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# Grabbing groundwater: Capture, extraction and the material politics of a fugitive resource

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ABSTRACT

This paper analyses local water governance in Delhi, India, to develop a political ecological reading of urban tubewell use. I draw on long-term qualitative fieldwork in informal neighbourhoods and focus on groundwater, a major source of urban water globally, to reveal relationships between technology, ecology, politics and informal land development. While discussions of water grabs have concentrated on corporate actors, I highlight local personalised control. At street level, tubewell technology enables *qabza* ('capture') of wells by powerful people. But ecological changes at larger scales limit the use of tubewells as political-economic allies. Analysis across the scales of the street, aquifer and city shows how different factors produce the contradictory role of informal water governance in urban political-economy. In this way, the paper suggests a scalar resolution to debates on materiality and agency.

## 1. Introduction

Since the 1970s, groundwater use has grown exponentially across South Asia as tubewells became increasingly available. In India, urbanisation is arguably groundwater dependent (Cullet, 2014; Kulkarni and Shah, 2015). Delhi, is the world's second-largest water-stressed city, and sits at the centre of North India's dramatic groundwater depletion (Richey et al., 2015; MacDonald et al., 2016; Central Ground Water Board, 2020). In 2014, a new organisation, the *Aam Aadmi* (common man) Party (AAP), contested the Delhi elections with a campaigned focused on water and corruption in public services.[1] With groundwater availability falling, AAP's political rhetoric against the 'water mafia' spoke to popular dissatisfaction and voters unexpectedly elected the new party into government. In 2015, AAP introduced policy reforms to improve water supply in unauthorised areas.

This paper addresses ideas of the relative agency of people, technology and ecology through a study of groundwater use. I argue for a multi-scalar perspective attentive to technical and material dynamics. Viewed from the urban street or block, tubewell technology allows individual human agency and social power relations to determine water governance practices. In my research site, this leads to water grabs or '*qabza*'; 'captured' tubewells used for financial or political gain by a range of actors, and I outline the historical development and political repercussions of this practice. Considered from the ecology of (underground) water, however, tubewells tap a larger system that imposes limits on individual human agency. In my research site, this manifests in two ways. First, hydrogeological data shows that while the area is uniquely positioned for above average groundwater supply, underground water is randomly distributed, leading to speculation over wells. Second, there are multiple effects of seasonal and long-term groundwater decline including: reduced water quality and quantity; the possibility of profiteering; very low summer water availability for residents; long-term changes in business models; and multiple backlashes against corrupt or ineffective politicians. These two differently scaled perspectives (street and aquifer) come together to shape the relationship of groundwater use to local urbanisation and politics. I note two aspects here. First, the continuation of local caste dominance in land occupation, water supply and political representation. Second, the invisible subsidy that off-grid water use presents for Delhi's piped network and wealthier central areas.

## 2. Scale and agency: technology, environment, capture

Theorisations of cities as dependent on 'urbanising' and metabolising water are foundational in urban political ecology (UPE) (Swyngedouw, 1996; Heynen, 2014). Research suggests that for water supply quality and quantity the 'materialities of technologies matter' (Ahlers et al 2014; Anand, 2017, p. 11; Rusca et al 2017; Zérah, 2000). This theme inspires studies of hydraulic infrastructures, particularly government-run piped water networks, which analyse social dynamics mediated

[1] https://aamaadmiparty.org/about/our-history/.

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and enacted through technical systems (Coelho, 2006; Anand, 2017; Björkman, 2015; Gopakumar, 2011). By focussing on a smaller ubiquitous Global South technology, I aim to shift focus from large technical systems, widely used in the North but less common around the world.

In rural areas, there has been a range of work on groundwater and decentralised smaller water technologies including wells, pumps, check-dams and tanks (Mosse, 1997; Birkenholtz, 2008; Shah et al., 2021). However, smaller *urban* water technologies have received less consideration, especially in the Global South (Furlong, 2014; but see Button, 2016). While several studies have been published in recent years, an authoritative review suggests that urban groundwater use has been largely overlooked by social science (Shah, 2016).

This paper approaches urban groundwater use through tubewells from the perspectives of technology and ecology. Here I outline two bodies of literature that inform my approach: on the politics of technology and the materiality of ecological processes.

### 2.1. Tubewell technology

UPE often builds on studies of science and technology that explore the mutual constitution of technology and social relations through interactions that preclude easy generalisation (Callon, 1986; Latour, 1988; Winner, 1980). This work, often from Europe or North America, calls attention to material characteristics and components - such as water pump mechanics, key-fob weight and bridge height - of socio-technical networks and the outcomes they produce, intentional or otherwise (de Laet and Mol, 2000; Latour, 1991).

This literature argues that modern forms of knowledge attempt to divide their objects into separate spheres, such as culture / nature, human / non-human, politics / economics, (Haraway, 1991; Mitchell, 2002; Ballestero, 2019a). Recognition of these artificial separations leads writers in this tradition to describe entanglements of these different categories as cyborgs or hybrids, often using hyphenation – as in 'socio-technical' or 'socio-material'.

The relationships of water technologies to wider socio-political arrangements are debated. Some writers find material relations articulate larger social forces. For example, Loftus examines reification of social relations through water meters to argue that non-human things help reproduce capitalism and patriarchy (Loftus, 2006). Ranganathan underlines ambivalent practices of patronage and politics exercised through water tankers and their owners' ability to work within and outside the postcolonial state (Ranganathan, 2014). Desai discusses non-state tubewell supply at the peripheries of Ahmedabad as infrastructural violence (Desai and Sanghvi, 2017; Rodgers and O'Neill, 2012). For all authors, institutional arrangements are more influential than the physical characteristics of a water supply mode.

Other writers suggest that material realities have destabilising power. Furlong argues that some readings of the politics of technology overlook unintended outcomes at smaller scales (Furlong, 2011). For exampe, tubewells in India cities are recognised as subversive infrastructures that can destabilise or support state power (Anand, 2017, p. 213). In another context, Meehan shows how buckets and wells are used in counter-hegemonic ways against water privatisation (Meehan, 2014, p. 222). In West Bengal, the variability of non-network water governance intersects with local party politics (Kundu and Chatterjee, 2020). These works challenge mechanistic understandings of determination and question the relationships between processes at different scales. While this literature sometimes engages with technology and politics, there is less attention to ecology, hydrogeology and histories of urban groundwater. I address this gap by demonstrating the distinct influences of technology and the environmental patterns of groundwater over time.

### 2.2. Groundwater ecologies

Scholarship on urban infrastructures has been argued to overlook the natural resources they depend on (Arabindoo, forthcoming; Monstadt, 2009). A small number of recent writings, however, do explicitly include nature, landscape and even aquifers, as 'infrastructure' (Carse, 2012; Belanger, 2016; Ballestero, 2019b). Groundwater's rhythms, movements and hydrogeology ask us to think vertically and over time. Sultana's work on groundwater supply in Bangladesh shows the value of integrating social, spatial and ecological factors (Sultana, 2009). Malghan and colleagues connect the hydrological and social conditions contributing to groundwater decline in Bangalore (Malghan et al., 2013) while work in environmental science has also started to move towards 'social-hydrology' (Srinivasan et al., 2013; Troy et al., 2015).

In the current era of environmental change, groundwater asks us to consider the unstable politics of water in multiple forms (Clarke-Sather et al., 2017). In relation to surface water flows, recharge, 'fossil water' in confined aquifers, anthropogenic impacts and future possibilities, groundwater requires thinking not only below ground, but across multiple temporal scales – as with other forms of extraction (Childs, 2018). In linking the social and political aspects of groundwater extraction to their geology, I build on interest in verticality (Ballestero, 2019c; Bebbington, 2012) and geosocial relations (Clark et al., 2018; Dawson, 2021; Yusoff, 2018).

