In the Shadows of Neo-liberal Urbanization and Climate Variability: Adaptations and Distress in Drinking Water Use in Peri-urban Hyderabad

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Keywords: Drinking water, Water governance, Peri-Urban, Privatization of water, Climate Change, Urbanization, Adaptation, Hyderabad

Backdrop

The complex water markets has evolved fairly rapidly in the last two decades, as the evidence from peri-urban Hyderabad elicits in this paper. This has changed, to a large extent, the choices available to the citizens of the peri-urban communities, and has implications for access to safe water and their various constituent hamlets, both in the lean and the normal seasons[i]. The water stress imposed on the residents have two primary agents, the urbanization process and sharp climatic variability that is said to have increased in recent years (Diffenbaugh *et al* 2015; Nicholls *et al* 1996, Katz and Brown 1992).

In recent periods in Telangana, there have been consecutive periods of droughts that has reportedly pushed the state into a great deal of distress. However, the impact of the extreme events on agriculture in rural areas has been the focus of enquiry (Rao and Rao 2017, Roy and Joshi 2017). It has been argued that consecutive periods of droughts have encouraged rural to urban migrations and reduced rural to rural flows. This has also increased the demand for basic services in and around Hyderabad, since the in-migration flow to a large extent is directed thus. The impact of climate change in the peri-urban spaces has not been part of the existing literature in any significant manner, except in a few cases (Narain 2010, Eakin *et al* 2010). There has, however, been a lot of discussion on the influence of urban processes on the peri-urban spaces. *It will be our endeavor in this paper to attempt to sieve out the relative influences of these two drivers on the (in)security caused in the drinking water domain in the peri-urban space.*

In particular, we would attempt to understand the national policy orientation vis-à-vis water privatization, followed by an analysis of how these changes have manifested in peri-urban Hyderabad. Since ground water is the single major source for drinking water, we will review the status of ground water depletion in the backdrop of rainfall conditions, taking into account extreme rainfall situations; in this section, we attempt a comparison of the ground water status

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of the peri-urban against the urban and the rural. Finally, we try to understand the implications of the above on drinking water patterns, both across and within villages, to evaluate the inequalities in access to drinking water, if any.

I. Importance of Peri-Urban Context

Peri-urban spaces have been understood in multiple ways, as physical spaces of environmental degeneration and inequalities, as a process of 'reterritorialisation' due to globalization contingencies, as an outcome of re-scaling of state power and domain, as areas of flux and transitions, and as sheer concepts (Brenner 1999, Shaw 2005, Aguilar *et al* 2003, Kundu 2007, Narain 2010; Sen 2016). This part of the work draws relevance, in a lessor or greater extent, from all of these conceptualizations, though the current context begs for a political economy analytical framework to understand this unique space as an outcome of urban processes shaped by neo-liberal policy mechanics. The latter not only is known to have immense impacts on the environments, but also on the freedom of basic livelihood choices. These impacts cannot be understood in the rural-urban binaries, and has to do with the process of sustainable urbanization (Simon 2008).

The importance of the peri-urban space emerges on ground of at least *six* important points. First, the peri-urban spaces of the large metropolitan cities have come under a process at the current moment that is qualitatively different compared to what it was experiencing three decades before this. In other words, the process of urbanization now is land intensive, capital intensive, has a low employment elasticity driven by private capital, one that encloses environmental commons, alienating those dependent on them; thus this is also a space where the scarcities driven by climate change is likely to be felt more acutely compared to it counterparts. Second, the interaction between the rural and the urban in the peri-urban context has future implication for the rest of the country. In other words, understanding the peri-urban today within the current context enables us to look into the future in terms of the way the urban will potentially 'treat' the rural. Third, even *in situ*, the situation in the peri-urban spaces over time impacts increasingly larger number of people, due to increases in migration and relocation of slum population from the cities (Bhan 2009, Mosse *et al* 2005); as per the Census of India, 2001 and 2011, the growth of population in districts around the large cities have registered around two and half times higher rate of population growth. Fourth, unsustainable peripheries of today are bound to make for unsustainable cities of tomorrow. The unsustainable patterns are visible in three major aspects, environmental, socio-economic and political (Sen 2017, Zhao 2013, Aguilar 2008, Dupont 2007, Allen 2003). Fifth, the peri-urban spaces of particularly the large metropolises of developing countries, accommodates new forms of inequalities that is probably not visible anywhere else. On the one hand, at least three kinds of poor, i.e. the locals that have that have suffered the consequences of land acquisition, relocated slum dwellers of the city and migrants from rural interiors whose mobility does not only represent aspirations, but lack of options in rural areas, are inhabitants of these areas. On the other, landscapes with high end infrastructure along with real estate development that house the *nouveau riche* is superimposed on the existing semi-urban or rural landscapes, with little incremental provisions for the marginalized who often 'make' the city, with little 'rights' to it (Harvey 2008, Purcell 2003,Lefebvre 1996). Sixth, this point being specific to water though applicable to other areas of governance too, the web of institutions that emerge to govern resources, particularly natural resources that have strong public good characteristics, are often specific to peri-urban contexts, that explain the process through which the state operates to make way for the private; in other words, the 'public' is so intrinsically intertwined with the private, that it is relevant to ask whether the private would have taken the current trajectory without this intervention.

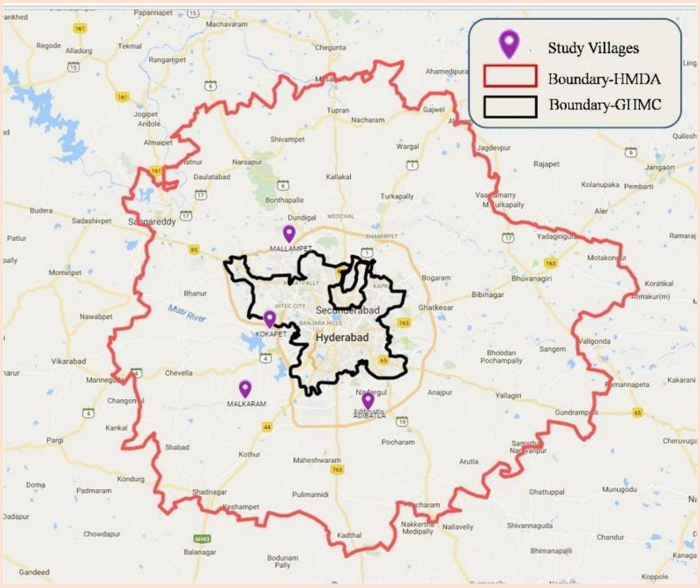
II. Study Area and Nature of Data Used

For this study, the peri urban area of Hyderabad has been identified and demarcated as the zone that lies between the Greater Hyderabad Municipal Corporation (GHMC) and the Hyderabad Metropolitan Development Authority (HMDA). The criteria for the selection of the study sites included its peri-urban characteristics, high incidence of groundwater extraction and presence of an informal water market. After several rounds shortlisting, Mallampet, Kokapet, Adibatla and Malkaram were selected as study villages (Figure 1).

Mallampet, Kokapet and Adibatla lie very close to the Outer Ring Road (ORR), which is an eight-lane expressway that encircles the city of Hyderabad. The construction of this expressway brought about a massive shifts in land use pattern in these three villages, with agricultural land being acquired not just for the road, but for the wave of industrialization and commercialization that followed around the villages. Bolarum Industrial area near Mallampet and Hitech City near Kokapet are prime examples of this. Mallampet and Kokapet have seen a large number of private ventures come up even within the village, which led to a huge increase in the value of land here, and brought in a lot of money into the villages. Adibatla, although comparatively less developed, hosts two SEZs of Tata Consultancy Services and Tata Advanced Systems Limited. These villages have been provided sources of drinking and domestic water by their *panchayats* (village councils). The informal water market that operates in these villages, serves the peri-urban residents, but is primarily thriving on its sales to the urban pockets in and around the villages.

Malkaram (part of Jawaharnagar) stands as the only village with no informal market operating in the village, and yet has a high dependence on informal water sources from around the village. Lying rather further from the ORR, it preserves its rural characteristics as it is the least developed of the study villages, and also the economically weakest village. The village lies very close GHMC’s largest dump yard, which receives 3500 metric tonnes of garbage every day, and has severely polluted the groundwater around the region. Further aggravating the situation is the fact that the ratio of formal to informal sources of water is the lowest in this region, with not even a single *panchayat* owned drinking water source.

