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*Annual Water Alternatives Review*

## Peri-Urban Water (In)Security in India: A Review

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**ABSTRACT:** This paper provides a review of the literature on peri-urban water (in)security in India. Articles were selected using a mix of a Google Scholar search and snowball sampling. The literature is dominated by the experience of peri-urban water insecurity in a few large cities that grew in response to the neoliberal expansion policies of the early 1990s. Peri-urban water insecurity is experienced in a variety of ways including: weakened access to water commons such as lakes, tanks, ponds and wetlands; increasing competition for groundwater; the physical flow of water from peri-urban spaces to urban centres; uneven access to safe drinking water; and declining water quality. Social and power relationships mediate how residents of peri-urban spaces experience changing access to water sources. A wide variety of approaches to improved peri-urban water security have been put forward by actors such as academics, NGOs, corporations and civil society groups. A gender and intersectionality lens should be used in further research that focuses on the peri-urban dynamics of water insecurity around smaller towns and urban centres.

**KEYWORDS:** Peri-urban, political ecology, urbanisation, water security, India

### INTRODUCTION

This paper reviews the literature on peri-urban water (in)security in India. In the Global South, there is rapid growth of peri-urban spaces that combine features of both rural and urban environments. They are socially, economically and institutionally heterogeneous, and are host to both agrarian and non-agrarian economic activities, land uses and institutions. They often provide the land, water and other resources needed for urban expansion, while at the same time serving as receptacles of urban waste. In India, the growth of peri-urban spaces occurred particularly after the adoption of the neoliberal policies for industrial expansion and growth in the early 1990s. Several state governments adopted policies for the setting up of Special Economic Zones (SEZs) and to attract business process outsourcing (BPO) and information technology (IT) service industries. This process of urban expansion was supported by the acquisition of land and water resources from the peripheral villages.

The emergence of peri-urban spaces points to increasingly blurred rural-urban boundaries. A visual landscape has arisen where modern gated communities, offices of corporate giants, high-rise residential buildings, shopping malls and recreation centres exist alongside a patchwork of agricultural land, village ponds, grazing lands and rural settlement areas. Modern residential high-rises and gated communities are often located adjacent to villages, or even within their administrative boundaries. The rural-urban dichotomy thus loses its relevance as a tool for spatial planning and development. On the one hand, modern infrastructure arises that is a hallmark of contemporary urbanisation and is associated with what are often referred to as 'millennium cities'; on the other hand, behind the story of such urban expansion lie narratives of dispossession of land and water resources to support the urban expansion process. This process of urban expansion creates patterns and pockets of peri-urban water insecurity, the

understanding of which sheds light on both the sustainability and equity dimensions of urbanisation. How is the ecological footprint of urban expansion borne? Who pays the price for contemporary urbanisation? How sustainable are such patterns of urbanisation? *Whose city is it anyway?*

The process of appropriation of land and water resources that is characteristic of India's peri-urbanisation process has led to changing control relations around water. (Former) users of peri-urban water, for instance, have lost access to, and control over, village water commons such as springs, lakes, tanks, ponds and wetlands and their relationship with those water bodies has undergone a change. New practices have at the same time emerged in relation to water resources that have survived in peri-urban spaces, including around, for instance, wastewater appropriation, and cleaning and maintenance of water courses and field channels. It is important to understand the processes through which the urban appropriation of rural water resources takes place and how peri-urban water users respond to these dynamics. This review seeks to address how various dimensions of peri-urban water insecurity in India have been analysed and theoretically approached; it aims to identify research gaps and weaknesses.

This paper uses the term 'water insecurity' as an umbrella descriptor to explore the dynamics of water governance and management and its outcomes in India's peri-urban spaces. A detailed review of the concept of water security is beyond the scope of this paper.<sup>1</sup> It is broadly defined, however, as having access to sufficient quantities of water for human activities and ecological purposes. The concept of peri-urban water insecurity draws attention to the processes that lead to the changing, uncertain or diminishing water supplies that are confronted by inhabitants of peri-urban spaces. The water security of peri-urban populations is shaped by changes in the tenure, use and control of land, as well as by changes in their livelihoods and economic activities, groundwater and surface water uses, landscapes and water quality (Roth et al., 2018).

The literature that has been reviewed for this paper was selected using a combination of a Google Scholar search and a snowball sampling approach. 'Peri-urban water security in India' was the dominant keyword for the search, but other keywords were also used including 'peri-urban water use in India', 'peri-urban water governance in India', and 'peri-urban water management in India'. Notably, all of these expressions yielded more or less the same list of publications.

This would have left out articles that were on the topic but whose title contained none of these four expressions; therefore, to make the literature database more comprehensive for the purposes of this review, we also reviewed relevant urban planning literature that addressed dimensions similar to those described in this paper but did not necessarily use a 'peri-urban' framing. The urban planning literature addressed specific dimensions of peri-urban water insecurity and thus was particularly relevant in filling some gaps. It provided a contextual explanation of the causes and factors supporting urban expansion in India, drawing attention to the structural and institutional changes behind, and accompanying, the process of contemporary urbanisation in India of which peri-urban water insecurity is a result. Examples of such literature are: Follmann et al. (2023); Zérah (2008), Das and Safini (2018); Cowan (2018); Das (2015); and Das and Skelton (2019). The most relevant urban planning literature was that which addressed dimensions of both urban planning and peri-urban water insecurity.

Scientific, peer-reviewed articles are the most significant among those presented and reviewed here; however, the review also draws upon edited volumes and books, papers that have been presented at conferences and included as part of conference proceedings, and some working papers. In our snowballing approach, reading the literature identified in the keyword-based search guided the author to other relevant literature; they then used their judgement to assess the suitability of such literature to further develop, fine tune or contextualise the arguments made.