Work on ecology and geology suggests that hydrological processes, at larger scales, are hard for humans to understand or control (Amrith, 2018). Mason's discussion of subsurface water in Lebanon shows the limits to state control over natural resources (Mason and Khawlie, 2016). The contradictory effects of urban groundwater use reveal aquifers as dynamic, living systems rather than simply 'underground infrastructure' or a standing reserve (Ballestero, 2019d; Carse, 2012). If the earth was long understood as fixed and societies as dynamic, climate change reverses this assumption (Clark, 2019, 2010). Geological processes have an autonomy that far exceeds human action and comprehension; "social and political agency is both constrained and made possible by the forces of the earth itself" (Clark and Yusoff, 2017). This paper illustrates one example of the intersection of geological and political change to analyse the varied scalar connections and contradictions between material and human influence.

### 2.3. Qabza: water, land, economy, politics

Research on water grabs, primarily influenced by the work of Mehta and colleagues, focusses on state or corporate entities at larger scales (Mehta et al., 2012; Franco et al., 2013; Birkenholtz, 2016; Veldwisch et al., 2018; Wagle et al., 2012). Building on other work rescaling water conflict, I extend this literature towards more local actors (Mustafa, 2021).

The vernacular term for water grabs, *qabza*, has rarely appeared in academic writing on India, but features in writing on Pakistan with reference to the occupation of space (Gayer, 2014; Hull, 2012; Khan, 2010; Ring, 2006). In Indian popular use, *qabza/kabzaa* is widely used in a similar way, for example, as a title for several crime films (e.g. Bhatt, 1988). The translation of *qabza* as 'capture' by my interlocutors realises multiple resonances. In English, 'capture' describes the legal status of subsoil resources ('rule of capture'), the physical effects of water extraction through wells ('zone of capture'), dominance of local elites and diversion of resources towards the powerful ('elite capture'), influence over state actors and political parties ('state capture', 'party capture'), electoral malpractice ('vote capture') and extraction of value ('value capture'); these phenomena are all at play in the local politics of groundwater governance. Voting booth 'capture' is well-known in India and one prominent political scientist describes India's current political regime as a strategy of 'democracy capture' (Yadav, 2020). Suggesting *qabza* as a motif for both groundwater governance and wider contemporary political shifts, I aim to move towards more empirically-rooted, locally-specific conceptual vocabulary (Bhan, 2019).

Scholars have questioned whether political ecology has become less engaged with material realities (Turner, 2016; Walker, 2005). Urban

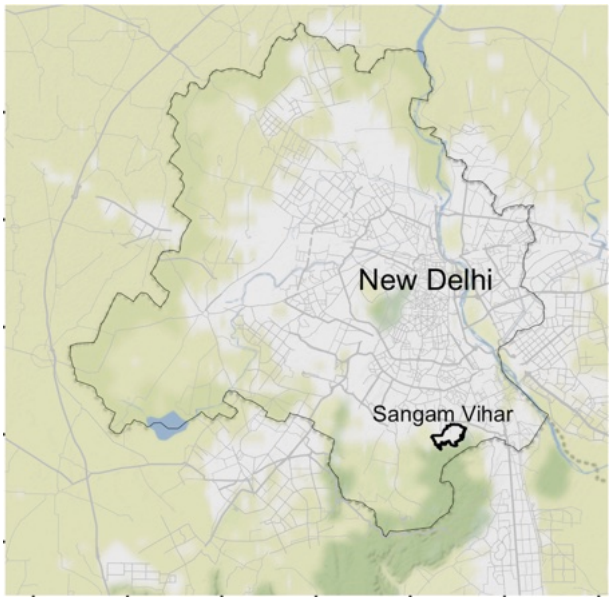


**Fig. 1.** Sangam Vihar location. Mapped with R (R Core Team, 2021) using Rstudio (RStudio Team, 2020), ggmap (Kahle and Wickham, 2013), tidyverse (Wickham, 2019).

tubewell use offers a perspective on UPE that combines water, technology, land, urbanisation and politics. This moves towards 'second wave' UPE developing theory from the South more sensitive to the contingency of socio-material relations in contexts where modern capitalism is an uneven aspiration rather than assumed condition (Heynen, 2014; Lawhon et al., 2014). For example, the practice of *qabza* indicates that neither state nor capital is solely responsible for the shape of water governance in my research site. Alternative sources of power - 'infra-power' or power from below – form through interactions between small technology, favourable geology, local histories of urbanisation and street-level dominance (Gupte, 2008; McFarlane, 2011).

## 3. Groundwater in India and Delhi

Underground water is a primary water source for nearly-one in three people worldwide (United Nations World Water Assessment Programme, 2015, p. 13). In India, tubewell water supply is often independent of the state, and limited access to surface water combined with weak regulation has led to unsustainable over-extraction (Shah, 2008). Groundwater supports the majority of India's human settlements (Kulkarni and Shah, 2015, p. 60) and is estimated to provide around half the water used in Indian cities (Narain, 2011, p. 50; NIUA, 2005, p. 46; Shah, 2016, pp. 10–11). 39% of the poorest quintile of India's urban households use wells as their primary water source, compared to 23% of the richest quintile (Grönwall et al., 2010, p. 82). Government agencies have expressed concern over groundwater depletion (NITI Aayog, 2018) and conservation projects are underway with various results (Shah et al., 2021; Taylor and Bhasme, 2021) (see Fig. 1).

Rural waterscapes in South Asia have been closely studied. The mechanisation of water supply in rural South Asia through tubewells has transformed or replaced earlier governance structures, introducing modern capitalist ways of thinking (Appadurai, 1990), and cash-crop agriculture that rewards water-intensive production (Gidwani, 2008, p. 100; Mustafa and Qazi, 2007). This 'tubewell capitalism' is mediated through landownership, access to finance, local histories and geography (Dubash, 2001). Technical features (tubewell depth, pump size, pipe