Figure 1: Map showing the study villages



Both qualitative and quantitative tools have been used to extract information used for this paper. While the institutional analysis has depended on key informants’ and in-depth interviews with general residents, the section on drinking water use primarily draws from quantitative tools. A household census was done to understand the drinking water sources they use in the normal and the lean season. 3436 households have been covered in the survey, which is above 97% of the total households in the village.

Table 1: Number of Households covered in the Survey

Village	*Numbers*
Malkaram	372
Adibatla	526
Kokapet	1149
Mallampet	1389
Total	3436

Other than the data mentioned above, spatial segmentation of water use has been analysed through household maps of villages, digitized based on both the field work and satellite imageries. The groundwater level data from year 1997 to 2015 was obtained from India- Water Resources Information System. Other than the above, a content analysis of policy documents was also done to understand the change in the water policies in India.

III. The Transitions in Water Policies in India: From a 'Resource' to an 'Economic Good'

Understanding of water as an anthropocentric resource need not be conflated with viewing it as an economic good, though the former may represent a departure from treating it as a community resource. In other words, the concept of water as a resource does not preclude the possibility of delivering it free of cost. However, in the recent years, the way water has been interpreted has clearly, and arguably rapidly transformed it from being a resource to an economic good, particularly by the nation state. The shift is visible between the 1987, 2002 and 2012 national water policies, though there has been a toning down in the degree to which implicit privatization of water is deemed suitable between 2002 and 2012, in letter, if not in spirit (Table 2). In fact, it would be fair to interpret that the 2012 water policy excludes drinking water from the purview of an economic good (to be bought and sold), though the mode of governance that it specifies does not exclude private provisioning, and is thus ambivalent in its intent. The matter is further conflated in the latest Draft National Water Framework Bill, 2016, that avers 'The state's responsibility for ensuring every person's right to safe water for life shall remain *even when water service provision is delegated to a private agency* (emphasis added) and in case of such delegation, the right of citizens to safe water for life and the duty of the state to provide the same shall remain in force' (p 7). The paper explores whether there is a fundamental contradiction between 'delegating' water service provision to a private agency and fulfilling state's duty towards maintaining 'the right of the citizens to safe drinking water for life'

Table 2: Change in Conceptualization of Water and Role of the State in Water Provisioning in National Policy Documents

	1987	2002	2012
Conceptualization of Water	Water is a precious natural resource hence it needs to be managed and utilized well	Water needs to be treated as an economic good	After meeting the needs of humans for basic purpose, water needs to be treated as an economic good
Role of the state in water governance	Role of the state getting diminished with the involvement of community for water management	Service provider, encouragement for private sector participation	Regulator and facilitator- PPP and private models (subsidized)

Source: National Water Policy

It is notable though that in spite of increasing gaps between demand and supply of drinking water provisions, and reports of widespread agrarian distress, the budgetary allocation of water, both for drinking water and irrigation has fallen. Over the past two and a half decades, water sector allocations have fallen as a percentage of total outlay both for the heads of irrigation, and water supply and sanitation (Sen and Chakraborty 2017). The erstwhile Andhra Pradesh, before the formation of Telangana, allocated only about 0.7% of its outlay on water supply and sanitation, significantly lower than even the corresponding share of 1.8% for all states in the same year in 2014-15. This average is much below that of the developing countries as a whole (Annamraju *et al* 2001). Thus the situation prevailing currently in the study area has to be understood against the backdrop of a lack of intent of the government to engage in public provisioning of water. The Government of Telangana, in deviance to most states in India, has opted for an ambitious public sector endeavour through the ongoing Mission Bhagiratha that promises safe drinking water to every household which is in the process of being implemented.

IV. Manifestations of Government Policies in Peri-urban Hyderabad: Institutions and Complexities of Water Governance

The peri-urban sites play a primary role in feeding into the urbanization process that unfolds near them. There is a large spatial outflow of water from these areas into the urban centres to serve their daily needs; also, the outflows from the villages serve the rapidly expanding industrial and services enterprises within the peri-urban spaces. The primary instrument through which the spatial outflows occur is an informal economy using tankers.

Tankers are mainly owned and operated by private individuals in peri-urban villages, who extract groundwater from bore wells and sell water to the urban population. Often the owner of these operations are former agriculturalists, who find it more profitable to carry out a water business with the urban actors, rather than use it or even sell it for the purposes of irrigation within the village. The rapidly changing land-use leading to land acquisition make the proposition of the using water for irrigation even less attractive.

We have noted in our field that the bore well owner and tanker owner may or may not be the same person. The arrangements made between those who own bore wells and those who own tankers vary a great deal. There are often middle men in the business, whose presence increases the price at which the water is sold.

In cases where agricultural bore wells are used, the electricity is completely subsidized, completely erasing the cost of operation. In case of other bore wells, the permission is given to extract water only for domestic use, since the selling of groundwater, even if the bore well is located on own land, is deemed illegal, though with a caveat. The Andhra Pradesh WALTA Act 2002[ii], states that 'extraction of water for sale from an over exploited (emphasis added) water source or aquifer or residential areas or in the recharge zones of residential areas depleting the public or private water sources and affecting the supply of water for domestic usage' (p 6). This implies that for sources that are not overexploited, sale of water is permitted. However, a second provision in the same act that may have curtailed the tanker operations that allows the state Government to prevent the sale of water if it is seen to impact public drinking water sources[iii]. Though this provision makes an allowance for curbing unbridled exploitation of ground water, has an underlying problem that may prevent its effective implementation. The provision comes to force only when a *public* drinking water source is impacted. Given the fact that the presence of public sources in the drinking water sector in the peri-urban spaces is insignificant as of now, the potential application of this provision is limited. At any rate, commercial licenses are needed for sale of water, which is not followed by any of the tanker operators in the study areas. The entire informal tanker economy thus operating in the peri-urban areas is dependent on illegal usage of water.

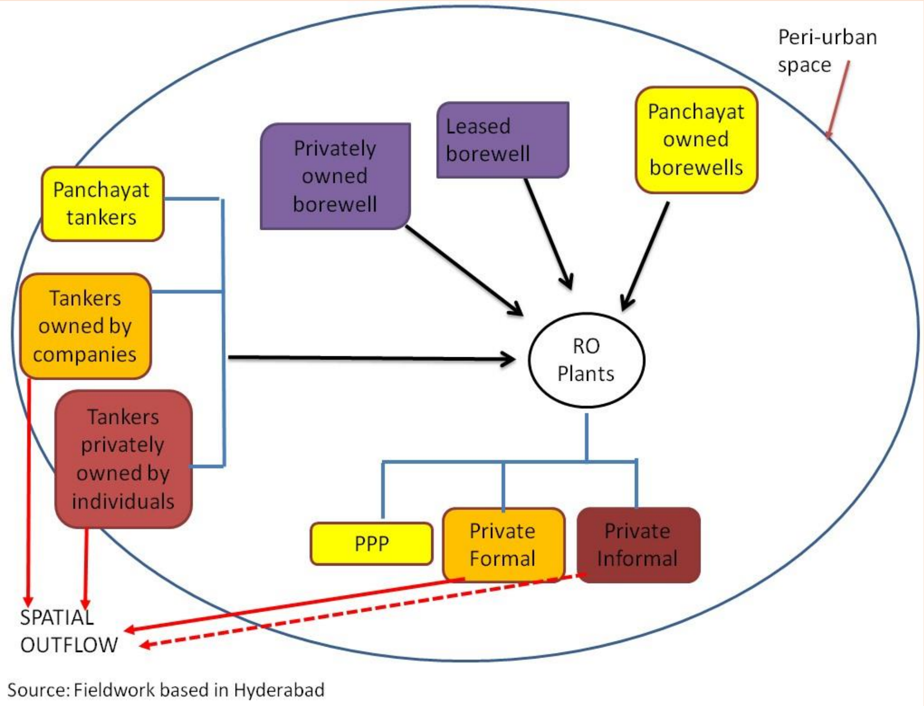
Tanker owners are often seen selling water to the *panchayats* and to households within their village. There is a significant involvement of *panchayats* in regulating such flows, which either hinder or promote the spatial flow of water. For example, in Kokapet, the *panchayat* is the dominant actor, and does not allow the sale of water outside the village, if the village is facing a water crisis. But in Adibatla, the *panchayat* willingly buys water from the tanker operators and allows free movement of tankers in and out of the village.