In accordance with the thematic focus of the journal *Water Alternatives*, the review focused mainly on critical water scholarship on the subject of peri-urban water security in India. Much of the reviewed

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<sup>1</sup> For a detailed conceptual discussion of the term 'water security', see Cook and Bakker (2012).

literature drew attention to the role of power and politics in shaping water access in peri-urban contexts; other articles – outside the purview of critical water scholarship – were reviewed for their broader connection to the themes of this review. This includes literature that points to the use of wastewater in peri-urban agriculture, and other papers that discuss the existence of local inequities in access to water (see, for example, Ranjan, 2024; Jampani et al., 2020). Other such articles on peri-urban water insecurity in India include those that: draw attention to quantitative analyses of peri-urban water insecurity in South India (Siriman and Chand, 2026); document land-use changes and drivers of urban growth in major Indian cities (Narain et al., 2022); assess water quality criteria in the aftermath of the COVID-19 pandemic (Mukherjee et al., 2021); and explore the potential of citizen science in responding to the impacts of urbanisation and climate change on peri-urban water (in)security (Lakshmisha et al., 2019). Cheepi (2012) explores the implications of the deterioration of the water quality of Hyderabad's Musi River for the health and livelihoods of the inhabitants of the city's 30 surrounding villages.

The rest of this paper is organised as follows. The following section provides a conceptual groundwork for an understanding of 'peri-urban'. It reviews the different ways in which the expression 'peri-urban' is understood in the scientific literature. In addition to the Indian literature on peri-urban water (in)security, this section draws upon some of the relevant global literature, much of which was indeed developed in an effort to describe situations in Southeast Asia. The subsequent section draws attention to the factors that shape peri-urban water insecurity in India, that is, the diminishing and changing access to water in peri-urban spaces. A typology is presented which represents a set of approaches and understandings of the different ways in which the literature addresses peri-urban water insecurity as it is experienced in India; these include: the acquisition or encroachment of the peri-urban water commons, the flows of water from peri-urban to urban areas through water tankers, growing competition for groundwater, uneven access to water of a sufficient quality, and the deterioration of water quality in peri-urban spaces. Political ecology and urban political ecology are the dominant theoretical approaches used in this literature, though a hydro-social lens is also used, with an occasional foray into science and technology studies. The section after that describes the responses to peri-urban water insecurity in India as found in the literature, that is, how different actors such as residents of peri-urban spaces, representatives of non-government and corporate organisations, academics, and researchers have responded to the challenges of peri-urban water insecurity; this includes efforts that embody both complementarities and weaknesses. The final section of the paper identifies the important research gaps and suggests a way forward for research on peri-urban water (in)security in India.

### CONCEPTUAL GROUNDWORK FOR UNDERSTANDING 'PERI-URBAN'

'Peri-urban' is framed in multiple ways and the concept is extensively debated. Broadly speaking, the literature deals with it in three different ways: as a place, as a process, and as a concept (Narain and Nischal, 2007). Debates in the global literature revolve around whether peri-urban is better understood *spatially* – that is, in terms of its location peripheral to the city core – or in terms of its *processes* and *features*.

The spatial interpretation of the term is the most common; peri-urban, in that sense, refers to places that are at the borders or peripheries of cities, also referred to as the 'rural-urban fringe'. In the global literature, other expressions are used to describe such spaces, such as 'mega urban' regions (Jones, 2002); 'agropolitan' areas (Friedmann and Douglass, 1978); 'kampung kota' or 'desakota' in Indonesia (Kusno, 2019; McGee, 1991); and 'thoroughgoing urbanisation' (Jones, 1997).

These expressions typically refer to rural areas into which the growing city is encroaching. They are often villages on the borders of cities that provide land, water and other resources for urban expansion, while serving as receptacles of urban waste. These villages may eventually come under urban jurisdictions or they may retain their rural administrative character; in this sense, the term peri-urban 'area' can convey the impression that these are politically or administratively demarcated regions.

As a *process*, the term peri-urban captures the dynamism inherent in urban transformation; it refers to the processes of rural-urban transition, that is, the process of *becoming* urban (see, for instance, Leaf, 2011). In this sense, the term draws attention to the urban metabolism of cities, that is, the tendency of cities to appropriate land and water, convert it into urban infrastructure, and throw the waste back into peri-urban spaces (Roth et al., 2018). As a process, therefore, the term peri-urban refers to the dynamics through which the ecological footprint (Rees, 1997) is borne by cities.

A study of peri-urban spaces sheds light on the processes that shape the rural-urban transition. These include changes in the allocation of land, water and other resources, the related struggles and contestations, and the emergence of new forms of conflict and cooperation over natural resources, including water. The flows and movements of goods, services and resources between rural and urban areas are crucial to sustaining peri-urban livelihoods (Allen, 2003). Institutions for the management of common-property resources such as land and water tend to become eroded (Vij, 2014; Nagendra and Ostrom, 2014) and governance structures are often overlapping or fragmented (Gomes et al., 2023).

This process dimension of the peri-urban is key to understanding the dimensions of peri-urban water insecurity discussed in this paper. Included here are changes in the allocation of land and water resources, the increasing flow of fresh water from peri-urban spaces to the city core, and a steady expansion in flow of wastewater from the city core to peri-urban spaces. These processes can trigger conflicts around water, but they can also provide an impetus for new forms of cooperation, for instance, through the emergence of new institutions or norms for sharing water (Roth et al., 2018).

As a *concept*, 'peri-urban' serves as a conceptual lens for studying these transitions. It draws attention to the decreasing relevance of the rural-urban dichotomy that has typically informed approaches to planned development – a dichotomy that overall is quickly blurring in the Global South (Narain and Nischal, 2007; Marshall, 2024; Butsch et al., 2021). 'Peri-urban' serves as an analytic construct that denotes the co-existence of rural and urban economic activities, actors and institutions.

The literature increasingly challenges place-based definitions of peri-urban, and various authors (Iaquinta and Drescher, 2000; Shrestha, 2019; McGee, 1991) challenge the conceptualisation of the peri-urban as a rural-urban fringe, as described above. Iaquinta and Drescher (2000) posited that the peri-urban is defined by institutional contexts and characteristics, rather than by location or physical proximity to the city. This also underlies McGee's use of *desakota* ('village city' in Bahasa Indonesia), to refer to spaces in Southeast Asia that combine features of both urban and rural.