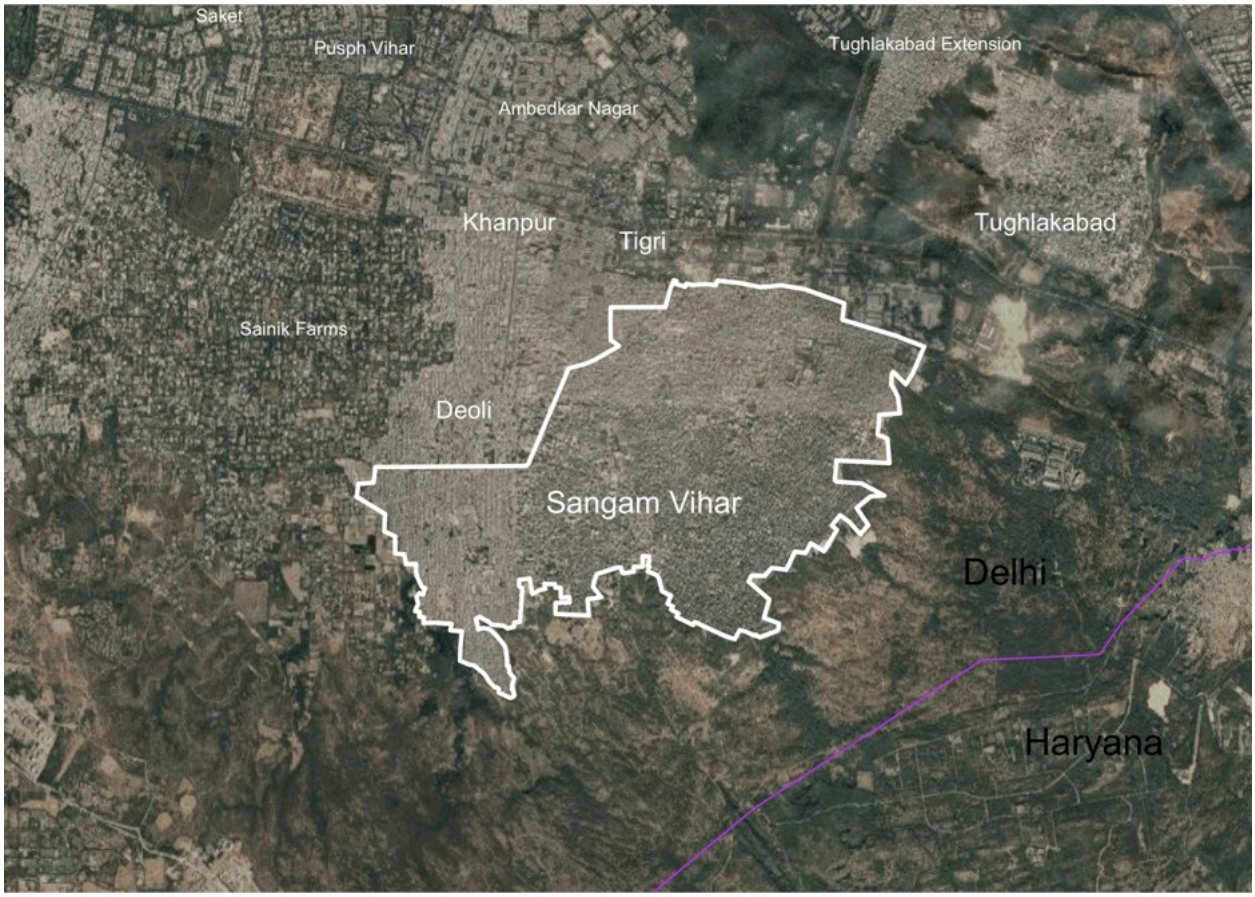


**Fig. 2.** Local area detail. Mapped with R (R Core Team, 2021) using Rstudio (RStudio Team, 2020), ggmap (Kahle and Wickham, 2013), tidyverse (Wickham, 2019).


**Fig. 3.** Street.

gradient) also shape social outcomes (Alankar, 2013; Birkenholtz, 2015). Tapping a largely invisible, weakly regulated, and shared resource, tubewells facilitate both 'undreamed of independence and three-dimensional chaos' (Acciavatti, 2017, p. 207). This is particularly the case in the heavily irrigated Indo-Gangetic basin where the Green Revolution increased outputs but radically changed agrarian ecologies (Bharucha, 2019, p. 288; Kulkarni and Shah, 2013). While governments across India have promoted rainwater harvesting in response to groundwater depletion, results have been uneven (Taylor and Bhasme, 2021) (see Fig. 2).

Delhi relies on non-government groundwater extraction for around half of total water supply (Maria, 2006). Around 127% of the renewable groundwater resource is extracted, largely privately, but rates are more than double this in the South of the city (Central Ground Water Board, 2016, p. 119). A recent study found groundwater extraction in Delhi causing land subsidence in several areas (Garg et al., 2022). In 2006–7, 16% of connected households in South Delhi used tubewells to supplement Delhi Water Board (Delhi Jal Board or DJB) supply, while another 17% had no piped supply and used borewell water only (Biswas, 2015, p. 145). This heavy groundwater use is due to a combination of insufficient bulk water, high distribution losses and sharply biased allocation, which favours the central city over peripheral areas.

Consequently, urban groundwater dependence is strong in unplanned and peri-urban areas. 70% of Delhi's population lives in areas without planning permission (Bhan, 2013). Before 2016, when the AAP government changed the law, the DJB was unable to supply water to these areas. Neighbourhoods on agricultural land without residential planning permission are known in Delhi as 'unauthorised colonies' (UC). Delhi's UCs are estimated to house four million people, a quarter of the city population (Sheik and Banda, 2016, pp. 138, 144). For infrastructure and services, residents of UC are often dependent on self-help, the private sector or political patronage. A survey in South Delhi's UCs found 67% of households used groundwater as their primary water source, 31% DJB water and 2% tankers (N. Khan, 2018, pp. 124–5).[2]

Sangam Vihar,[3] said to be Delhi's largest cluster of UCs, is a group of 38 neighbourhoods housing over a million people at the south-eastern corner of the city. The area has been dependent on non-network groundwater for over thirty years and is a good limit case for understanding decentralised water supply in the city.

Sangam Vihar's commercial streets are lined by concrete buildings between two and five stories, with businesses at ground level. The main roads are lively and often jammed with traffic while narrow side lanes are quieter with people sitting on doorsteps and children playing in the street. The area is surrounded on three sides by the rugged scrub land of Delhi ridge. Even at the edges of the settlement, over the last twenty years, many single-story dwellings have become multi-storey 'builder flats' with upper floors let out on rent. Single room dwellings in overcrowded apartment blocks are common, as are single-family dwellings, but tents and self-built huts are rare. Lack of services means rents are low. Many residents are migrants to Delhi working as daily or manual labour in construction, manufacturing and services. In 2020, 75% of migrant workers in Delhi rented rooms in low-income tenements like this, and 10% rented rooms in JJ clusters (Housing and Land Rights Network, 2020, p. 10).[4] Around half of Sangam Vihar residents are Scheduled Caste or Scheduled Tribe and around one in three are Muslim. 82% households earned less than INR 8,333 ($130) a month (Roller,

[2] Locations, sampling and number of respondents unreported.

[3] The unplanned neighbourhoods at Sangam Vihar-Deoli are commonly divided into "Deoli side" and "Sangam Vihar side", following the Delhi state assembly constituencies. Instead of writing "Sangam Vihar-Deoli", I use "Deoli" for the urban village of Deoli and "Sangam Vihar" here to refer to the urban agglomeration of 38 UCs (see Map 2).

[4] Locations, sampling and number of respondents unreported.

2016, p. 12).[5]

Sangam Vihar is the subject of a growing number of studies (Das Gupta and Puri, 2005; Jha et al., 2007; Priyam, 2015; Sheik et al., 2015; Kacker and Joshi, 2016; Birkinshaw, 2019). This paper highlights how the specificities of place and history influence water supply in the area. I extend previous research by demonstrating how the variation in water governance across blocks relates to ecology and connects to wider processes of urbanisation and party politics.

I lived in Delhi between 2014 and 2016 to conduct 18 months of qualitative fieldwork. I also visited in 2017, 2018 and 2019. This paper is based on transect walks, focus groups, ethnography at NGO and political party offices, and semi-structured interviews and conversations with over 100 individuals in the Sangam Vihar-Deoli area, including 18 political party representatives, 14 water vendors, eight real estate brokers, six NGO workers, three journalists, two health workers, and around 50 residents across eight blocks. The work was documented in around 250 field notes and triangulated with respondents from the larger city, as well as official documents, media reports and archival sources (see Fig. 3).

## 4. Off-grid networks

An unknown amount of water is lost in Delhi's 9,000 km of pipes and both water quantity and pressure are reduced in the south of the city. Sangam Vihar is 16 miles south of Delhi's bulk water infrastructure on a hilly zone at the edge of the city; nearby government pipes have not been illegally tapped as they are in more central informal areas. Water supply in the area has historically been through handpumps, tubewells, tankers and packaged drinking water. In 2015, household monthly spending on these multiple sources of water was often over 3,000 rupees (USD 46.80). This section sketches a history of off-grid water in Sangam Vihar and outlines the contribution of tubewell technology to governance patterns.

I have spoken with many older long-term residents over the years and in 2018 worked with a focus group on historical mapping to construct a story of the development of off-grid water supply in the area.[6] The unauthorised colonies at Sangam Vihar and Deoli are built on land historically belonging to villagers from Tughlakabad and Deoli (see OLD MAPS). In 1980, Delhi's Lieutenant Governor issued notification that land from these villages was to be acquired for planned development to prevent "speculation and illegal colonisation" (Kirpal, 1983). Before land was acquired, however, landowners from dominant (Jaat and Gujjar) groups in the villages subdivided and sold land in parcels, despite not necessarily having legal possession. These parcels were then further subdivided, through a system of brokers in what residents call a 'chain system'.[7]

In the 1980s, early settlers used water from handpumps or brought it from outside. With the first wave of growth and investment in the 1990s, handpumps began to go dry. When the water table fell below the reach of handpumps, people who could afford it installed private tubewells. These private tubewell networks charged whatever people would pay and continued to add consumers, resulting in very limited supply of water. Privately drilled and commercially operated wells are one of several practices said to be done by '*paani mafia*' (water mafia) by residents and politicians. In 2016, there were an estimated 200 private tubewells in Sangam Vihar. Private networks charged 500–800 rupees (USD 7.80–12.48) a month for water supplied once in ten days to once in six weeks.