However, these tankers primarily thrive on their demand from the urban residents and urban expansions in peri-urban zones. Both Mallampet and Kokapet have up-scale residential colonies that have come up in the peripheries of the village, who form the largest consumers of this tanker water. Apart from that, the tankers are also sell water to industrial and commercial establishments that have come upon the outskirts of the city. For example, there is a massive outflow of water from Adibatla village to Wonderla Amazement Park, for their water rides on a daily basis.

This perpetual and unrestricted flow of water from peri-urban villages to urban spaces have induced an artificial scarcity that is thus separable from the scarcity caused by natural factors like drought. This artificial scarcity in the peri-urban villages has also impacted the availability of drinking water, particularly in the lean season. The emergence of the drinking water market (water treated through Reverse Osmosis) can be seen as a result of poor recharge of lakes, depleted groundwater levels and a fall in the quality of groundwater as a result of industrial pollution.

Figure 2 explains the intertwining of the tanker economy and drinking water availability. Out of the marketized water models (where water is bought and sold), which can be seen in a continuum of public to private modes, the existing options, when we consider all villages are Government Reverse Osmosis (RO) Plants, RO plants in public private partnerships (PPP) and private RO plants. Unlike the treated Krishna water, which is also provided by the Government, the government RO plant water is priced, though the price is lowest among all other plants with similar technology. Also, notably, the price for the government RO plant is fixed, irrespective of the season. Between the PPP and the private RO plants, the price difference is more than double in the latter case, in both the lean and abundant season. The difference in the lean season (summer pre-monsoon months), in proportionate terms is higher compared to that in the normal seasons. The PPP models as per out field survey function at variance with each other, and depend mostly on the informal arrangements with the *panchayat* or the village council. In all cases, the land and the bore wells are owned by the *panchayat* is handed over to the private firm to operate, and the latter ranges from an unknown informal sector to multinational corporations. The RO plants (both public private partnerships and private ones) in the study villages procure raw water from multiple sources like bore wells that they own or lease, those owned by the *panchayats*, or water tankers, that transfer water from bore wells in other places, or even a combination of these. The raw water source, thus, as well as the plants themselves represent an example of not only various types of institutions, but an intermixing of public and private institutions on the one hand, and formal and informal, on the other. Our case studies of RO plants in and around the study villages revealed that the PPP model, for example, leased out the land and often tube wells to the private partner.

Figure 2: Institutional structure of Reverse Osmosis plants in a peri-urban space



The PPP plants are mostly operated under an agreement between the *panchayat* of the respective village and a private water treating company. Our study villages have PPP plants where the partnerships with multinational companies like Dr. Water and SMAAT. The agreement is such that the bore wells for raw water and the space for operating the plant are provided by the *panchayat*. The maintenance and the operation is handled by the private company who also gets 100% of the revenue. The plant has to be handed over to the *panchayat* after 10 years of operation by the private company. Until then, the company is obligated to sell water at an 'affordable' rate, which at times is fixed for the year. This price ranges between Rs.4-Rs.8 for 20 liters of water. Almost all of this water is unsealed, thus there is no legal commitment from the part of the seller of the water, though arguably, sealing and labelling would increase the cost.

One may assume that a private registered RO can be classified as a formal entity, but formality gets diluted since the raw water purchased very often from an informal entity. Although the RO plant may itself be registered and formal, the source of the water or the bore well may not have been installed with prior legal permission. It is this connect through which the drinking and domestic water, the formal and the informal as well as the public and the private get connected.

From our field interviews it becomes clear that at times the multinational corporations participating in the PPP model sell water to outside the village at far higher prices, though in some cases, the agreement with the *panchayat* appear to have prevented this. It is not clear if this is permitted by the *panchayat*, whether there is a minimum volume that has to be mandatorily sold to the residents of the village. In any case, the agreements often appear to be informal and no penalties for deviating from the norms have been mentioned by the members of the *panchayats* that were interviewed.

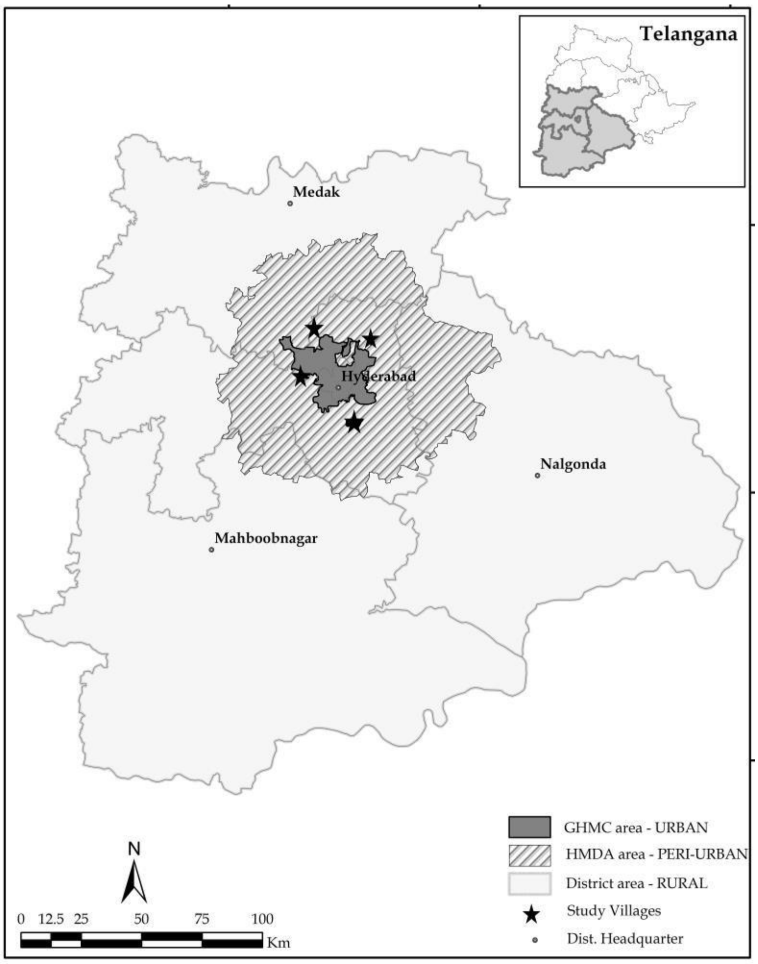
V. Ground Water Status in Peri-Urban Areas vis-à-vis Hyderabad and Rural Peripheries

The changes in drinking water institutions notwithstanding, droughts could cause significant scarcity in the availability of water. Telangana is a drought prone state; 43% of the area of state is drought prone and the probability of occurrence of drought in Telangana is once in 2.5 years, on an average.

This section analyses the ground water status of peri-urban areas and compares it with Hyderabad city on the one hand and rural peripheries outside Hyderabad Metropolitan Development Area (HMDA) on the other, but restricts it to the districts falling in the HMDA area. The purpose of this section is to get a sense of the degree to which the rainfall patterns explain ground water levels.