Marshall (2024) argues that McGee used the term 'desakota' as a way to steer away from Western conceptualisations of city and village to which many places in the Global South do not conform; indeed, this rural-urban patchwork is characteristic of large parts of many Global South cities and does not exist only at their geographical peripheries. Shrestha (2019), similarly, sees peri-urban as a sociological phenomenon whose characteristics or features are more important than its location with regard to proximity or distance from the city.

Defining peri-urban in terms of processes and features is relevant from an academic standpoint, but may have little relevance for urban planners and policymakers. The latter may find greater relevance in the geographical delineation of a peri-urban area, as that focuses their attention on a concrete geographical space in need of attention or intervention. Academics and researchers, on the other hand, argue that a spatial definition of peri-urban is problematic because rural and urban boundaries are constantly blurring, and rural and urban areas are constantly being reclassified.

Urban planners tend to think that what is peri-urban today will get absorbed by the city tomorrow and that, by virtue of its being incorporated under urban jurisdiction, its governance-related challenges will be addressed (Mehta and Karpouzoglou, 2015). As Marshall (2024) argues, however, peri-urban may represent a specific kind of urban, rather than a space that will inevitably get absorbed into the city. This view is reinforced by other peri-urban scholars such as Butsch et al. (2021), who note that the peri-urban is a heterogenous zone whose final stage is not necessarily determined. This challenges Leaf's (2011)

conceptualisation of peri-urban as a space that is in the process of *becoming* urban; that is, the 'peri-urban' of today is not necessarily the 'urban' of tomorrow.

### FORMS OF PERI-URBAN WATER INSECURITY IN INDIA

In recent years, a huge body of literature has emerged on the processes and factors that shape peri-urban water insecurity in India. This includes such factors as the acquisition of village common-property water resources and the takeover of common and private lands for the construction of water and other urban infrastructure (Vij, 2014; Nagendra and Ostrom, 2014; Prakash, 2014; Das and Skelton, 2019). Water is transferred from rural or peri-urban areas to the city through water tankers and canals (Vij et al., 2019; Prakash et al., 2015); at the same time, urban residents move to the city's peripheries to buy land for weekend getaways, and to build tourist resorts and hotels that extract groundwater, often placing it out of the reach of local peri-urban water users (Narain, 2014). For the latter, inadequate access to safe drinking water and declining water quality are other dimensions of peri-urban water insecurity (Ranjan, 2024; Karpouzoglou et al., 2018). Polluting industries relocate from the city core to the periphery because of lower land prices and more lax pollution control standards; water quality thus deteriorates rapidly and local groundwater aquifers become polluted. The pollution of Hyderabad's Musi River, for example, creates negative health and livelihood implications for inhabitants of the 30 villages near the city (Cheepi, 2012).

Much of this literature has been produced in the context of larger Indian cities that grew in the post-liberalisation era. Their expansion was driven by policies that established Special Economic Zones, supported the growth of IT and BPO industries, and encouraged the expansion of real estate; included here are, among many others, Gurgaon, Bangalore, Hyderabad and Chennai (see Vij, 2014; Nagendra and Ostrom, 2014; Vij et al., 2019; Prakash, 2014; Das and Skelton 2019; Sen and Nagendra, 2021; Nagendra, 2016).

There are, however, some notable exceptions to this attention to larger cities. Halkatti et al. (2003), for instance, focus on peri-urban dynamics and processes around smaller towns, though not necessarily in the context of water use, access or insecurity, while Narain and Singh (2019) describe changing access to water in a small-town hill resort of Mukteshwar in North India. Mukherjee and Chakraborty (2016) and Mukherjee (2015) draw attention to the transformation of the East Kolkata Wetlands; they describe a process that is not necessarily a product of neoliberal expansion of the kind witnessed in the other Indian megacities described in this review, however they still use a political-ecology perspective as do the other authors reviewed. Table 1 presents a typology of literature on peri-urban water insecurity in India.

The review of literature on peri-urban water insecurity in India in this section is organised around the five major themes listed above and is elucidated as follows.

#### The loss of the water commons

Cities on India's Deccan Plateau such as Hyderabad and Bangalore were historically sustained through a network of cascading lakes that performed a number of ecological and livelihood support functions. With the rapid pace of urbanisation, however, and the expansion of modern networks of piped water supply, these lakes fell into disuse and neglect and the norms, rules and customs that had sustained them for centuries broke down. Many of these water bodies were acquired by the state for urban expansion or were encroached upon by real estate and land mafia. Local communities that historically depended on them for their livelihoods were thus deprived of their use, though this occurred in a socially differentiated manner. This seems to be a common narrative underpinning studies of peri-urban water insecurity in the major cities that have expanded rapidly over the last 30 years such as Hyderabad, Bangalore, Gurgaon and Chennai.

Table 1. Typology of peri-urban water insecurity literature in India

Loss of water commons (lakes, ponds, tanks, wetlands)	Sen and Nagendra (2021); Vij and Narain (2016); Das and Skelton (2019); Prakash (2014); Vij (2014); Mukherjee and Chakraborty (2016); Mundoli et al. (2015, 2022); Mukherjee (2015); Mishra and Vij (2022); Mukherjee et al. (2025)
Operation of water tankers	Vij et al. (2019) ; Prakash et al. (2015); Prakash (2014); Packialakshmi et al. (2011); Lim and Das (2022)
Inequalities in drinking water access	Das and Skelton (2019); Prakash and Singh (2012); Prakash and Singh (2012); van der Woude (2018); Hui and Wescoat (2019); Ranjan (2024); Randhawa and Marshall (2014); Das and Safini (2018); Das (2019); Lim and Das (2022)
Deterioration of water quality	Karpouzoglou et al. (2018); Mehta and Karpouzoglou (2015); Ranjan (2024); Parthasarathy and Raja (2014); Singh and Prakash (2016); Cheepi (2012)
Competition over groundwater	Narain (2014); Packialakshmi et al. (2011); Vij et al. (2019)

Source: Compiled by author.