From the 2000s, when densification and vertical rebuilding increased, DJB-drilled tubewells also began to be installed by Members of the Delhi Legislative Assembly (MLA). After the government started providing DJB tubewells, the owners of the pre-existing "private tubewells converted themselves into water mafia, big men".[8] Private tanker and packaged drinking water businesses also emerged during this time. With the new AAP government in 2014, DJB water tanker supply improved but is still unreliable or unavailable in some areas. In 2016, Sangam Vihar had 165 government (or DJB) tubewells, unevenly distributed across blocks, supplying between 20 and 500 houses each.[9] Government tubewell networks supplied water to each house for one hour a day in some blocks. Most people said they got tubewell water once or twice a month, even less in summer and at the edges of the colony. Households are officially charged 50 rupees (USD 0.78) monthly for government tubewell water, but sometimes fees are higher. Tubewell electricity is paid for the by DJB. Many residents are connected to both government and private tubewell networks.

To obtain a tubewell, residents ask their MLA who writes to the local DJB office, the DJB write to the Sub-District Magistrate, and then have a survey done, before tendering a contractor to do the work. The underground elements of a tubewell are hard to inspect and contractors and DJB officials have been accused of making money by reducing the pipe used, resulting in lower water supply and shorter tubewell life (for cases in Sangam Vihar and Deoli see Kanta, 2014; Saini, 2015).

During my research, a tubewell in South Delhi cost around Rs 5–600,000 rupees (USD 7,800–9,360).[10] Government tubewell construction is paid for through Member of Legislative Assembly Local Area Development Scheme (MLALADS) funds of 4 crore (USD 624,000) per legislator in 2015. Both MLAs and DJB officials can exercise influence over both the location of wells and appointment of managers. Partisan bias is likely: "patronage is there, because the MLA approves borewells, so of course bores in areas which are known to be supportive will get preferential treatment".[11] Skewed MLALADS allocation has been documented in Delhi and across India (Biswas, 2015; Bussell, 2019). Some Sangam Vihar residents described obtaining a well from their MLA in the early 2000s as requiring 'speed money', while other residents were not aware that they could request wells from their MLA.[12]

## 5. Capture and extraction

Government wells in Sangam Vihar are not managed by government employees. With or without MLA or DJB support, some government wells are managed by residents' welfare associations (RWAs), others by individuals – often local informal leaders, known as *pradhan*.[13] Pumps and pipes transport water to individual houses, but tubewell networks over a certain size need a person to govern supply times by opening valves for different lanes. This everyday network management is done by person known locally as a *kholnewala* (literally 'opener'). Valve-openers are often employees but may also be well managers, referred to as *paani malik* ('water owner'), a role often connected to, or performed by, a *pradhan*. The quality of democracy and representation that RWAs and *pradhans* offer can be opaque. RWA presidents may also be called *pradhan* and *pradhans* also have '*pradhan* committees', but not all

[5] SC 37%, ST 12%, OBC 11%. 2015 survey by Centre for Urban and Regional Excellence. Locations, sampling and number of respondents unreported. All currency conversions at 2015 annual average.

[6] Focus group and mapping workshop with twenty-three older residents, 16 November 2018. Respondents are only cited for direct quotes. Unless noted otherwise, all communications are in Sangam Vihar. Names and blocks have been removed as a condition of anonymity.

[7] Personal communication, former AAP party worker, 15 July 2017.

[8] Interview, RWA treasurer, 28 November 2018.

[9] Tubewells divided by population suggests one well for every 6,000 residents (Birkinshaw, 2019, p. 193).

[10] Interview, MLA, 13 July 2017.

[11] Personal communication, BJP MLA candidates, 27 November 2014.

[12] Group discussion with thirteen residents, 16 February 2015.

[13] Literally 'leader, head, chief' (Dasa, 1965, p. 3174). For discussion of pradhans in Indian *bastis* see (Auerbach, 2019; Jha et al., 2007; Srivastava, 2014).

*pradhans* (or presidents) are elected. I maintain the distinction between the terms here to reflect that some individuals operate in a more personalised style (*pradhan*) and some as part of a bureaucratic organisation (RWA). A party worker explained; "there are many *pradhans*, you could even say I am a *pradhan*! There will be one for each party in an area".[14]

When government-drilled well managers charge fees above the nominal amount, fill water tankers for private sale or DJB contracts, or provide a biased allocation of water to political supporters, residents say that the well has been 'captured'. Sangam Vihar tubewell managers collect revenues, but unlike other areas, they are not DJB employees, revenues are not returned to the DJB and residents are not issued bills (Ghertner, 2017, p. 740). Although my interlocutors in other areas of Delhi also described tubewells as controlled by local people, this situation appears particulaly common in Sangam Vihar. A former senior local party worker said "thirty to forty per cent" of government tubewells are run by people appointed by the MLA, another thirty percent are run by RWAs, and another thirty percent are run by '*dabang log*' ('tough guys') who have taken control themselves.[15] A distinction between different methods of tubewell capture – social influence, verbal threats or physical force – was not apparent to me. Managers of captured wells are also referred to as '*paani mafia*'. Captured tubewells are described by local people as being seized by force by criminals, toughs (*dabang*), bad characters (*badmash*) and hooligans (*goonde*). Another party worker said, "the BJP guy was earlier doing the *kholnewala* [managing the well]. These *kholnewalas* are just gangsters, the people with power will take the job".[16] A local MLA described well capture as done by '*dabang log*' saying that whether government was able to act depended on the 'strength' of politicians and political alignment of local residents.[17] In North India, *dabang* refers to both "violent political entrepreneur[s]", and people "who tout their rough edges—either their direct involvement or simply the veneer of criminal association—as a badge of honor" (Michelutti, 2018, p. 198; Vaishnav, 2017, p. 184).

Residents often seemed wary of tubewell managers. Securing water is seen as a female responsibility and most water users I spoke to were female. Except for one *kholnewali* and one *pradhan*, tubewell managers, local politicians and MLA staff I met were male. For most (female) residents, complaining to the (male) *kholnewala* about water supply, was either a novel or foolish idea. Their response to my questions about who they could complain to was either an awkward silence or emphatic assertions that – despite all the water problems they had just told me about – their water supply was actually fine. Objections to paying for captured DJB well water can lead to disconnection (Endlaw, 2010). *Kholnewale* too said that people did not complain. In general, assertive masculinity from managers and the pragmatic self-interest of water users keeps complaints low. Sangam Vihar water customers are referred to by other researchers as 'captive consumers' (Kacker and Joshi, 2012, p. 28). Residents have an interest in maintaining a good relationship when water is managed by intermediaries for state services (*pradhans* or people close to politicians) (Naik, 2019, p. 59). However, the situation is not entirely fixed; the female *kholnewali* I spoke with had given up the job as declining water levels were causing too many complaints. She said that before she was given the job the tubewell was managed by 'twelve men'.[13] During my visit to another area, a group of women in a lane were able to bring a sympathetic female BJP *pradhan* to berate a tubewell manager for over-charging, although the situation was not resolved on the spot. Gender is clearly important in local water management (O'Reilly, 2006; Truelove, 2011; Adams et al., 2018) and other research has found similar cases of gendered urban water conflicts in urban India (Bapat and Agarwal, 2003; Mehta, 2011; Rodgers and Satija, 2012).

Tubewell governance varies across a spectrum of street-level management patterns and outcomes: from government wells managed by RWAs, to government wells managed by political appointees, captured by a *pradhans* (or other local power holders), and private wells, privately managed. I offer four illustrative examples here. In one long-established block near the main road, the RWA has taken over management of private wells to form an integrated network with multiple borewells. The RWA is run by committee and key positions are elected and rotated. Prices are lower than other tubewell networks at 30 rupees (USD 0.48) a month. In more peripheral areas, management is different, for instance, in an area bordering the southern edge of the settlement, a man who has been the area *pradhan* for over 20 years, has been supplying water for the last three years. His father arranged for him to manage the well with a local politician and DJB official. This well manager is not a DJB employee – "they cannot use their own men here", he says – and the DJB does not collect revenues.[18] There is one well for 400 households, who pay 60–70 rupees a month. Residents say the water comes for two hours every month in summer and every-two weeks in winter. The *pradhan* says he supplies water 'as a social service', but residents say that in the summer there is less water for them as he fills water tankers from the well 'to earn'.