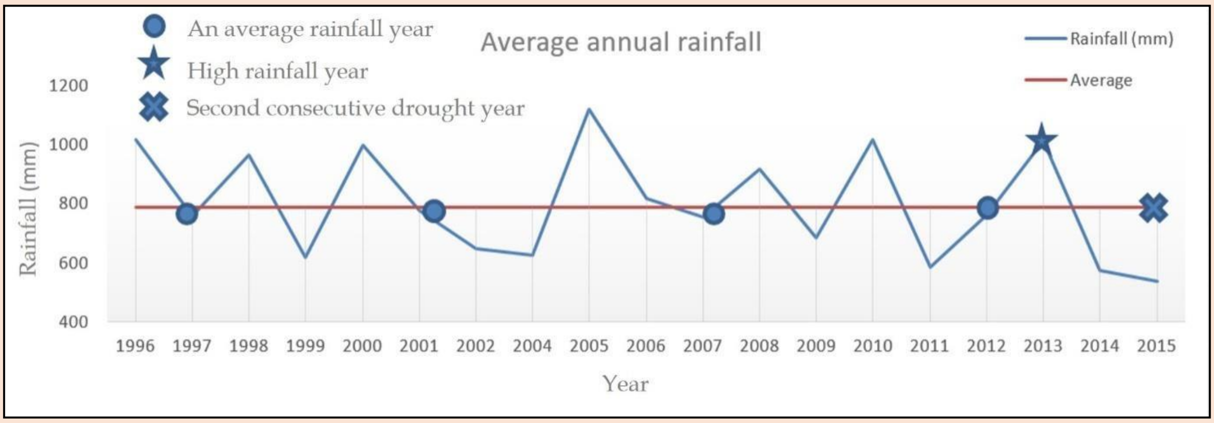
Ground water level fluctuation is a combined consequence of precipitation and its use and extraction. Climatic variability resulting in the increased occurrence of droughts or floods with decreasing number of rainy days poses a challenge to ground water recharge. Even with heavy rains with low number of rainy days, the infiltration feeding the stock of ground water can reduce significantly. A second factor that prevents infiltration is an increase of the built-up area, which are typical of urban areas, particularly large cities. The nature of ground-water extraction, that impacts the water table, depends on its uses, their intensities and trends. It is not necessary, for example, that the largest user of groundwater, i.e. agriculture, would necessarily be the primary cause of ground water decline. Thus the status of ground water decline is explained by a complex set of factors.The changes in ground water level have been analyzed using geo-spatial techniques for three different zones around Hyderabad (Figure 3).

Figure 3: The map showing GHMC, HMDA and District area as Urban, Peri-urban and Rural



1. **The urban core** - around 626 square kilometers area which comes under Greater Hyderabad Municipal Corporation (GHMC),
2. **The peri-urban area** - the periphery of GHMC area which spreads over an area of 7,257 square kilometers (2,802 square miles) falls under Hyderabad Metropolitan Development Authority (HMDA). The HMDA area partially covers, Mahboobnagar, Medak, Nalgonda and Rangareddy districts.
3. **The rural area**- the remaining district area of Rangareddy, Mahboobnagar, Nalgonda and Medak beyond the HMDA limit.

Figure 4: Average annual rainfall from 1996- 2015



The groundwater level data from year 1997 to 2015 has been obtained from India- Water Resources Information System[iv]. The water level maps were generated for certain years selected on the basis of rainfall criteria (Figure 4).

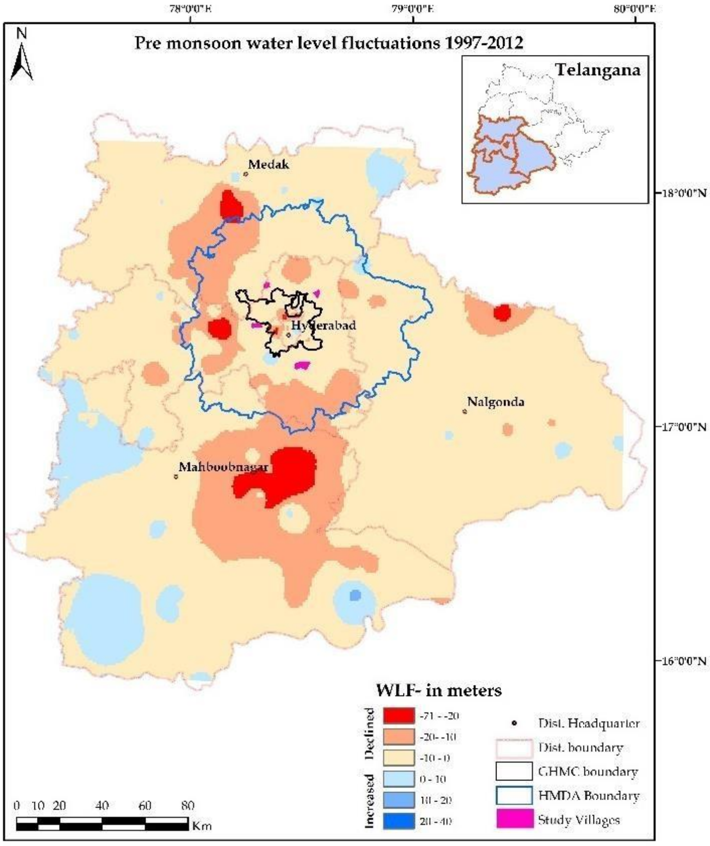
The long term average annual rainfall for five districts viz, Hyderabad, Mahboobnagar, Medak, Nalgonda and Rangareddy has been calculated to be 785 millimeters. To observe the long term water level decline, the years 1997 and 2012 have been selected as average rainfall years; 2013 and 2015 were selected to understand the impact of climate variability, while the years as they represent high and low rainfall years respectively.

The ground water table in the study area has depleted visibly. In the pre-monsoon season of 1997, water level for most of area was between 5 - 10 meters below ground level (mbgl) and expectedly increased in post-monsoon season of the same year. In 15 years period between 1997 and 2012 there has been a notable depletion in water level particularly in the pre-monsoon seasons. The changes observed in the post-monsoon seasons are less, but still evidences of depletion are clear. The latter show high correspondence with rainfall patterns (Figures 5, 6 and 7). Isolated though not extensive areas dropped to below 40 mbgl in 2012, which were absent in 1997. From the depletion between the two selected years, it would be fair to conclude that it is connected more with extraction patterns and less with the rainfall characteristics.

The two other selected years for this analysis were 2013 (Figure 6) and 2015 (Figure 7), which experienced 30% excess and deficit rainfall respectively. With 30 % excessive rainfall in 2013, the water level came up after post monsoon season, though the trend of depletion continued in the pre-monsoon season in spite of normal rainfall in the year before. The drought year of 2015 expectedly demonstrates widespread depletion in both the pre and the post monsoon periods in comparison with all preceding years.

A comparative picture of the three zones can be understood from Table 3 and Figures 8 and 9. For the period under study, the two of three zones *viz.* urban and rural shows roughly similar decline in average ground water level for both pre and post monsoon season. In both zones, the level has gone down by approximately 5 meters and 1 meter in the pre and post-monsoon season respectively. In comparison, the depletion was far steeper in the peri-urban zone with a water level of 8 meters and 3.5 meters for the pre and post monsoon seasons respectively. Two observations are clear from this analysis: firstly, the depth at all periods of time, starting 1997, have been the highest in the peri-urban areas. Secondly the decline, for the most part of the period under study was the sharpest in the peri-urban areas for both seasons. The above mentioned differences cannot be accounted for by rainfall; the spatial outflow and extraction of water supporting the tanker economy elaborated on in the last section probably holds an answer to this.

Figure 5: The pre to pre and post to post monsoon water level change map from 1997-2012