Sen and Nagendra (2021) note that, historically, the lakes around Bangalore had sustained the landscape but that, with encroaching urbanisation, they became polluted by both industrial and residential run-off. The growing city engulfed former villages that had been inhabited by long-standing indigenous communities with stable "caste and gender stratified social-ecological and sacred relationships with the lake" (ibid: 18). These lakes had once acted as common pool resources that served social, ecological and economic functions (Nagendra and Unnikrishnan, 2019) that were importantly influenced by the topography. The undulating terrain of the region allowed excess monsoon water from higher lakes to overflow to the lakes below, which formed a cascading system. Lake access, however, was built on unequal and stratified, yet intertwined, socio-ecological relationships within and among communities; these were divided on lines of caste and gender, with each group visualising the use of the water body differently. Lower caste women, for example, were not allowed to use the lake waters at times when they were being used by higher caste women. The lakes also carried a spiritual value and deities associated with them were worshipped; indeed, this spiritual value was instrumental in their conservation. These water bodies were constructed, maintained and managed by local communities and rulers and their use was constrained by locally crafted rules and norms. In that sense, they could be considered good examples of what are described in the water literature as self-governing water systems (Ostrom, 1990, 1991).

As urbanisation spread, however, the relationship between communities and lakes underwent a change. Communities' dependence on them declined with expansion of piped water networks, and lakes soon became polluted with sewage and industrial run-off. They came to be seen as a health risk and source of disease, and as malarial swamps that needed to be drained and converted into developed areas such as sports stadiums and malls (Nagendra and Unnikrishnan, 2019). This changing perception of these water bodies was perhaps instrumental in their takeover by the state and real estate for construction of modern amenities in the urbanising cities; they came to be seen as a source of land for urban infrastructure such as high-rise gated communities, shopping malls and recreation centres.

The impacts of urbanisation on lake-dependent communities in peri-urban Bangalore were not uniform. They were shaped in large part by prevailing power relations (Sen and Nagendra, 2021) and were thus experienced differently by different castes and social groups. Members of privileged castes sought to develop an urban outlook and thus gave up their ecological and cultural practices; marginalised castes, on the other hand, continued to retain strong cultural affinities with the lake and the surrounding

landscape. Many members of marginal caste groups, however, used urbanisation to transcend the humiliation of their traditional caste and gender barriers; for many members of privileged castes, on the other hand, urbanisation was seen to cause a decline in the stability of socio-ecological relations and left them resenting the rupture of caste hierarchies. Many in the privileged castes moved towards a more recreational use of the lake, while some of the marginalised castes continued to perform many of the rituals associated with it.

A similar narrative applies to Hyderabad. Historically, it also had a system of cascading lakes (Das and Skelton, 2019; Prakash, 2014; Prakash et al., 2011), but these disappeared through the processes of land acquisition and encroachment that supported the expansion of the city. Hyderabad's lakes were built about 500 years ago, during the Nizam's rule,<sup>2</sup> and were an essential part of the region's growth. They were a source of drinking water to both urban and rural locations and were used for irrigation and to support other livelihoods such as that of washer men (Prakash, 2014). Their ecological functions included recharging groundwater, and the cascading lake system provided protection against floods and droughts. Under the Nizam's rule, like Bangalore's lakes, they were managed through locally enforced norms. In the post-independence period, however, these lakes quickly fell into neglect. A study that was conducted over the period 1989 to 2009<sup>3</sup> using GIS and satellite images showed a sharp decline in the area of Hyderabad's water bodies. The resulting water insecurity for the city's large population is attributed to a combination of three factors: a disruption of natural water flows, increasing groundwater overdraft, and increasing rural-urban water flow (Prakash, 2014).

As Hyderabad expanded, its lakes, which had been part of the urban commons, thus fell into a state of decline (Prakash, 2014; Das and Skelton, 2019). Their interconnected cascading effect was broken down by blockage of the feeding channels by unauthorised constructions; like Bangalore's lakes, they became dumping grounds for garbage and household wastewater; and the lakes were choked further by large-scale encroachments by private entities.

For peri-urban Gurgaon, as well, the acquisition of village common land and water resources to create urban infrastructure is known to have deepened social and power differences. The collection of water, fodder and fuelwood was made more difficult for inhabitants, which particularly added to women's burden of work (Vij, 2014). Urban planning authorities in Gurgaon responded to the increased demand for water by creating new infrastructure to augment the urban water supply. A water treatment plant was built by acquiring private and common grazing lands from two peri-urban villages, which further undermined residents' access to fodder and fuelwood. In peri-urban Faridabad, potters were deprived of access to the village ponds (*johads*) from which they collected the silt that they needed to ply their trade (Narain and Nischal, 2007).

Given the gender-based division of labour around collection of water and other natural resources, peri-urban transitions have strong gender implications. In higher caste households in the village of Sultanpur in peri-urban Gurgaon, for example, it was the men who traditionally collected water for household purposes. With occupational diversification, however, men started commuting to the city for work and women from those households began to venture out to collect water (Ranjan and Narain, 2012). In Mukteshwar, in another example, acquisition of village lands for the construction of tourist resorts and guest houses led to communities losing access to springs; this added to women's water burdens, which were further compounded by changes in precipitation patterns that affected the discharge of springs (Narain and Singh, 2019).

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<sup>2</sup> The Nizam ruled Hyderabad State until 1948.

<sup>3</sup> The study was conducted by the South Asian Consortium for Inter-Disciplinary Water Resources Studies (SaciWaters), headquartered in Hyderabad, and the International Institute of Information Technology (IIIT).

### **The operation of water tankers**

In Hyderabad as elsewhere, the transport of water by tanker trucks from peri-urban locales into the city constitutes another form of water insecurity for residents of peri-urban spaces (Vij et al., 2019; Prakash et al., 2015). Without a property rights structure for groundwater, and with rights to water being tied to land ownership, owners of groundwater extraction structures can extract as much groundwater as they are able, and transport it to the city for sale.