In another peripheral block, the *pradhan* has captured ("*qabza kiya*") the government well and taken control of management and fees. Residents feel unable to object (cf Naik, 2019, p. 59). House connections to the well cost 50 rupees (USD 0.78) a month, but residents also need to use private tubewell connections costing 50 to 450 rupees (USD 0.78–7.02) for 2–3 hours of water every 20 days, and private tankers, which cost 1,000 to 1,500 rupees (USD 15.60–23.40). The *pradhan* part-owns a water tanker business and uses the tubewell to fill his tankers. When the water is low, residents must purchase water elsewhere. The tankers are hired to the DJB but sell the treated government water to private buyers and deliver tubewell water to the DJB clients instead. In a more remote block, one private tubewell owner stopped supplying water to residents through the micro-network and now only fills their tanks on demand using a long flexible plastic pipe. The plastic pipe means available water can be supplied only to those residents able to pay – useful if there is limited water (cf Kacker and Joshi, 2012, p. 31). This private well owner also fills tankers and packaged water cans. 20 litre cans from illegal factories like this sell for 30–40 rupees (USD 0.47–0.62). Residents feel this business means less water for government wells, but feel threatened by the owner and his connections with the police and judiciary.

These tubewells networks are close to what Filip De Boeck has called "zero degree infrastructure" (De Boeck and Plissart, 2015). There is a low degree of complexity in the technical arrangement, but enough that these micro-pipe networks are a semi-sealed system, easier for one person to capture and control than a piped network. In this way, the technology allows the centralisation of knowledge and power in network operators and owners. The forms of sociality and contention that might evolve around a shared hand-pump, for example, are less present. Human managers have agency, but the characteristics of tubewell technology influences the range of governance outcomes in four ways. First, cost; tubewells are expensive but affordable for some households, particularly when water was available at shallower depths. Some private individuals can afford installation, and politicians can provide them through their discretionary area development funds. Secondly, tubewell installation is noisy and visible so government might be informed and need to be negotiated with.[19] Thirdly, once installed, tubewells are decentralised, discreet and not obvious from a distance. Fourth, these are low-tech, small-scale installations, amenable to repair and maintenance by local actors, like a Zimbabwe bush-pump (de Laet and Mol, 2000). Drawing on Winner's discussion of technology and politics, we can say tubewells are *strongly compatible* with personalised

[14] Personal communication, AAP party worker, 18 May 2015.
[15] Personal communication, former AAP party worker, 15 July 2017.
[16] Personal communication, AAP party worker, 18 May 2015.
[17] Personal communication, South Delhi MLA, 13 July 2017.
[18] Personal communication, pradhan, 11 December 2014.
[19] For legal cases see (Sehgal, 2012; Singh, 2015).

**Fig. 4.** Flooding.

management (Winner, 1980).

In analysis of off-grid and network electricity in West Africa, Akrich observes how mechanical objects mediate relationships and eventually generate knowledge and moral positions (Akrich, 1992; see also Shah and Boelens, 2021). Here, I argue that the relatively open technical form of the tubewell network exercises 'relatively weak constraints' on management styles while still permitting the localised control and capture of water supply for hundreds of people (Akrich, 1992, p. 214). The micro-politics of urban tubewells are diverse arrangements which both support and mirror personalised, mediated and extractive political cultures.

In an earlier paper discussing tubewell networks in Sangam Vihar, Kacker and Joshi describe the replacement of private tubewell management in some neighbourhoods with RWA management. However, I found that the situation varies across blocks, particularly at the fringes of the settlement. In this case, it does not appear that "informal piped networks […] offer greater potential for collective action" than other forms of supply (Kacker and Joshi, 2012, p. 33). On the contrary, the technical characteristics of tubewell networks facilitate to elite capture and political entrepreneurship. However, governance styles depend on multiple variables, including location. Tubewell managers demonstrate a range of motivations, which in practice may overlap; from RWA actions to improve quality of life and maintain property values; *pradhans* interested in political influence, and '*dabang log*' extracting financial profit. This diversity of management styles (public service, commercial, political, capture) in water micro-networks has been documented in Mumbai (de Bercegol and Desfeux, 2011, p. 8). The greater influence of local *pradhans* in peripheral, more recently settled neighbourhoods is consistent with other work on informal leadership in Delhi (Jha et al., 2007). If we consider it co-production, the management of government tubewells appears as a case of the widespread blurring of public and private interests with inegalitarian, unaccountable and sub-optimal outcomes. This unequal, contested and exploitative 'co-production' is a recognised reality in much of the world (Ahlers et al., 2014; Joshi and Moore, 2004, pp. 40, 45–46). Infrastructural citizenship here appears limited, precarious and heavily mediated by both social and material dynamics (Hope, 2021; Lemanski, 2020).

## 6. Political geology?

Moving below ground, I want to place the combination of technology and human action described above in the context of hydrogeology. Sangam Vihar has a unique geological setting, modified by large pre-colonial infrastructures, that produces above average water availability. These advantages have facilitated informal habitation unconnected to the city water supply. Over time, though, heavy groundwater use has reduced groundwater quantity and quality. These dynamics affect the water governance in Sangam Vihar and its relationship to the urban economy and politics.

Groundwater availability underwrites urbanisation, particularly in the absence of piped supply. Sangam Vihar's geological setting is favourable. The settlement lies on alluvial soils, surrounded by quartzite hills of Delhi ridge to the west, south and east (See Fig. 7). A party worker from a hilly part of the settlement explained that in his area, 'there is black stone, and you can't get water from underneath it'.[20] Sangam Vihar's urban form maps so closely to the underlying rock that the difficulty of obtaining water from quartz may provide a limit to the informal urbanisation. Quartz is a hard rock, difficult for water to permeate, so recharge is slow and water runs off the hills to replenish the aquifers under Sangam Vihar. Excess rainwater run-off also forms streams; historical maps show the site as the origin of three streams running north, which merge to form the Chirag Dilli *nallah* (stream / drain), and other streams running north-east.

At the northern edges of Sangam Vihar, run-off is impeded by human constructions. Large hydraulic works used in the region since the 10th Century include *bunds* (check-dams) to store water for agriculture. At the north-western edge of Sangam Vihar, "Bandh road" lies along the site of "Deoli *Bund*" (see Fig. 5, lower right map); the land drops roughly-six feet on the northern side and the area south of the road still floods after rains (see Fig. 4). At the north-eastern side of Sangam Vihar, the Mehrauli-Badarpur (MB) road is also said to be built on an old *bund* network connecting the lake at Tughlukabad to the tank at Mehrauli, and the land to the north of the road is at higher elevation (Cherian,

[20] Personal communication, party worker, 9 July 2015.


**Fig. 5.** Maps (1807, c.1890, 1910, c.1960), British Library and Delhi Archives.

2004, p. 39; S. A. Khan, 2018, p. 26). Consequently, Sangam Vihar south of MB road captures the flow from the ridge from both north and south, again leading to flooding. All these factors give the location unusually high groundwater recharge and deeper volume of fresh water compared to surrounding areas with the same geology (Sarkar et al., 2016; Chatterjee et al., 2009).

Despite these advantages, the water table is falling rapidly due to local extraction. In 2016, the South Delhi tehsils that include Sangam Vihar were using over 260% of the renewable groundwater, the highest rates in the city (Central Ground Water Board, 2016, p. 119).

Extraction affects both lateral and vertical water movement and excessive withdrawal creates depressions of lower water. In northern Sangam Vihar, the water table is also 100 feet lower than surrounding areas. The ridge should recharge Delhi's groundwater, and the underground water table should flow down towards the river. Instead, water is being pulled up from larger flows several miles wide to replenish the extraction in quartz.[21] To affect large-scale flows like this, groundwater extraction must be extensive. Illegal mining and luxury villas on the ridge are heavy groundwater users, but the water table is lowest under a some of South Delhi's most expensive shopping malls, private hospitals and high-end hotels – all heavy groundwater users.