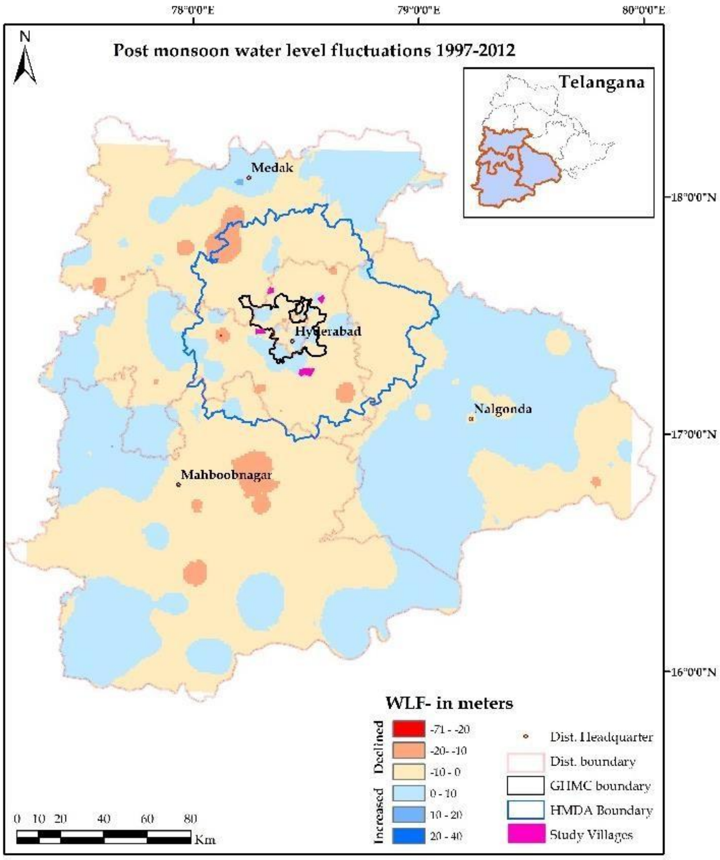


Figure 6: The pre and post monsoon water level map for the year 2013

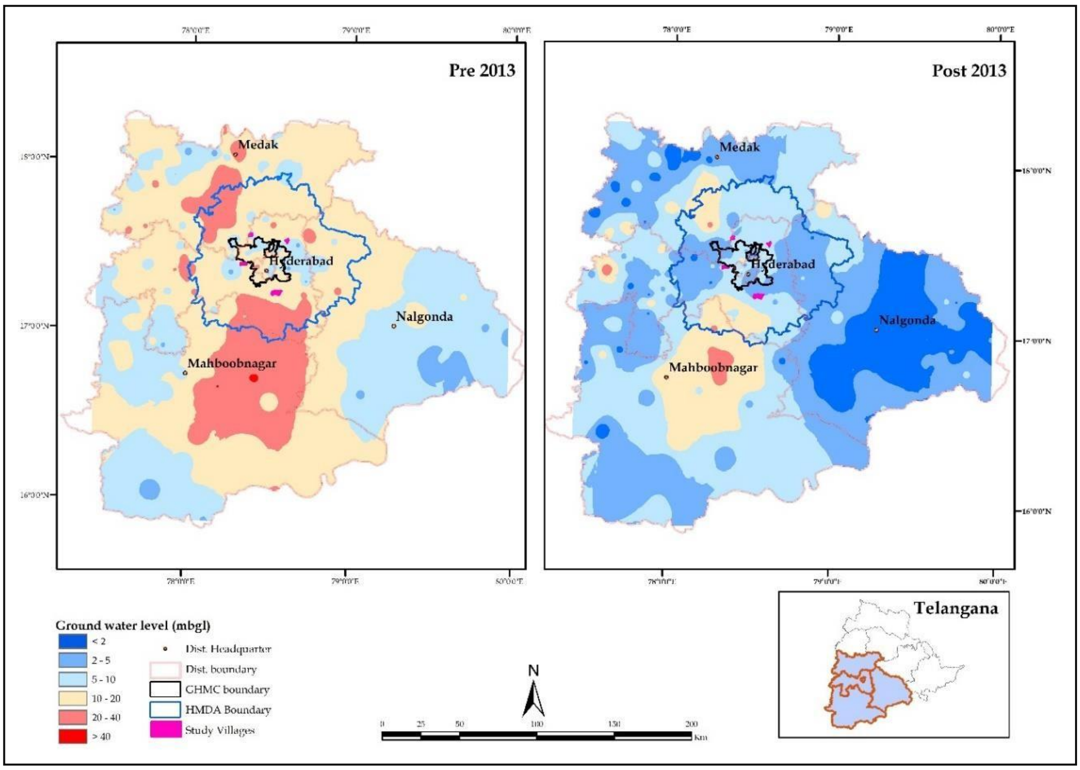


Figure 7: The pre and post monsoon water level map for the year 2015

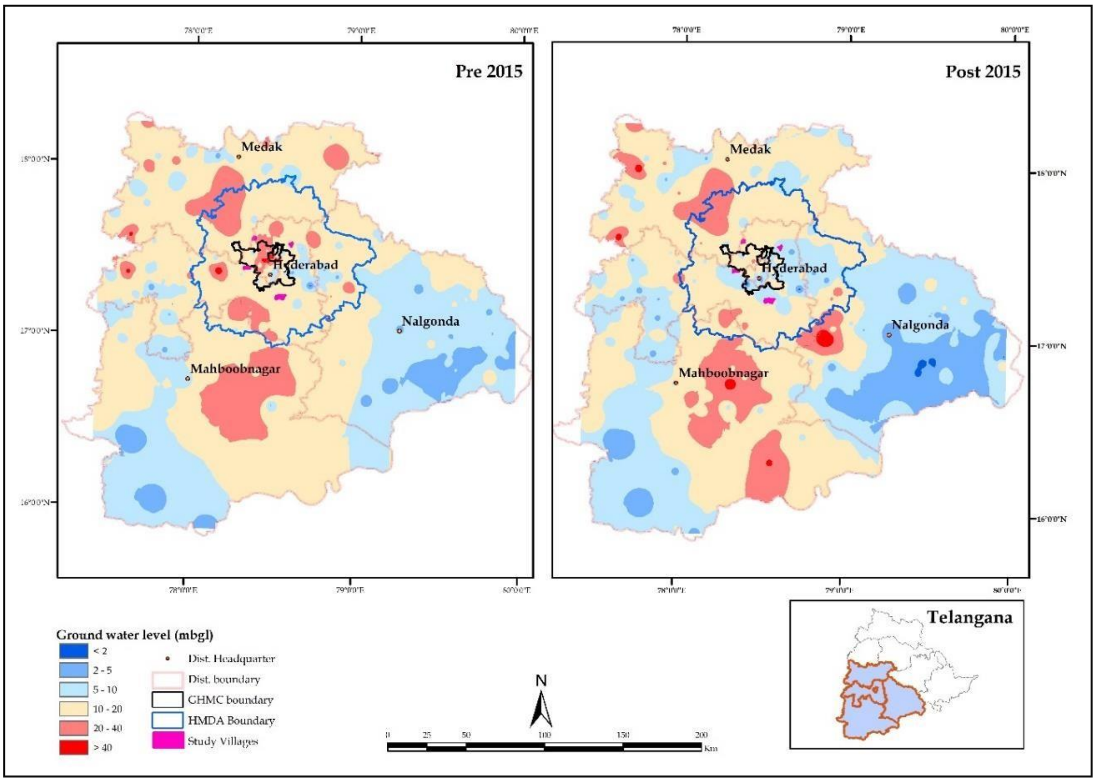


Table 3: Temporal and seasonal water level fluctuations within the Rural, Peri-Urban and Urban Area

Year	Rainfall	Rainfall (previous year)	**Rural (Districts excluding HMDA)** AWL Pre	AWL Post	WLF	AF	**Peri-urban (HMDA excluding GHMC)** AWL Pre	AWL Post	WLF	AF	**Urban (GHMC)** AWL Pre	AWL Post	WLF	AF
1997	757	1016	8.64	7.19	1.45	0.18	9.31	7.7	1.61	0.19	7.21	6.43	0.78	0.11
2001	775	997	10.92	6.98	3.94	0.44	11.82	8.76	3.06	0.30	7.56	5.81	1.75	0.26
2013	1010	761	12.92	5.6	7.32	0.79	15.85	6.68	9.17	0.81	11.75	5.8	5.95	0.68
2015	537	573	12.1	11.95	0.15	0.01	15.92	13.57	2.35	0.16	16.7	10.95	5.75	0.42

AWL - Average water level
WLF - Water level fluctuation
AF - Average fluctuation (the ratio of fluctuation versus average of pre and post monsoon water level)