These flows of water from rural and peri-urban spaces in Hyderabad to city residents are made possible through a strong nexus among local authorities, politicians and water sellers that allows them to bypass laws such as the Andhra Pradesh Water, Land and Trees Act, 2022 (APWALTA), which seeks to prevent the mining of aquifers (Prakash et al., 2015). In Mallampet and other adjoining villages in the city, water was appropriated by about 15 to 20 water tanker companies that were owned mainly by residents local to the area, most of which were operated without legal permission. Their operation is crucial to bridging the demand-supply gap and presents a lucrative opportunity for water sellers. Transferring water from peri-urban to urban areas, however, compromises local water security in the peri-urban extraction zones. Local residents – that is, the villagers who lose access to water – are forced to buy drinking water from local commercial vendors. Since the poorest in the city cannot afford tanker water and in order to cater to a more prosperous clientele, the tanker operators often tap villages farther away in times of erratic water supply, especially during the drier months.

Among the water sellers in peri-urban Hyderabad are farmers who sold their agricultural lands when agriculture was seen as no longer lucrative; such farmers, however, retained small parcels of land from where they pump the groundwater that they sell commercially.

These findings for Hyderabad are reinforced by Vij et al. (2019). They suggest that while in principle local governance organisations are responsible for enforcing the APWALTA, in practice they themselves are involved in the informal water market supply chain. Prakash (2014) argues that local governments even take a share of the profits in exchange for allowing these markets to operate; that is, water sellers and local politicians collaborate to bypass groundwater regulations that are in place under APWALTA.

In the case of Hyderabad's water markets, conflicts around water seem to have been latent (Prakash 2014) because of unequal power relations between those engaging in water sales and those at the receiving end. In the case of Chennai, however, the functioning of water markets is seen to be associated with the eruption of explicit water conflicts (Packialakshmi et al., 2011) that have arisen in the face of a depleting water table, changes in water quality, and the agricultural decline that has been brought on by thriving water markets.

The residents of Vengaiwasal, Sittalapakkam and Koilambakkam villages in Chennai protested against the uncontrolled pumping and sale of groundwater (Packialakshmi et al. 2011). Unbridled pumping of groundwater led to a steep decline in the local water table level, which affected farming operations and livelihoods. Government officials, in response, seized 11 tankers, to which water tanker owners responded in turn with protests. Packialakshmi et al. (ibid) advocate appropriate mapping of groundwater potential in the villages that witness groundwater extraction for informal water markets, and call for it to consider aspects of both water quality and quantity. They make a case for water markets to be legally and appropriately regulated in order to protect the resource base and enhance environmental sustainability.

### **Competition over groundwater**

Peri-urban water security is compromised not only by the physical flows of water between peri-urban spaces and urban centres or the city core, but also by the movement of urban residents from the core to the periphery. Urban residents moved to the peri-urban periphery of Gurgaon, for example, and acquired plots of land to build farmhouses as weekend getaways (Narain, 2014). These farmhouses compete for local groundwater, placing the resource out of reach of small and marginal farmers; the latter then adapt

by leaving their land fallow or by switching to sprinkler irrigation. The operation of water tankers in Chennai as well, as described above, results in greater competition among groundwater sellers and local users (Packialakshmi et al., 2011).

### **Inequalities in drinking water access**

A fourth form of peri-urban water insecurity to which the literature draws attention is inequalities between the city core and peri-urban spaces with regard to drinking water access. Water access in peri-urban spaces is shaped by social differentiations such as caste, class and gender; however, it is more broadly shaped by the nexus or web of social relations that exists among elite residents, state authorities, politicians and industry (Mehta and Karpouzoglou, 2015).

Das and Skelton (2019) contrast Cyberabad, Hyderabad's HITECH city, which is "air-conditioned, gardened, watered", with adjacent Madhapur, which is "hot, dusty and desiccated [and is] a space of dryness and water struggles" (ibid: 1553). Using a qualitative research approach that relies on narratives and life histories, Das and Safini (2018: 195) describe water as a "commodity splintered between the haves and have-nots"; they go on to say that, "the results of this study reaffirm past findings on water insecurity among the urban poor, and that women are more likely to be water insecure than men" (ibid).

Similar conclusions are drawn by Prakash and Singh (2012), they used a very different methodology, however, conducting a quantitative survey that collected household-level gender-segregated data for Aliabad, a peri-urban village in Hyderabad. Here, the intersection of caste, class and gender is shown to shape water allocation and access, and location within the village disadvantages households belonging to Scheduled Caste (SC) residents. Being located at the opposite end of the village from the water access point, SC residents are deprived of water when voltage fluctuations prevent electric pumps from moving it to the farthest locations. For Prakash and Singh (2012), however, 'peri-urban' seems to be understood simply as a dimension of the location of the village; the mechanisms and processes through which the peri-urban character of the research site causes these differences to persist or be perpetuated thus remain underexplored. Van der Woude (2016) reaches similar conclusions for Sultanpur, a village in peri-urban Gurgaon. That author also shows how caste, class and gender shape differential access to water and how the location of households importantly shapes differential access. There, as elsewhere, those in more remote parts of the village – who are usually lower in both caste and wealth status – experience poorer access to water and are also less well represented in water-related decision-making processes.

In their study of water conditions in peri-urban areas of Maharashtra's Pune District, Hui and Wescoat (2019) demonstrate that water supply has improved in some areas, but that sanitation and drainage have not kept up. Based on their study of 1861 populated villages in the district, they note that large peri-urban villages tend to have better drinking water and sanitation amenities than small villages, but that they are no different with regard to drainage infrastructure and thus their overall sanitation conditions are likely to deteriorate. As these authors noted, census data indicates low levels of service in towns of around 5000 population, and that towns that fall between rural and urban categories appear to be particularly ill-served. Peri-urban water insecurity here is not so much a result of the neoliberal policies that have influenced the expansion of larger cities; rather, it reflects poor local planning and institutional inadequacies.

For peri-urban Ghaziabad, as well, Randhawa and Marshall (2014) note that there is social fragmentation of services and that people in poorer colonies pay different amounts for water. For the very poorest, there are time and opportunity costs as well as the health costs associated with poor water quality. In extreme cases such as in Ghaziabad's Ambedkar Colony, the cost of water for the poorest residents has sometimes been life itself! Until these residents could influence political leadership to get a submersible pump, some people lost their lives crossing a railway line to fetch water from an adjoining middle-class colony.

