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Review

Intensive groundwater use and (in)equity: Processes and governance challenges

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ARTICLE INFO

Keywords:
Groundwater
Equity
Governance
Water policies
Theory of access
Environmental justice

ABSTRACT

Groundwater forms the basis for millions of rural and urban livelihoods around the world. Building on insights from the theory of access, in this article we present how groundwater development has brought much well-fare in many parts of the world; and how resulting intensive groundwater use is leading to ill-fare through aquifer overexploitation and processes of water accumulation and dispossession. We show the difficulty of state regulation and the modest achievements of other governance approaches that aim to solve existing groundwater problems. To study these processes we propose a framework of analysis that is based on the study of hydrosocial-networks, the political economy of groundwater and the domains and discourses that define groundwater access. Such analysis highlights the challenges of devising policies and modes of governance that contribute to social and environmental sustainability in intensively used aquifers. These we argue should build on an analysis of equity that scrutinizes the discourses, actors, powers and procedures that define groundwater access. By inciting debates on equity a first and fundamental step can be made toward advancing more inclusive groundwater governance that crucially engages the marginalized and addresses their groundwater problems, concerns and needs.

1. Introduction

Land and water grabs have received increasing attention in the media and research (Mehta et al., 2012; Edelman et al., 2013; Franco et al., 2013; Bridge, 2014; Joy et al., 2014). With this article we contribute to this field of research by analyzing how intensive groundwater use can lead to different forms of concentration of access to groundwater and related processes of dispossession (see Blomquist, 1992; Knegt and Vincent, 2001; Prakash, 2005; Ahlers, 2010; Venot and Molle, 2008). We do so based on insights from political ecology (cf. Mukherji, 2006) and a focus on 'groundwater access'. These inform our analysis of groundwater development trajectories and related processes of environmental injustice. Based on Ribot and Peluso (2003) we define *access* as 'the ability to benefit from things' (p. 153). In doing so we shift the focus from property relations (*rights*) to the *ability* (and related social webs of power) that enable or constrain people to benefit from groundwater. As such, our analysis aims at better understanding the structural and relational mechanisms that determine legal and illegal access to groundwater through technologies,

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http://dx.doi.org/10.1016/j.envsci.2015.04.004
1462-9011/

capital, markets, authority, capabilities and other social relationships (Ribot and Peluso, 2003).

Groundwater forms the invisible, subsurface part of the hydrological cycle and is crucial for the maintenance of wetlands and the base flow of rivers (Kløve et al., 2011). Although there is uncertainty about the data, ice caps and glaciers store around 86% of the world's freshwater, while groundwater stores 13.5%. The remaining 0.5% of the world's freshwater is contained in lakes, soil moisture, rivers, reservoirs and the atmosphere (Jones, 1997). Although the stock of groundwater is nearly 25 times the stock of surface water, annual groundwater recharge is estimated to be only 10% of total river discharge globally (Oki and Kanae, 2006). As aquifers contain large quantities of water, when aquifers become intensively used their recharge capacity is quickly surpassed by extractions (Aeschbach-Hertig and Gleeson, 2012). As water tables drop wetlands and springs dry up, and rivers flip from gaining rivers (receiving base flow from groundwater) to draining rivers (losing water to the underground).

Groundwater access is largely determined by dispersed technology. It is a ''horizontal'' resource, meaning that ''farmers [and other users] located above an aquifer can sink wells independently of each other over a significant areal extension'' (Kemper, 2007: 156). Groundwater is a very reliable source of high quality water, and – as explored in Section 2 – it has developed into a cornerstone of both rural and urban socio-economies around the world; becoming the primary source of water for domestic, urban and industrial uses in many countries (Burke and Moench, 2000; Shah et al., 2003). Groundwater's role in irrigated agriculture has become central as producers adopted its use on a massive scale in South Asia, the Middle East and the Mediterranean, China, North America and to a lesser extent sub-Saharan Africa and South America (Scott and Shah, 2004; Aeschbach-Hertig and Gleeson, 2012). Its use has transformed rural economies through improved crop productivity and diversification and at present groundwater covers about one third of the total 300 million hectares of irrigated land worldwide (Shah et al., 2007). As such, it has significantly improved the livelihoods and household food security of millions of farmers and pastoralists worldwide (Kemper, 2007). However, in many areas the 'groundwater boom' is starting to go bust.

As analyzed in Section 3, the much needed regulation of groundwater pumping in intensively used aquifers is proving very difficult. This is alarming, as the medium and long-term effects of water overexploitation are more significant for groundwater than for surface water. A condition of low surface water supply can be reversed in just 1 year of high rainfall and runoff, whereas aquifer depletion may be permanent or take years to reverse (Gleeson et al., 2010; Aeschbach-Hertig and Gleeson, 2012).

The situation of virtual open access to groundwater has serious implications in terms of equity as is explored in Section 4. Whoever has the strongest and deepest pumps can pump the most, to the detriment of others and with impunity. Consequently intensive groundwater use easily leads to outright as well as diffuse and invisible forms of groundwater access accumulation and related dispossession and overexploitation. As a result, groundwater injustice is rife and increasing.

To better understand and tackle these injustices in Section 5 we propose a framework to explore the processes leading to overexploitation, accumulation of – and inequity in – groundwater access. In the conclusions we suggest that to tackle the existing groundwater challenges first a grounded understanding of groundwater access and accumulation processes in socio-ecologies is required. Based on these insights and a related equity analysis, a first and fundamental step can be made toward advancing more inclusive groundwater governance that crucially engages the marginalized.

2. Till the wells run dry: from groundwater well-fare to ill-fare

Since the 1950s there has been a ten-fold increase in groundwater irrigation world-wide, as groundwater is a reliable and often easily accessible water source. Especially since the 1970s a groundwater boom has occurred in many countries due to advances in drilling technology and sharp drops in the cost of pumps and the fuel or electricity to run them. The boom in groundwater pumping in many countries created much well-fare and positive effects on poverty reduction and emancipation. For South Asia, Shah (2009: 92) argues that ''[a]s the world's largest non-government irrigation initiative, complete with its own specialized economic institutions, South Asia's pump irrigation economy has been a boon that for long dwarfed the collateral damage it produced. Rapid expansion in this form of irrigation has had a powerful equalizing, stabilizing, and income-enhancing impact on a subcontinental scale''. He argues that groundwater pumping in South Asia since the 1970s has benefited half a billion people, through the following mechanisms:

- Some for all rather than all for some, as in surface irrigation schemes;
- Regional balance in irrigation development, with dry-land areas also receiving irrigation;
- Drought-proof monsoon agriculture;
- More work for the landless, by increasing demand for year-round labor;
- Access to water for marginal farmers, with pump irrigation having a strong bias toward the poor due to its land-augmenting and labor-absorbing impact;
- Intensive diversification of agriculture, with higher-value production (Shah, 2009: 92).

The initial increase in groundwater irrigation leads to spectacular agricultural growth and real impacts on poverty reduction (Burke and Moench, 2000; Shah, 2009). Treadle pumps, shallow tubewells and cheap diesel pumps, combined with inexpensive drilling techniques, bring groundwater in reach for poor farmers, male and female, and can quickly lead to a doubling or tripling of their annual income. As groundwater is a distributed and horizontal resource, this makes it accessible to a wide range of individuals with relatively modest means, as opposed to the 'lumpy' and capital-intensive investments in canal irrigation. Shah et al. (2007: 411) conclude that ''especially in Asia the evidence is overwhelming that the groundwater boom has demonstrated greater interpersonal, interclass, and