Figure 8: Temporal Average Water Level - Pre monsoon

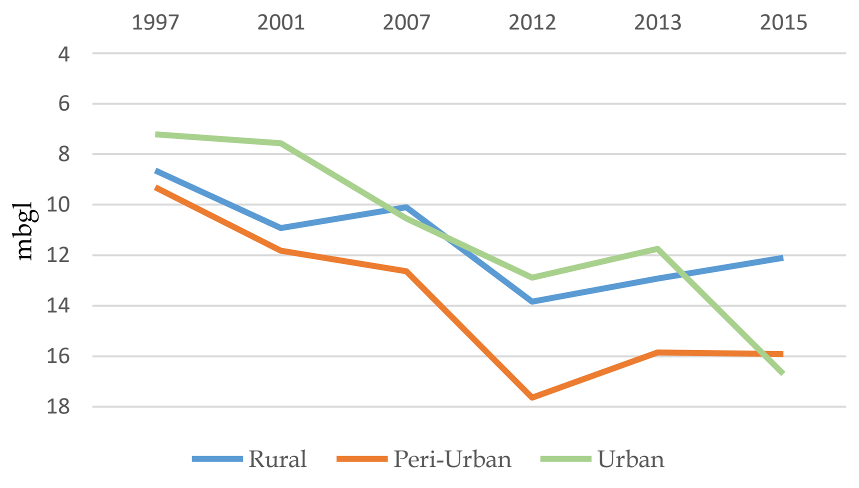
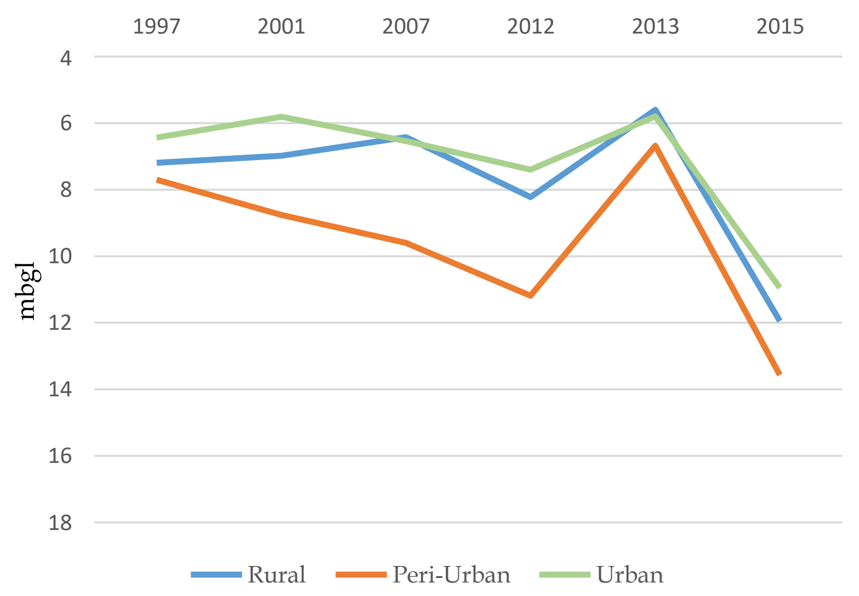


Figure 9: Temporal Average Water Level -Post monsoon



The depletion pattern, however, makes it clear that the peri-urban areas are at a particular disadvantage in the pre-monsoon or the lean seasons. The pre-monsoon seasons are also periods where there is an increase in water demand due to the increasing temperature. The implications of the increasingly scarce ground water is examined in the next section.

VI. Existing Sources of Drinking Water in Peri-Urban Hyderabad

The availability of the options for both drinking and domestic water shapes the choices available to the households. The difference in these two categories is important, since the quality of water used differs, and hence the available choices are different. From our field-work, it is evident that the sources of water used for drinking and cooking are the same and these sources, to a very large extent, are mostly what is perceived to be 'safe'. In contrast, water used for washing, bathing, and cleaning is primarily from untreated sources, though in an extremely polluted environment, washing vessels with untreated water, for example, may hold some degree of health related threat, which is commonly discounted in the study villages.

Table 4 and 5 provide village wise distribution of primary sources of treated and untreated water. Table 4 throws up some significant evidences. Firstly, treated Krishna water, which is the only government and surface unpriced water source, presumably free of industrial pollution, is *not supplied to any of the peri-urban villages that have been selected by the government.* The two villages that make use of it informally from Gandipet and BITS Hyderabad connections are Kokapet and Malkaram respectively; in other words, informal connections have been extended to the two villages, in a socially agreed upon norm with the institutions for whom the water connection was sanctioned.

The distribution of the RO plants across different villages reveals unequal conditions. The cheapest variant, i.e. the government model with a fixed price is available in only one of the four villages, i.e. Mallampet. For the other villages, this does not represent a choice. The PPP model is also not available in this village, though one plant each of this variety is available in the other villages. Private ROs are not located either in Malkaram and the village that is farthest from the city core, i.e. Adibatla[v], though water from private firms get delivered to these villages from nearby areas. Malkaram, a small part of an urban outgrowth called Jawaharnagar that houses the biggest dump-yard of the city leading to water pollution in the former, thus has no 'formal' option of treated drinking water source. The poorest section of the village, Farah Nagar is the most disadvantaged as the only source of treated and unpriced water, i.e. the Krishna water is not available in this cluster; the only 'safe' option is water from private RO plants located outside the village which is the most expensive source of water. For the most part, this settlement, which experiences urban growth processes very acutely, actually lies in a 'shadow zone' with negligible basic facilities.

Table 4: Sources of treated water in the study villages

Sources of water	Descriptions	Cost	Mallampet	Kokapet	Adibatla	Malkaram
Krishna Water supply	Treated surface (river water) provided for the city by the HMWSSB, sometimes to villages that lie en route the path of the pipeline. Free of cost and a shared source.	Free	No	Yes-Informally tapped	No	Yes-Informally tapped
Public RO	Treated groundwater plants owned by *panchayat*s.	Rs.5 per 20 litres	1	0	0	0
PPP RO	Treated groundwater plants run using a public private partnership model. Co-owned by *panchayat* and private entity.	Rs.4-Rs.10* per 20 litres	1	1	1	0
Private ROs	Treated groundwater plants owned by private individuals.	Rs.10-Rs.25* per 20 litres	12-15	3	0	0 (5 plants outside the village)
Water from industry through tanker	Treated surface water from HMWSSB pipeline in Tarnaka.	Rs. 30-50 per month	No	No	No	Yes (Church Malkaram) **

* The higher prices are charged during the scarce period, i.e. summer.

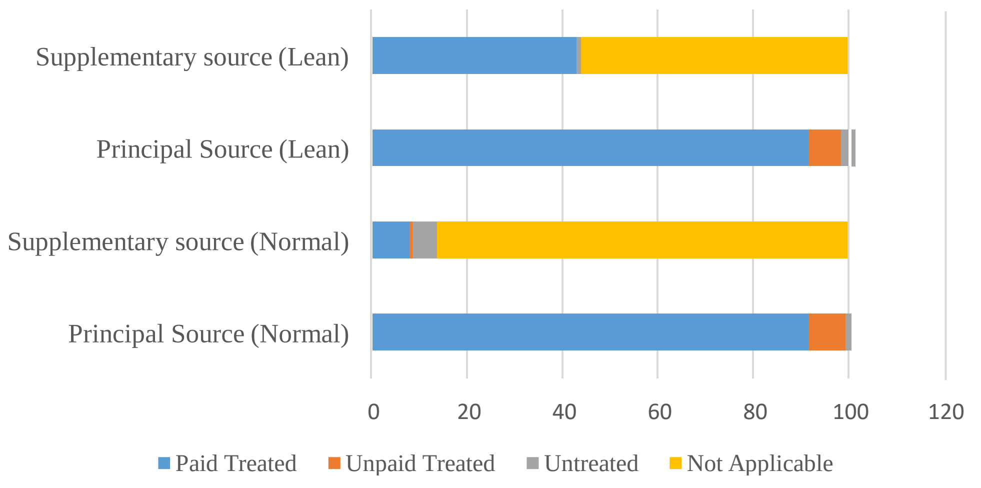
** This colony is provided drinking water from Ramky industries, as it lies on the downstream from the industry and their water was most polluted. The residents protested violently on the roads or more than a week, after which this negotiation was made.

VII. Choice or Compulsion?: Sources of Drinking Water in the Study Villages in Seasons of Relative Abundance and Scarcity

The choices of drinking water available to the peri-urban villages are intrinsically linked with the complex institutional governance that has panned out in this area. While the commonalities across villages in terms of available drinking water options is primarily driven by the state's changing conceptualization of water and an understanding of their responsibility with respect to this sector, the differences are drawn from the characters of the villages, nature of the respective *panchayat*s and their commitment to their constituencies, as well as the existing water related infrastructure in the village.