Peri-urban water scholarship in India is dominated by a political-ecology perspective (Swyngedouw, 2009; Bryant and Bailey, 1997). According to this perspective, the appropriation of rural and peri-urban water resources by urban areas, and the deterioration of water quality in peri-urban spaces, are shaped by configurations of social, political and economic power (Sen et al., 2019; Karpouzoglou et al., 2018). Local networks play an important role in mediating the operation of water tanker markets and these markets are heavily influenced by the unequal power relations between tanker truck owners and water users (Vij et al., 2019). Sen et al. (2019), argue that the poor quality and quantity of Hyderabad's water and the social relations around it co-produce each other. The involvement of the private sector in the provisioning of drinking water produces yet other forms of distress in peri-urban spaces.

### **Deteriorating water quality**

A fifth and final dimension of peri-urban water insecurity in India is deteriorating water quality, to which an urban political-ecology perspective is also applied. Karpouzoglou et al. examine the issue of water quality decline in the Trans-Hindon area of India's National Capital Region; they note that it is "far from apolitical" (2018: 491). The quality of water in peri-urban spaces is a matter of constant politicised negotiation among urban and peri-urban elite interests. The peri-urban space is drastically reconfigured by powerful actors; this reconfiguration seeks to provide the resources necessary for housing, industrial production and other uses that are "written into the lexicon of urban planners while ignoring the social and environmental impacts upon the poorer residents and the vital natural resources they rely on" (ibid). The contamination of peri-urban water sources happens mainly because polluting industries are located in the peripheral areas in a bid to keep the city core clean. Industries are often relocated to peri-urban spaces because land is cheap and pollution control norms are more lax than in the city core. This demonstrates a strong bias in urban planning and puts a fine point on who modern cities are meant for (Shatkin, 2016).

Through a survey of 300 households across five settlements in the Myorpur block of Uttar Pradesh, Ranjan (2024) revealed that most of the collected water samples exceeded the permissible level for physiochemical elements suggested by the WHO 2011 and the Bureau of Indian Standards 2012. Access to safe drinking water is influenced by the socio-economic status of peri-urban inhabitants, with socially and economically marginalised households being more disadvantaged in this regard. Such households are also less equipped to cope with the repercussions of consuming contaminated water.

Policymakers and some academics see peri-urban spaces as problematic and as being in a state of *becoming* more modern. They are often bypassed by planners and authorities and are characterised by jurisdictional and administrative ambiguities that lead to the systemic exclusion of their poor and marginalised citizens (Mehta and Karpouzoglou, 2015). Since planning models for peri-urban areas are poorly conceived or misplaced, their water needs end up not being addressed. This leads to a systematic exclusion of poorer people's perspective and to a general neglect of peri-urban dynamics in urban planning. It also points to the peri-urban/urban interface being increasingly characterised as an interface between official and unofficial, formal and informal.

Large-scale technological infrastructures are expected to provide long-term solutions to poor water and sanitation coverage; these same infrastructures, however, manifest power asymmetries (Das, 2015; Das and Safini, 2018). In the absence of adequate state coverage of the drinking water supply in peri-urban spaces, alternative forms of service delivery become institutionalised; these tend to be based on local private initiatives such as the private sale of groundwater, which fill the gap left by the failure of government supply networks, often mimicking the state itself (Narain et al., 2023).

## **RESPONDING TO PERI-URBAN WATER INSECURITY: ADDRESSING CHALLENGES OF GOVERNANCE AND INSTITUTIONAL ADAPTATION**

This section reviews the literature that addresses the questions of how peri-urban spaces – and the expanding cities that are supported by them – respond to the challenges presented by water insecurity. A wide diversity of actors is involved in this process, including academics, researchers, non-government organisations, corporations, and citizens' action groups. Each has brought specific strengths and perspectives to the situation and context, and there is mutual complementarity in their efforts.

The peri-urban space is institutionally complex and governance structures are in a constant state of flux. Very often, rural governance structures at the village level (such as village panchayats) may cease to exist or to function before new urban governance structures have become functional – even if the latter does exist in principle or through formal jurisdictional characterisation. The peri-urban context is characterised by the co-existence of statutory and non-statutory institutions that straddle the formal/informal divide. This kind of institutional environment creates space for intervention from a wide range of actors, including academics, researchers, corporations and NGOs. A wide variety of approaches have also been experimented with in peri-urban contexts in an effort to fill institutional voids, mobilise communities, and improve the accountability of service providers to resource users.

Among academics and NGOs there are efforts to build forums for mutual accountability between the state and peri-urban water users and to mobilise communities for better sharing of information on groundwater (Gomes and Hermans, 2016; Narain et al., 2020). Hermans et al. (2021) examined the trans-disciplinary Negotiated Approach as a way to ameliorate groundwater management challenges in rapidly urbanising parts of the Ganges Delta. This approach seeks to improve the access of local groundwater users to groundwater-related information. It goes beyond creating a multi-stakeholder dialogue to encourage water users to bring their own knowledge, needs and environmental realities to a process of actively developing, proposing and negotiating policy measures. Trans-disciplinary approaches are seen as necessary for transforming resources such as the East Kolkata Wetlands from a contested to a collaborative space (Mukherjee et al., 2025).

In an action research project in peri-urban Gurgaon, a team of researchers initiated a series of dialogues between the residents of the village of Sultanpur and the Public Health and Engineering Department (PHED), with the aim of establishing a relationship of mutual accountability between the two sides (Narain et al., 2020). Initial investigations revealed a lack of accountability on the part of the service providers; further investigations revealed the presence of illegal connections and broken pipes in the village, which were leading to pilferage and the waste of water. This was attended to through a series of stakeholder workshops that brought together residents of Sultanpur village and representatives of the PHED. This approach improved the accountability of water service providers to water users.

