensive literature on groundwater resource exploitation in arid and semi-arid regions. We also address relationships between competing resource managers, particularly centralised state/national government versus village- and catchment-scale councils supported by TBS, to explore how the system evolved and why the Indian state is beginning to accept it as a legitimate form of integrated water management.

Our research organised knowledge deduced from the literature and field visits around the STEEP (Social, Technological, Economic, Environmental, Political) framework to test the hypothesis that

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multiple and complex factors are entailed in restoring community-based groundwater recharge in target catchments, and further to deduce key lessons about success criteria that are potentially transferrable to other arid and semi-arid, groundwater-dependent regions. STEEP was developed initially to assess global change issues (Morrison and Wilson, 1996). However, it has been applied to analyse systemic relationships in different domains of human activity in meeting sustainability goals (Steward and Kuska, 2011), including deployment of appropriate technology and associated governance systems in management of water, ecosystem service flows and dependent development issues in South Africa and Europe (Everard and Colvin, unpublished;Everard et al., 2012; Everard, 2013) Aside from structuring the analysis of interconnected factors, use of the STEEP framework also helps overcome acknowledged subjectivity due to data limitations in wetland assessment and valuation (Woodward and Wui, 2001) through integration of objective and subjective assessments (Aretano et al., 2013).

2. Methods

Methods comprise three sub-sections: (2.1) review of relevant aspects of groundwater use and dependence in Rajasthan, India; (2.2) overview of case study regenerated river basins; and (2.3) review of pertinent aspects of the Tarun Bharat Sangh programme of water management in Alwar District.

2.1. Groundwater use and dependence in Rajasthan, India

Environmental water resources support multiple indirect ecosystem services and associated societal benefits in addition to direct uses (Everard, 2013). 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 extractions of groundwater are for irrigation (Central Ground Water Board, 2006). Groundwater-irrigated land area increased by nearly 105% in the two decades to 2009 (Jha and Sinha, 2009). Across India, more than 22 million operational wells support poverty reduction in rural India and the wider Indian economy (Wani et al., 2009), with the number of mechanised wells increasing from less than one million to more than 19 million during the last four decades of the twentieth century (Jha and Sinha, 2009). Small and marginal farmers comprise 20% of the total agricultural area yet 38% of the net area irrigated by wells, with 35% of tube wells fitted with electric pump sets (Jha and Sinha, 2009). Globally, the contribution of small and local-scale farming to food security is significantly under-appreciated as approximately 500 million smallholder farmers, many struggling in the face of climate change and economic uncertainty, feed one third of the world's population (Birch, 2012).

Rajasthan is India's largest state, occupying 10% of national land area and encompassing significant regions of desert, mountain, city, wetland and some of the Gangetic Plain in northern India (Fig. 1). However, it contains only 1% of the nation's surface water resources. Consequently, 60% of Rajasthan is arid and 40% semi-arid, 90% of annual rainfall occurring in the monsoon months of July to September (Jayanti, 2009). Agricultural activities in Rajasthan consequently rely heavily on groundwater. However, groundwater overexploitation has triggered mass movements of people from Rajasthan's semi-arid villages towards better watered regions or urban centres offering greater material life prospects (Hills, 1966). Crop and animal husbandry remain important components of Rajasthan's economy yet also contribute to water stress (Hills, 1966). The Government of India classified groundwater zones as ‘white’, ‘grey’ or ‘dark’, depending on degree of exploitation; more than 50% of aquifers were declared ‘dark’ (over-exploited) across Rajasthan (Rathore, 2003).

India has a long tradition of water harvesting adapted to climatic conditions, historical records revealing reservoirs and dams in Rajasthan from the 1660s through to the pre-colonial period serving cultivable areas through canal irrigation and groundwater percolation (Gupta, 2011). Diverse water harvesting structures (WHSs, also known as rainwater harvesting structures, RWHs) formerly proliferated in India, ranging from massive to diverse types of small local structures adapted to local topography and agro-ecology (Gupta, 2011). British chroniclers in 1856 found a

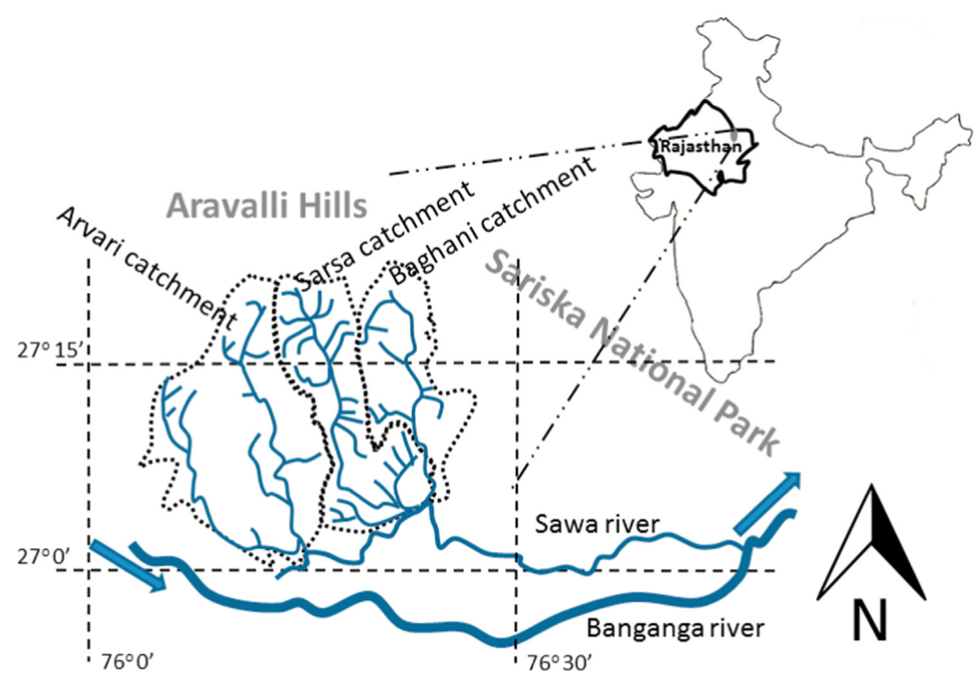

Fig. 1. Location of the Arvari, Sarsa and Baghani catchments in north Rajasthan.