In Sangam Vihar, lower groundwater levels cause tubewell pumps to break. DJB sub-contractors have tubewell repair work every day. Conversations with engineers, as well as legal depositions, suggest that if the average life of borewell in south Delhi should be five years, in low water table areas, like Sangam Vihar, lifespan may be a year or six months (Kanta, 2014). Submersible pumps in tubewells use the water they extract for cooling. If the water falls below the depth of the pump, the motor wiring will overheat and burn out. This disrupts supply and increases costs. Wells in Sangam Vihar go dry both seasonally and permanently. In 2019, a man told me he had two pumps burn out in three months.

Falling water tables affect water quality as well as quantity. As the water table falls in an alluvial aquifer, suspended particles (known as total dissolved solids) increase; the water gets harder. Under northern Sangam Vihar, near MB road, the water has dropped close to or beneath the underlying layer of salt water in the aquifer, depending on variation in the bedrock. Many people complain of hard water and tubewell drillers in some areas say that after 600 feet the quality of water is bad. Older people say that the water used to be sweet but is now not potable (*'pine ke liye layak nahin'*). Harder water is bad for human health, causing problems with kidneys, skin and hair.

Harder water also damages tubewell pump blades ('like sandpaper' in the words of one engineer) and corrodes pipes, meaning shorter hardware life. Pipe corrosion also allows pollutant entry from surrounding strata. This is a health concern as Sangam Vihar relies on open drains and septic tanks that generate subsoil pollution (Dasgupta et al., 2018, p. 13) and the closest government water quality test-well shows high levels of groundwater contamination (Central Ground Water Board, 2016, p. 73).

For southern Sangam Vihar, by Delhi ridge, the water table is already around 79 feet below bedrock (Sarkar et al., 2016; Shekhar and Sarkar, 2013). This affects water quality and quantity in other ways. Quartz bedrock fissures and fractures but is less productive than alluvial

[21] Personal communication, Professor Shashank Shekhar, Geology Department, Delhi University, 18 July 2019.

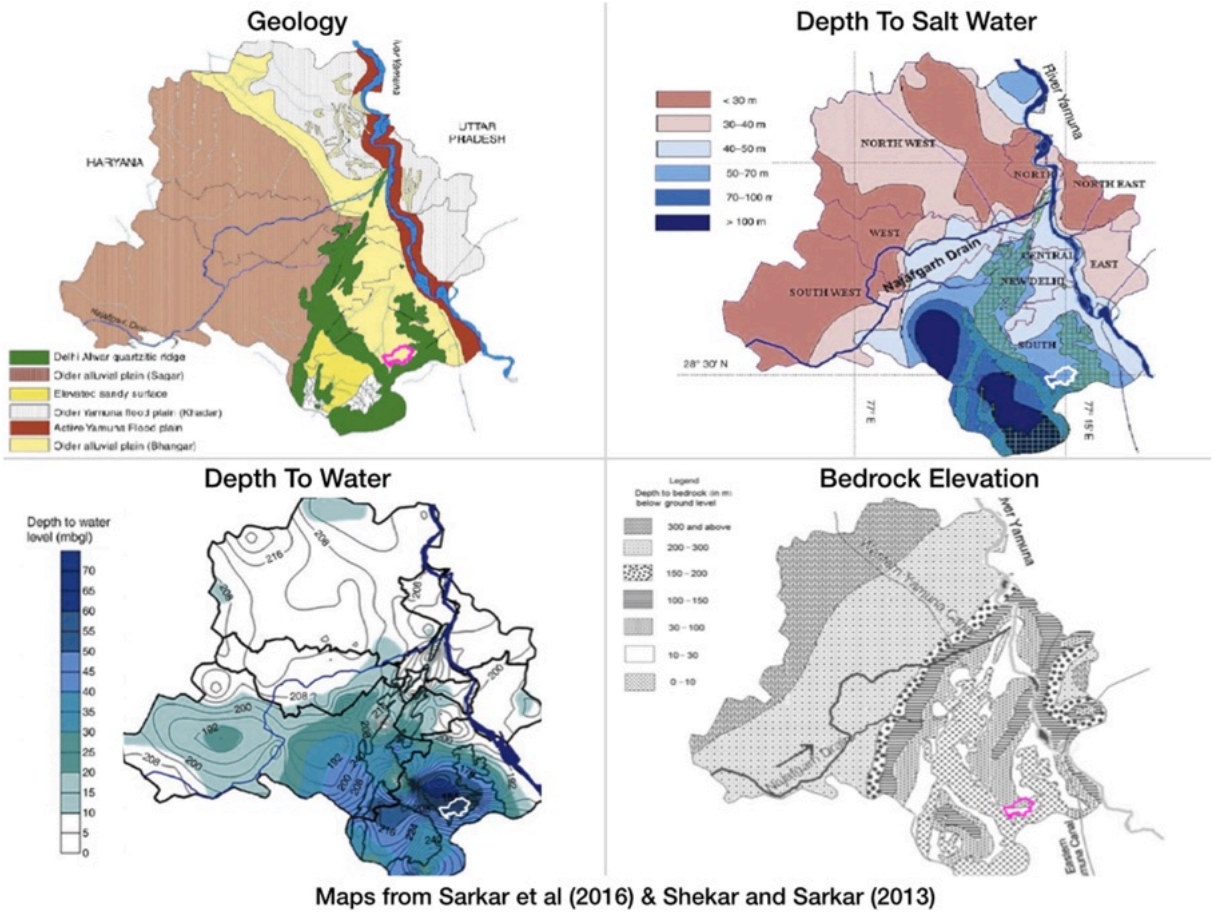


**Fig. 6.** Hydrogeology (Geology, Depth to Salt Water and Depth to Water from Sarkar et al 2016, Bedrock Elevation from Shekar and Sarkar 2013).

aquifers. Unlike the smooth distribution of water in the alluvium at higher levels, in quartz, water is found in cracks in the rock and deeper wells do not guarantee water supply. The amount of fissures varies, meaning that drilling a well is a gamble (Chatterjee et al., 2009). With deeper bores, fissures become narrower and the amount of water does not increase. Wells that were previously 450 feet, have had to be rebored to 600 feet or more because they were no longer productive at that depth. Many of my interviewees describe their wells as over 600 feet deep. Wells this deep cannot be using fissures (see Fig. 6).

However, Sangam Vihar lies at the edge of the Aravalli hills, a zone where the bedrock is split by large faults. Faults supply water of good quality in high quantities. Wells productive at 650 feet or deeper are likely to be tapping a fault.[22] Because of the uneven distribution of faults, well drilling in quartz is a risk (the bore may not find a fault) that may produce a lucrative asset. A tubewell manager who worked for a real estate broker described speculation in wells, 'the real estate brokers control tubewells and they buy and sell the wells amongst each other. It is a sort of game, a monopoly game'.[23] Navroz Dubash in Tubewell Capitalism also describes the high risk, high return potential of rural tubewells in crystalline aquifers (Dubash, 2001). A second, more problematic feature, is that while hard rock filters water, faults and fissures, like tubewells themselves, allow for rapid entry and spread of pollutants from the surface. Again, this is a concern given the area's dependence on septic tanks.

Sangam Vihar's historical and geological inheritance renders it perfectly positioned for large scale informal urbanisation. Additionally, the rock formations in the area make groundwater extraction a lucrative gamble. Groundwater as a resource is largely invisible, facilitating surreptitious forms of capture. Groundwater is also fluid, moving in space and time, and merging with other substances, not least subsoil minerals (such as salts) and pollutants from the surface.

At local scales, the physical form of the tubewell facilitates a range of governance formations with divergent outcomes. The materiality of technology influences, but only partially replaces individual agency and social relations. Approached through the wider ecology of groundwater, from rains to aquifers to waste water, the relationship between agency and materiality is different. Across the aquifer, human actions are only part of a much larger system. The utility of groundwater as a vertical dimension of urban metabolism becomes a vulnerability as extraction rapidly depletes the natural resource. As the groundwater table falls, some wells to run dry, while the value of wells tapping faults increases. Possibilities for human control and intervention are reduced, given the large spatial and temporal extent of these processes and our limited scientific knowledge.