Through a comparative analysis of local adaptation processes in villages in the peri-urban areas of three Indian cities, namely, Kolkata, Pune and Hyderabad, Gomes et al. (2023) note a disconnect between how peri-urban spaces are perceived by outsiders (who view them as future cities) and their development trajectories as understood by residents. Gomes et al. argue that working around locally favoured trajectories of development can play a key role in empowering local communities and making them partners in the development process. Butsch et al. (2021) use the concept of hydro-social cycles to examine the transforming waterscape of six peri-urban villages on the fringes of Pune, Hyderabad and Kolkata. They note the emerging peri-urban waterscape to be characterised by a constant renegotiation of the meaning of water rights, of actual water access, and of water-related infrastructure. The emergence of new actors and activities in the peri-urban space results in power struggles over the increasingly sparse and contested resource. In terms of governance, this transition occurs in a space where old institutions are eroding and new ones are constantly emerging, thus presenting a high degree of informality.

Wastewater plays an important role in supporting peri-urban livelihoods and constitutes an important coping response for peri-urban residents in the context of growing water insecurity (Jampani et al., 2020; Roth et al., 2018). The literature points to a sociotechnical mediation of peri-urban water insecurity (Lim and Das, 2022) in which wastewater irrigation plays an important role (Roth et al., 2018). Among irrigators, there emerge norms of cooperation in sharing wastewater and devising new institutions or norms for appropriating the resource. Users also install new technologies or artefacts to appropriate water from canals that were built to serve the city. They negotiate with the water bureaucracy for, for instance, higher discharges of urban wastewater to be used in peri-urban agriculture.

Water institutions in peri-urban spaces are in a state of flux. Singh and Narain (2019) draw attention to how village johads, or ponds, in peri-urban Delhi that were once used to store rainwater are now used to store wastewater. Furrows are dug to transport wastewater from a wastewater canal to be stored in a johad and then later pumped to agricultural plots for irrigation. Wastewater is thereby converted from a flow into a stock that can be used when the wastewater supply has been turned off. Potential irrigators contribute to the creation of irrigation infrastructure in proportion to the size of the landholding to be irrigated, even though non-contributors are also allowed to appropriate the wastewater, this being justified on the strength of the narrative that the water is wastewater after all!

In Bangalore, collaborative action plans have been designed and implemented by state entities, citizens groups, and various self-organised non-state organisations to conserve lakes whose area is gradually shrinking (Nagendra, 2016). Corporations and citizens groups have responded through corporate social responsibility (CSR) initiatives to restore tanks and water bodies in peri-urban spaces (Nagendra and Ostrom, 2014). Public interest litigation, active engagement by civic action groups, and action by the Karnataka courts have played an active role in protecting the remaining lakes of the city, achieving for them legal protection from encroachment and development. A group of local residents inhabiting the southeast part of the city engaged the Bruhat Bangalore Mahanagara Palike (BBMP), the local urban municipal body, to rejuvenate and maintain Kaikondrahalli Lake in the city. The success of efforts to restore the lake are presented as a strong case in favour of collaborative action among diverse groups which mobilises their relative strengths (Nagendra, 2016). Local residents who live near the lake are able to monitor and identify issues such as land encroachment, blocked water channels, the dumping of solid waste, and the inflow of sewage and industrial effluents. Government agencies, on the other hand, have the legal authority to prevent unwanted activities and harmful use of the lake, but rarely have information about local incidents and developments that may have a bearing on its functioning. A strong case is thus made for partnerships between the state and citizen action groups so that, together, they can play an effective role in monitoring, protecting and restoring lakes.

The above-described efforts, however, suffer from some weaknesses. Though restoration programmes have been conducted in several Bangalore lakes, in many cases sustained community participation has been lacking and lakes' condition has thus deteriorated (Nagendra, 2016). This is understood to be partly due to the piecemeal approach to lake restoration, which seems to ignore their interconnected nature. After a lake is rejuvenated, the lake upstream from it may continue to discharge sewage, thus returning it to its original polluted condition. Lake restoration can be socially challenging due to the difficulties of urban collective action; these include the high levels of diversity and inequity, constant changes in the socio-economic and cultural backdrop, and the apathy of real estate developers and local residents. Contestations among different political parties can also threaten protection efforts, and cooperation between local actors and government agencies increases the likelihood of success of urban collective action efforts.

Lake restoration needs to foster inclusivity and a deeper socio-ecological connection that goes beyond recreation and groundwater recharge to ensure longer-term sustainability (Nagendra and Unnikrishnan, 2019). Though citizens groups and NGOs have collaborated to restore peri-urban water bodies in the city, this restoration has tended to focus exclusively on the recreation value of the lakes; this caters to an urban middle-class elite, while ignoring the diversity of social relations and resource use patterns that

traditionally existed around the lakes. Cementing surfaces and walkways around the lake ignores their potential ecological significance with regard to recharging the groundwater and acting as a buffer zone in times of heavy rainfall.

### **ASSESSMENT OF THE LITERATURE, RESEARCH GAPS, AND WAY FORWARD**

The literature on peri-urban water insecurity in India has tended to focus mainly on large cities such as Bangalore, Chennai, Hyderabad and Gurgaon, which expanded in the aftermath of economic reforms and liberalisation in the 1990s. Such megacities grew through the expansion of real estate and due to a surge in the IT and BPO industries. Studies by Hui and Wescoat (2019), Ranjan (2024), Mukherjee (2015) and others, however, constitute an exception to this large-city focus, and their work helps us develop an overall typology of the ways in which peri-urban water insecurity is experienced in India. This typology may indeed be more broadly relevant in the Global South.

This literature describes how the process of urban expansion has dispossessed peri-urban communities of their land and water, with water being portrayed as a splintered resource (Lim and Das, 2022). The process of urban expansion of modern cities was made possible mainly by acquiring and engulfing the land and water resources of villages at their periphery. This process created pockets of deprivation amidst enclaves of prosperity and abundance. In some situations this produced explicit conflicts, while in others the conflicts remained latent. There is some evidence of emerging forms of cooperation around water resources, but this literature is not yet fully developed. There is little attention in the literature to determining which conditions transform peri-urban water insecurity into explicit conflicts and which result in conflicts remaining latent, although some pointers to this can be found in Prakash (2014) and in Roth et al. (2018). As it is put by Vij et al. (2018), conflicts and cooperation are not polar extremes but rather points along a continuum.