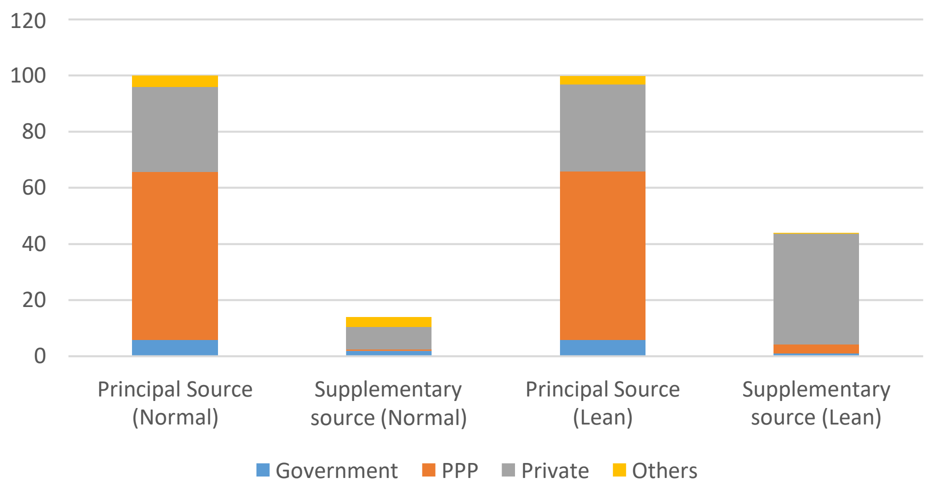
Figure 10 shows the use of sources of drinking water by payment and treatment across village[vi]. Over 90% of the households pay for the principal source of water they drink, both in the lean (summer months, pre monsoon) or normal season. It is relevant to note that our reference year for the lean season included a drought year, which was a second consecutive year of low rainfall. It would be fair to conclude from this observation, that scarcity of water does not have much to do with whether households pay or not[vii].

Figure 10: Drinking Water Sources by Treatment and Payment



There are, however, some notable differences across seasons which is shaped by scarcity of water. Firstly, the share of people who depend on only one source of water reduce drastically from normal to lean season, from around 86% to 56%. Secondly, though a small share of households depend on untreated water for drinking as a principal water source, this share doubles in the lean season from 1.3% to 2.7%. Most of these households belong to Malkaram village, where households have very few options and limited capacity to pay, and the groundwater aquifer is noticeably contaminated.

Figure 11: Drinking Water Sources by Ownership



The dependence on drinking water sources by ownership indicates a strong presence of public-private partnerships, a form of which is present in all the villages other than one (Figure 11). The private ownership is the second important source. The dominance of the private sector significantly goes up in the lean season, as the main source of water has to be supplemented by many households in this season. The category of 'others' are multiple sources like own source, community sources, water shared among neighbours. The extent to which households depend on this can be collectively understood as coping strategies to deal with limited options, which is further restricted in the lean season.

Table 5: Village wise distribution of households by primary and supplementary sources of drinking water in abundant and lean season, 2017

Source	**Primary source in abundant season**				**Primary source in lean season**			
	Malkaram	Adibatla	Kokapet	Mallampet	Malkaram	Adibatla	Kokapet	Mallampet
Public stand post (treated water)	39.5	0	0	0	42.5	0	0	0
Industry tanker (treated water)	21.2	0	0	0	0.3	0	0	0
Private RO	29.6	1.7	0	66.6	32.5	1.7	0	66.6
PPP RO	0	97.5	100	28.7	0	97.5	100	28.7
Govt. RO	0	0	0	3	0	0	0	2.8
Direct piped water (temporary) managed by the community	3.2	0	0	0	7.5	0	0	0
Common taps/ stand-posts managed by the community	1.1	0	0	0	7.5	0	0	0
Others	5.4	0.8	0	1.8	9.7	0.8	0	2
	Supplementary source in abundant season				Supplementary source in lean season			
Public stand post (treated water)	2.4	0	0	0	NA	0	0	0
Industry tanker (treated water)	0	0	0	0	NA	0	0	0
Private RO	40.9	0.2	1.6	6	NA	1.4	87.4	14.2
PPP RO	0	0.2	0	1.4	NA	1.1	0	6.6
Govt RO	0	0	0	0.4	NA	0	0	0.8
Direct piped water (temporary) managed by the community	11.8	0	0	0	NA	0	0	0
Common taps/ stand-posts managed by the community	5.9	0	0	0	NA	0	0	0
Others	29.7	0.2	0	0		0.2	2.3	0
None	7	99.4	98.4	92.2		97.3	10.3	78.4
Total Observation (N)	372	526	1149	1389	372	526	1149	1389

Table 5 provides us the village level details of use of drinking water sources and the following points emerge from it:

- The pattern of Malkaram is very different from the others, and expectedly so. The provisions of cheaper options like the Government or PPP models are not available in the village as in case of the three other villages. While in the normal season, more than 90% of the households do not have to depend on a second source in the three other villages, 93% of the Malkaram households use a supplementary source. In this village, 21.2 % and 39.5% of the households primarily depend on treated water sources from the industry and treated Krishna water respectively in the normal season, both of which are a successful demonstration of collective action. The former source reduce in importance drastically in the lean season, and 9.7% of the households have to fall back on untreated options as a primary water source[viii]. A staggering 25% of the households depend on untreated water as supplementary sources in the village even in the normal season. It needs to be mentioned here that the health risks would be similar irrespective of the quantum of polluted water consumed by individuals.
- The dependence on private RO, which is the most expensive source, increases in the lean season both as a supplementary source and primary source. 41 % of the households in Malkaram depend on private options as a supplementary source even in the normal season, and this is a significantly high share given the villagers' are economic status.
- The analysis for the other villages point towards the importance of the *panchayat*'s bargaining power with the private sector on the nature of water used by the residents. For example, two of the villages, i.e. Mallampet and Kokapet have entered into contracts with multinational corporations named Dr. Water and SMAAT respectively. While the *panchayat* in Kokapet has not allowed the SMAAT to increase the price of the water in the lean seasons, that in Mallampet has been more flexible with Dr. Water. The consequence of this has been that in case of the former village around 90% of the households have to depend on supplementary sources (87% on private ROs). As per our qualitative field insights, it was reported that on a number of days in the summer months, SMAAT was non-functional, forcing the residents to depend on private firms. In case of Mallampet, Dr. Water supplements the bore well water as a raw material with private tankers and manages to provide water in its entirety to around 78% of the residents, albeit at an increased price. Significantly, Dr. Water charges the highest price among three of the PPP models that we have empirical evidence of. In Adibatla, which is the village located in the farther periphery of HMDA with respect to the core city, the shift to supplementary source in the lean season is negligible. Notably the private

partner in the village is an informal one and the water table decline has been relatively small. In Adibatla too, the prices were not increased in the lean season, though this did not impact the supply.

- The government owned RO, though selling water at the lowest price among ROs, is completely ineffective in the only village it has an existence, i.e. Mallampet. It serves only 3 and 2.8% of the residents in the normal and lean seasons respectively as a primary source of water, and less than 1% of the households as a supplementary source.

VIII. Spatial Segmentation in Villages and Inequalities in Water Availability and Access

In the preceding section, unequal conditions across villages have been discussed. The inequality of water related infrastructure was seen to be clearly lacking in the most deprived village, and this reveals that the lack of public coverage is not covered by the private operators in the drinking water sector. This kind of inequality in literature has been called a potentially negative and fragmenting socio-spatial effect that exacerbates inequalities primarily shaped by economic reforms (Zérah 2008). There are a number of studies that elaborate on complex relationships in the society that manifests spatially, and it has been argued that the new forms of spatial inequalities imposes itself on the older ones to deepen the existing cleavages(Pflieger & Matthieussent 2008, Daniels, & Friedman 1999).

In this section, we take the case of one village, Malkaram, which has been discussed in details, because of high incidence of poverty and lack of infrastructure. At a broad level, this is a manifestation of a spatio-social inequality. However, it can be argued that this runs within the village and are also expressed in intra-village differences; this case study reveals new forms of inequalities that were not clear from village-level comparisons.

Figure 12: Caste Group Distribution in Village Malkaram

There is a mix of caste groups in the three clusters of the village, though there is a religious segregation (Figure 12). Farah Nagar is dominated by Muslim households, Bada Malkaram, which is the central part of the village is inhabited largely by Hindus, while a fair share of the households in Church Malkaram are Christians. In this cluster, there is a concentration of SC households in the North West portion of the cluster. Thus, for the most part, other than that of Church Malkaram, the caste groups are intermixed, and thus any spatial differences that may be observed is not likely to be driven by caste identities in this village. Farah Nagar is the most deprived cluster, economically, socially and in terms of basic facilities. Church Malkaram is as well as Bada Malkaram are better off in the generally neglected village, and a large share of the households in the former cluster are in regular salaried jobs.