As a low-visibility, dynamic, common pool resource, groundwater is difficult to sustainably manage. The use of subsoil water could also be considered a 'spatio-temporal fix', that subsidises the present at the cost of the future. However, groundwater is not only a 'low-cost asset' for productive investment of capital (Harvey, 2003, p. 149); aquifers are dynamic and exert their own influences on water governance and urban politics. For residents, a decrease in quantity and quality of water means greater reliance on other expensive privately supplied water and an increasingly urgent demand for piped water supply. For providers, a falling water table requires changes in business model or a change of business. For politicians, groundwater has both supported machine

[22] Personal communication, Professor Shashank Shekhar, Geology Department, Delhi University, 18 July 2019.
[23] Transect walk with tubewell manager, 04 February 2015.

politics (BJP, Congress) and the promise of change (AAP). Fundraising, urbanisation and political patronage exercised through water are all sensitive to declining groundwater yields.

## 7. Groundwater politics

Tubewells susceptibility to *qabza*, and Sangam Vihar's historically abundant groundwater both feed into the economy of politics by allowing politicians to gain income and influence, beyond the approval and locations of tubewells and tankers.

Urban development without planning permission requires water supply and dominant caste groups from local villages are involved in both land sales and water supply. When asked about the meaning of '*paani mafia*', an MLA explained to me that "those people [who] have tubewells in their houses from before have become a water mafia ('*water mafia ban jate hain*'), they sell water and fill tankers […] they fill DJB tankers too". When I asked about the role of local villages in politics and water supply, he said "these are the people who divided the land and the area […] The people from [village name] also sell water from tubewells".[24] A tanker business owner explained these dynamics further:

> "Villagers capture the tubewells and sell it to people from other states [*bahar se wale log*]: UP, Bihar, Rajasthan, Bengal. The migrants cannot say anything. The tubewell people are charging 500–600 [USD 7.80–9.36) a month. The tubewell people have a committee, headed by the *pradhan*, so people cannot say anything, cannot complain."
>
> Interview, Sangam Vihar tanker owner, August 2015, (Hindi)

In addition to their involvement in water supply businesses serving the migrant population, people from local villages are prominent in real estate and local politics in the Sangam Vihar area. The local MP is from a dominant caste community in one of these villages and has three relatives at MLA level and others in bureaucracy and real estate (Indian Express, 2015). In Sangam Vihar, other research has found that a Jaat community block has better water supply than blocks with larger Dalit and Muslim populations (Priyam, 2015, p. 105). Elsewhere in South Delhi, the role of locally dominant castes in both informal urban services and real estate has been documented (Xess and Zérah, 2017). A link between caste dominance and accumulation through migrant rental housing has been found by other research in the region (Naik, 2019, p. 50).

Control over tubewells can generate funds for party workers in charge of collecting fees. A party worker and resident explained that a former MLA "placed his people on the water sources" to "make money", because these were "strong people in fighting mode" other residents would "not say anything".[25] After deducting around ten percent as a salary (similar to other valve operators in the area), the money collected, INR 50,000–200,000 (USD 780–3,120) a month,[26] was sent to higher party workers to cover the costs of council and state elections. This coincides with reports in earlier research that link borewell capture to the MLA's office (Bhardwaj, 2015; Kacker and Joshi, 2012; Sheik et al., 2015). Tubewell technology facilitates extraction of rents from occupied land and water supply, and this situation supports local political actors through both 'machine' (BJP, Congress, and some AAP politicians) and 'reform' politics (AAP in 2014–2015).

Among Sangam Vihar residents I spoke to, the idea was common that they are courted for votes with tenuous promises of infrastructure. The emergence of AAP disrupted this pattern. Kacker and Joshi note that the connection of incumbent politicians to informal water supply promotes anti-incumbency; a sentiment that AAP were able to capitalise on (Kacker and Joshi, 2012, p. 32). However, in 2020, both Sangam Vihar and Deoli re-elected two AAP MLAs by comfortable margins.

Despite their electoral wins, AAPs initial efforts to reform tubewell management and tanker supply in Sangam Vihar met with less success. The entrenched social power relations of gender, caste, origin, wealth and political connection that make it hard for consumers to challenge tubewell operators, also made it hard for the new government to reform informal water management. The persistence of informal management indicates that initiatives under previous governments to 'reform' or 'renationalise' private tubewell supply in Sangam Vihar have also had a mixed success (Birkinshaw, 2019, p. 198; Kacker and Joshi, 2016, pp. 263–267).

For the new AAP regime in Delhi, water reform has been a difficult promise to deliver on – and groundwater, a fickle political ally – due to embedded social formations around tubewells, and the time required to change regulation. Groundwater dynamics facilitated the rise of AAP and then exposed them to the same charges of corruption and inefficiency they had directed at their predecessors.

In 2015, the AAP government began to allow MLALADS spending in unauthorised areas. The most substantial reform from the AAP government is to connect Sangam Vihar to the piped network (The Statesman, 2019). In 2016, AAP passed the *Jal Adhikar* (Right to Water) Connection Act, allowing legal metred connections for all residents regardless of tenure status (Bhan, 2016). Under AAP from 2015 to 2019, water pipelines were laid in 579 colonies, double the number of the preceding government term. At time of writing 250 of Delhi's 1,797 UCs are without piped supply, around 45 of which sit on protected land (Aam Aadmi Party, 2019). In 2018, households in some parts of Sangam Vihar had connections to the main DJB water network. In some streets, people collected money and got the pipes laid themselves. Other areas, on forest land, at higher elevation or unable to collect money for the work are still without piped water (see e.g. Baishya et al., 2019). In a 2020 pre-poll survey, 71% of respondents said water supply had improved under AAP (Lokniti-CSDS, 2020). Although there continue to be intermittent efforts to close illegal tubewells, recent far-reaching changes under the Delhi 2021 masterplan and 2021 CGWA guidelines on groundwater regulation are likely to have more impact.

At the city scale, south Delhi's use of non-network groundwater, facilitates both informal urbanisation, and uneven distribution of piped water. The historical reluctance to extend piped water to informal and peripheral areas correlates with very generous water provision towards the central and planned city, one form of elite capture. The extensive use of groundwater is convenient for the DJB; it offers a cheap raw water input that reduces bulk demand and allows Delhi to avoid the politically challenging task of addressing stark water inequalities across the city as a whole.

The social relations of both the piped water network (denied to unauthorised colonies) and the availability of groundwater are largely reified into natural conditions; insufficient water is inaccurately attributed to 'water scarcity', rather than distribution (Mehta, 2001; Shah and Narain, 2019). Delhi, as a city, consumes a lot of water, but it is not evenly distributed. Illicit urban groundwater use is a response to inadequate government supply and access challenges for households with informal tenure. The Delhi case, shows that in the absence of adequate supply, reform of illicit groundwater is hard. Delhi's recent history also shows that expansion of piped supply is a question of political will that depends on progressive public sector reform. While private sector and non-profit decentralised water supply initiatives (and private sector management initiatives, CURRENT AUTHOR, UNDER REVIEW) have been tried in other areas of Delhi, whether these are viable to expand at scale and/or compete with illicit and/or politically-connected businesses remains an open question.

## 8. Conclusions

This paper shows the variable politics of technology amongst decentralised infrastructures. Rather than a flat ontology (Marston et al.,

[24] Interview, South Delhi MLA, 13 July 2017, (Hindi).
[25] Personal communication, AAP party worker, 18 May 2015.
[26] e.g. 300–500 houses paying INR 150–500 (USD 2.34–7.80) each.