Further research should document the conditions that lead to conflicts, cooperation, or conflict avoidance in relation to water use in peri-urban contexts. This can throw light on the social and structural causes of peri-urban water insecurity and on the unequal power relations between peri-urban spaces and the city core that cause these persistent inequalities. The process of dispossession of the peri-urban communities has the potential to trigger conflicts that can remain latent due to these unequal power structures; however, urbanisation-induced scarcity can also be a trigger for cooperation and can result in the formation of new norms or rules for resource sharing and appropriation. Further scientific research should consider the conditions that trigger conflicts or cooperation, or that lead to conflict avoidance around water in peri-urban contexts (see Vij and Narain, 2025).

The literature reviewed in this paper is nevertheless significant in that it addresses the justice and equity implications of urbanisation and land-use change; it speaks to the urban metabolism aspect of modern cities, that is, their tendency to absorb land and water resources for the creation of urban infrastructure and eject waste back into the peri-urban spaces. Peri-urban spaces are in this way seen as bearing the ecological footprint of urbanisation.

The peri-urban literature draws attention to the dimensions of both sustainability and equity in India's urbanisation trajectory. In terms of a framing of water insecurity, the literature positions peri-urban communities against the residents of modern cities; the latter are presented as being privileged with regard to their access to water and, more generally, in terms of their superior access to civic amenities and other infrastructure. This literature thus draws attention to the inherent bias in urban planning, which presumes the needs of cities to take precedence over those of rural or peri-urban spaces. It raises questions about who modern cities are actually meant for (Shatkin, 2016), and it draws attention to unequal power relations between cities and peri-urban spaces. Peri-urban water security scholarship in India has been dominated by political ecology, a hydro-social lens, and urban political-ecology perspectives, with occasional forays into science and technology studies.

Urban planning literature provides a deeper understanding of the structural and institutional reasons why urban expansion has created pockets of deprivation of land and water among peri-urban water users. Three key processes are seen as shaping peri-urban dynamics across various political-economic contexts; these are: market- and speculation-driven property development, state-led development strategies, and fragmented planning and development practices (Follmann et al., 2023). The process of urban expansion is seen as being rooted in neoliberal policies that created more space for private enterprise, especially for IT and engineering services and for BPO industries. It is also rooted in specific state-level policies that laid down norms and guidelines for land acquisition and the creation of Special Economic Zones (Cowan, 2018; Zérah, 2008; Das and Safini, 2018; Das, 2015; Das and Skelton, 2019). Cowan (2018) attributes the mixed patchwork of urban and rural land uses in Gurgaon to the state's urban expansion policies which exclude village settlement areas from the purview of land acquisition. In Hyderabad, state-level leadership has clearly been influential in copying external models of the expansion of modern "smart cities" (Das, 2015).

The impacts of such processes on peri-urban inhabitants are not uniform, however, but rather are mediated by social and power relationships. The wide heterogeneity of peri-urban spaces has caused scholars to critique the notion of a 'peri-urban community' (Shrestha, 2019). The emphasis on community in discourses on resilience stems from a mythic view of it that sees community as a homogenous whole (Shrestha, 2019; Roth et al., 2018), while in fact the peri-urban space is socially very heterogenous, with a very wide diversity of social and economic interests. The implication of this social and economic heterogeneity for the differential vulnerabilities of peri-urban communities needs further scientific attention. The gendered dimensions of peri-urban water insecurity provide a particularly fertile ground for further research, as does the intersection of gender with other social identities. A more in-depth examination of these factors can yield important observations with regard to differential vulnerability to changing water access in peri-urban spaces. These identities are fluid and thus have the potential to be differently impacted by urbanisation.

As the literature demonstrates, residents of peri-urban spaces are not passive recipients of such changes; rather, they exercise agency in response to growing stresses on their land and water resources. Water insecurity is socio-technically mediated, as seen in the emergence of technological and institutional innovations that support adaptations to peri-urban water insecurity. These responses need to be seen against a background in which cities and urban centres receive much policy attention in terms of, for instance, resources for infrastructure creation, while peri-urban spaces suffer from policy apathy. Adaptive responses exist both at the individual and the collective level. An examination of collective responses provides scope for further scientific attention to the role of social capital among residents of peri-urban spaces, including in its three forms of bonding, bridging and linking (Adger, 2010). It could be asked: does bonding social capital fill a void left by the absence of linking or bridging social capital?

Another area for further scientific research is the implication of different and often contradictory normative systems for resource access and struggles in peri-urban spaces. Though the literature recognises the transitory character of peri-urban governance structures, the implications of the co-existence of statutory and non-statutory forms of resource allocation and governance receive scant attention. A conceptual lens of legal pluralism (von Benda-Beckmann, 2001) has the potential to highlight contestations and struggles over resources in peri-urban areas.

Finally, and most important, there is perhaps a need at this juncture for stronger attention to peri-urban water dynamics in smaller towns and cities, and a need also to investigate the process of changing access to land and water in such contexts. It is in the smaller towns and cities of India (administratively referred to as Tier-2 or Tier-3 towns) that much of the country's urban expansion is expected to be concentrated in the coming decades. The absence of this focus from the literature thus constitutes a stark exclusion from peri-urban water security scholarship and it is where attention should be turned. As demonstrated by Hui and Wescoat (2019), Ranjan (2024), and Randhawa and Marshall (2014), peri-urban water insecurity in smaller towns and cities reflects local institutional inadequacies and a reproduction

of social inequalities. A comparison of the drivers of peri-urban water insecurity in smaller towns and urban centres with the scholarship described in this review could yield insights that are relevant for both academia and practice. It may yield alternative ways of theorising on the links between peri-urbanisation and water (in)security and may also challenge the hegemony of theoretical frameworks such as urban political ecology and science and technology studies. More nuanced explanations of these processes may thus be generated which are grounded in the specific local context of the Global South. Such analyses should use a lens of gender, social inclusion and intersectionality to understand better the socially differentiated nature of peri-urban water insecurity. As a final point, the potential of feminist research methods remains underexploited in peri-urban contexts and provides an important area for further development of peri-urban water security scholarship, both for larger cities and smaller towns.

## ACKNOWLEDGEMENTS

The author would like to acknowledge comments and feedback received from the editors of the journal and from three anonymous reviewers at various stages of developing the manuscript.

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