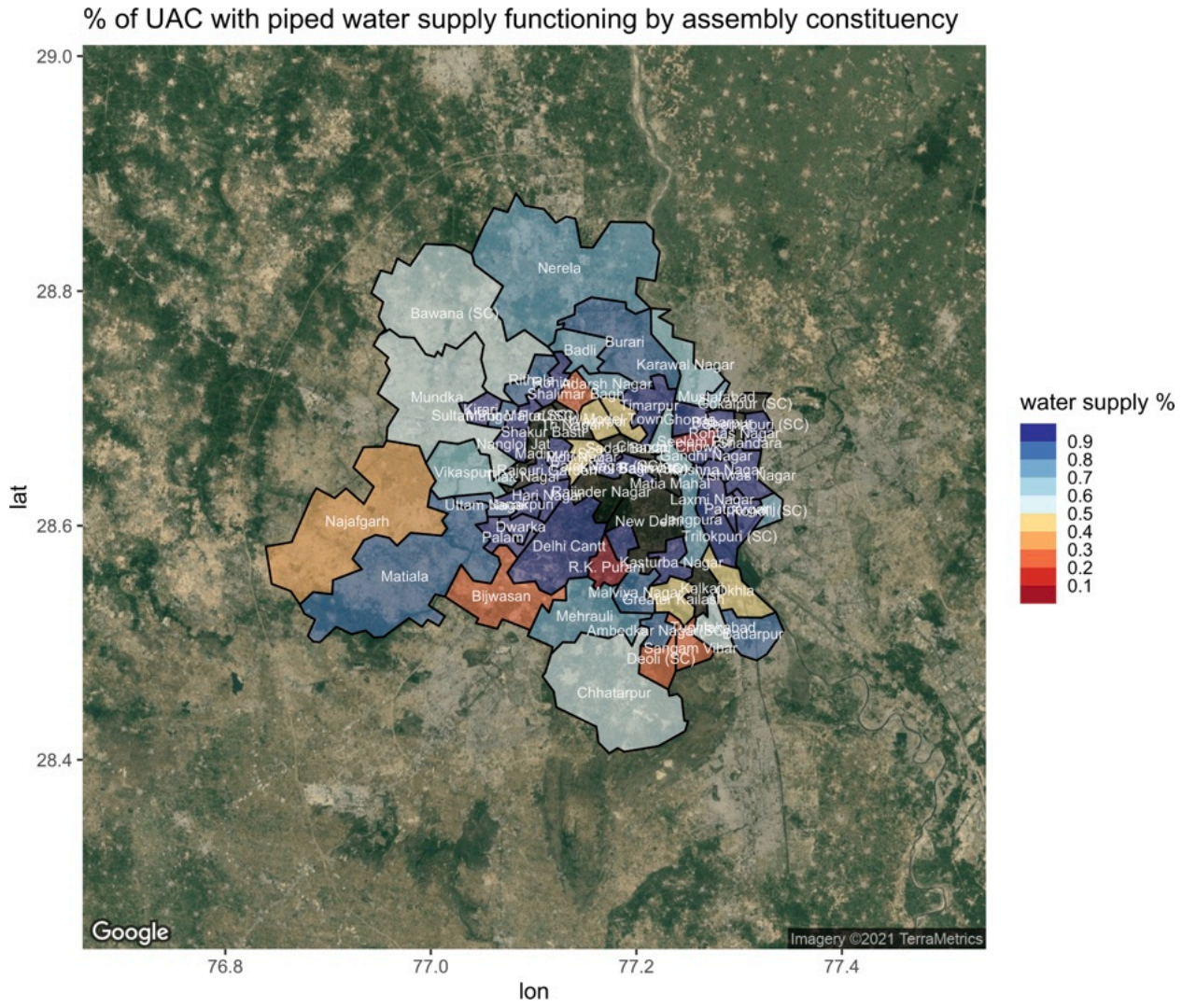


**Fig. 7.** Percentage of Unauthorised Colonies in Delhi Assembly Constituencies with functioning water supply. Delhi Government data. Mapped in R (R Core Team, 2021) using Rstudio (RStudio Team, 2020), ggmap (Kahle and Wickham, 2013), rgeos (Bivand and Rundel, 2021), RColorBrewer (Neuwirth, 2022), tidyverse (Wickham, 2019).

2005, pp. 422, 425), different balances of forces become involved for processes at different operational scales (Sayre, 2009, p. 97). The idea that material realities have different power at different scales is intuitive; the "mismatch of ecological and social scales is a basic recognition from which political-ecology analysis should begin, not end" (Rangan and Kull, 2009, p. 35). As a tightly coupled socio-material system, urban groundwater presents this mismatch. Attention to the technical and ecological factors is not a distraction from broader power structures but uncovers how material conditions produce and shapes local power relations. This paper has tried to extend interest in the materiality of urban water to include both technology and ecology, which in this case exert different influences on governance and operate at different scales. This multi-layered account moves towards a reading of the challenges of AAP reforms for urban groundwater supply in Delhi.

To recap, I suggest that tubewells as low-tech, low-visibility, mechanical-natural systems, are strongly socially embedded and consequently challenging for government agencies to control. Decentralised non-network infrastructure through small-scale private sector actors might offer interim solutions for urban water in some cases (Gidwani, 2015, p. 1). However, in a social context like the present case, at street level - whether through a benevolent residents' association bureaucracy, personalised patronage and dominance, or ruthless privateering - the everyday governance of decentralised infrastructures and resources is rarely democratic or egalitarian. The governance of natural resources is 'often elite-driven, exclusive, messy and conflict-ridden' (Mehta, 2005, p. 25).

Viewed at the scale of the tubewell network or street, technologies with a lower 'degree of infrastructure' or closure, facilitate greater levels of human intervention. Human agency and social relations strongly impact water distribution. Tubewell networks both challenge state power and take on themselves state-like features. Embedded within local structures of power, including patriarchy, caste and political economy, tubewell networks are a challenge to reform. The range of possible management styles suggests that, at street level, tubewells are compatible with forms of micro-politics, tending towards capture and personalisation, enabled by the materiality of technology and environment, but not reducible to them.

Shifting spatial and temporal scales to consider groundwater extraction across the aquifer, the situation changes. Groundwater ecologies – including aquifer geologies, three dimensional water movements, quality changes, and rainfall and recharge patterns – connect processes at larger scales and beyond individual human control. The balance of agency in socio-natural processes varies over space, time and scale (Clark and Yusoff, 2017) and considering these socio-natural formations alongside tubewells' socio-technical arrangements radically transforms concepts of agency. In the context of regional patterns of

groundwater depletion, urbanisation and monsoon change, human agency decreases. While the local capture of water supply in Sangam Vihar, and the area's groundwater ecologies, support the larger political economy of urbanisation and elite (water) capture in Delhi, changing combinations of ecological elements mean that groundwater use involves dynamics beyond the state and social relations, and is difficult for any actor to sustainably capture and control. I draw attention to social, technical and ecological influences on water politics to suggest that we might reconcile these perspectives by combining analysis at the scales of street, aquifer and city.

This research also suggests how *qabza* references the connections between land grabs, water grabs, state capture and political capture. Land grabs and tubewell capture are related and these in turn fuel the labour, real estate and political party economies of Delhi. Groundwater thus both supports the political economy of urbanisation and, as the water table falls, begins to undermine it. Considering the dependence of tubewells on a larger ecological system highlights their disruptive and unreliable potential as political tools (Furlong, 2011). As noted, distribution of land, water and power are highly unequal. In this context, material factors structure the development of socio-political forms as well as their breakdown in contradictory and regressive ways. In offering *qabza*, or capture and extraction as conceptual frames for groundwater governance and wider political shifts, I aim to contribute towards more situated theoretical vocabularies (Bhan, 2019) and respond to Ranganathan's call for UPE alert to socio-technical and socio-natural influences on urban processes (Ranganathan, 2015). While I have presented a story about the edge of Delhi, I suggest these processes have broader resonance for human relationships to earth and water in the Anthropocene (Clark and Yusoff, 2017). Contemporary political economies have increasingly become subject to forms of capture and extraction and dominated by new forms of rent (Loftus and March 2019). Future profits become powerful motives in the present while global ecologies of resource extraction enact irreversible global damage.

## CRediT authorship contribution statement

**Matt Birkinshaw:** Conceptualization, Methodology, Software, Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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