Figure 13: Primary Source of Drinking Water during Normal Season in Village Malkaram

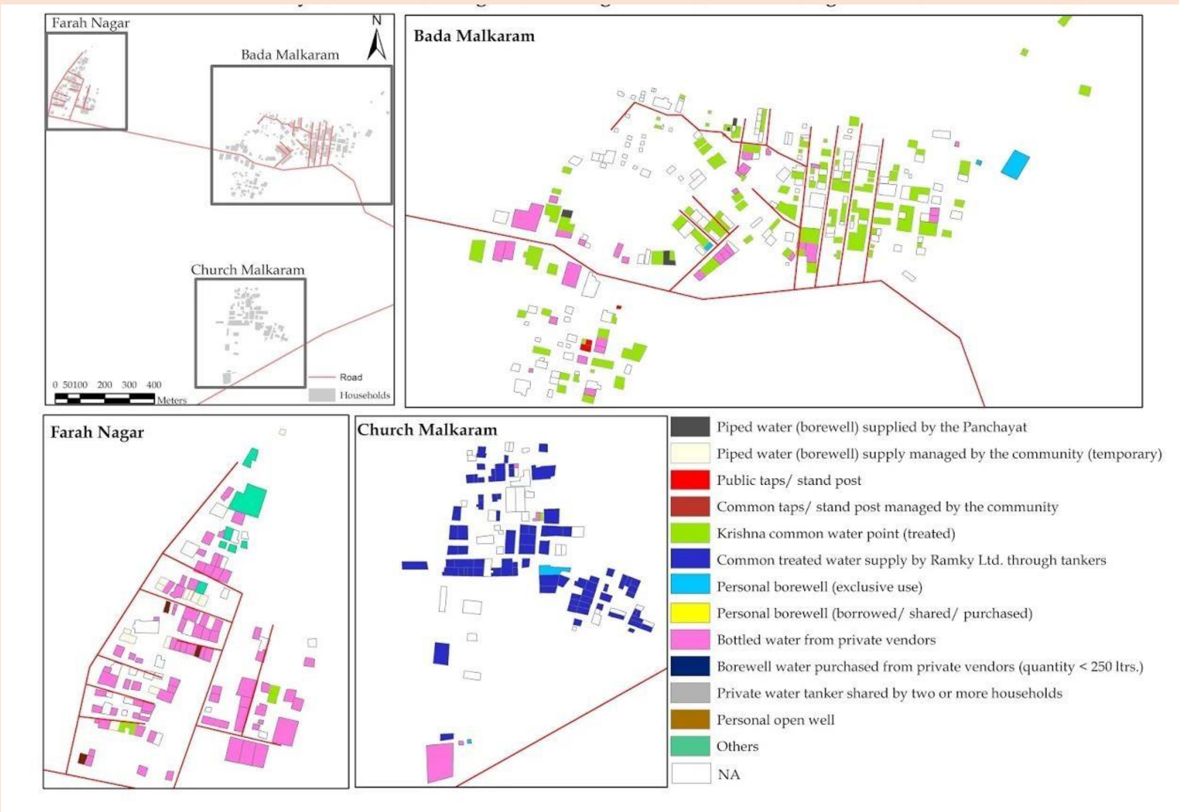
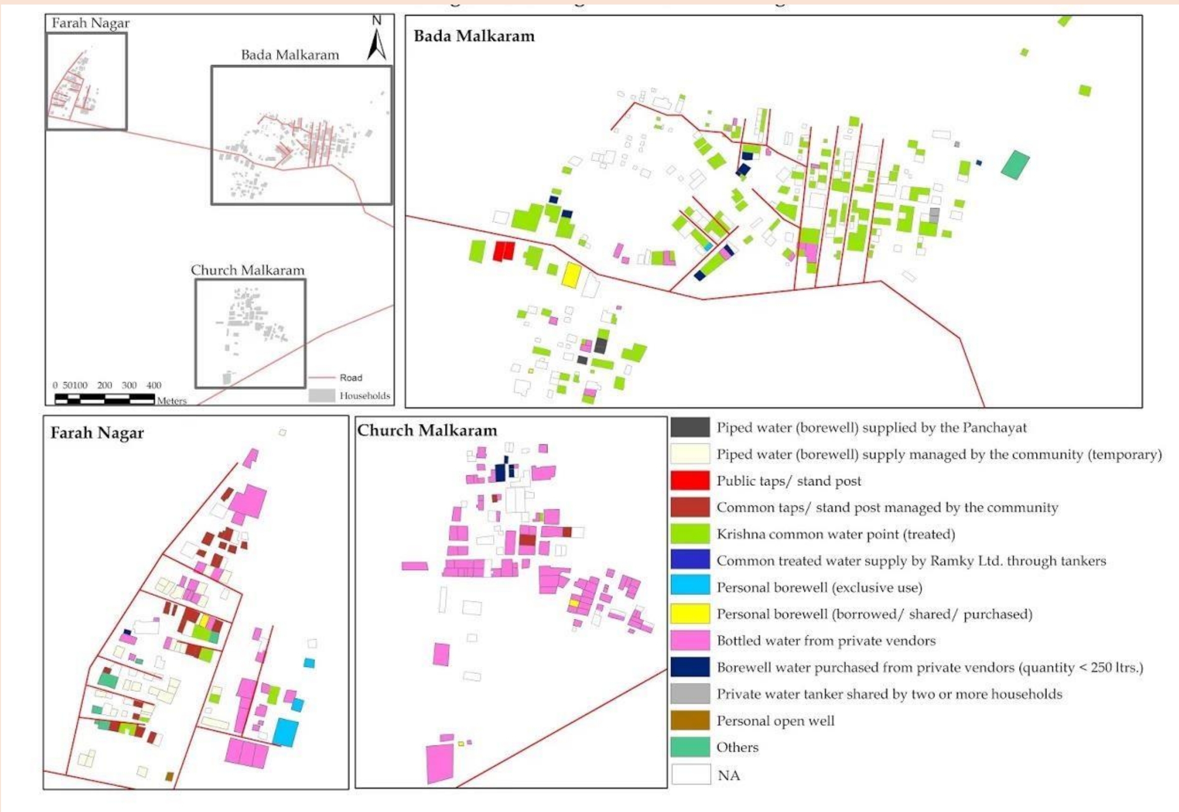


Figure 13 shows a complete spatial segmentation in terms of drinking water sources in the three clusters of the village in the normal season, and the pattern is in some sense counter-intuitive. While Bada Malkaram and Church Malkaram benefited from collective community actions which were restricted to these clusters, Farah Nagar, the poorest section of the village is almost completely dependent on private RO plants. This can be explained through two interrelated facts; the Jawaharnagar Dump Yard pollutes most of the surface and ground water around the cluster and due to this no other option other than treated private and priced sources are viewed as safe.

The lean season too reveal an unexpected spatial pattern. While the situation in Bada Malkaram remain unchanged in terms of the sources of water, Church Malkaram shifts primarily to private RO plants due to near withdrawal of supply by Ramky industry. *Farah Nagar actually shifts out of RO water to multiple sources of water that either involve labour for women or/and are unsafe sources.* Women from a few households walk to Bada Malkaram to carry back Krishna water, due to which they have to drop out of work for the season, as reported by residents of the cluster. The shifting out of RO water from normal to lean season is related to the price of this water that doubles in the lean season.

Figure 14: Sources of Drinking Water During Lean Season in Village Malkaram



It can be observed from Figure 13 and 14 that the incidence of households consuming unsafe (untreated) sources of water has increased visibly in the lean season, and this increase is mostly concentrated in Farah Nagar. As mentioned before, in the village, around 27% of the households during water scarcity depend on unsafe water source.

IX. Conclusion

The paper has attempted to examine the pattern of drinking water use among the peri-urban residents and identify the major factor that shape the use. Two major aspects that were considered were climate variability and urbanization related institutional changes in a neo-liberal environment.

We have come to the conclusion that there is a great deal of water-related distress in the selected villages in peri-urban Hyderabad that is evident merely by identifying the main and supplementary sources of water in the normal and lean seasons used by the households; this distress heightens significantly in the lean season, and thus is related to the scarcity of water. However, the degree of distress is unequally distributed across villages and clusters of habitation in the villages. Notably, the village and the clusters that are the most disadvantaged in terms of economic status and availability of infrastructure, are the ones that suffer the most. In other words, *households that are least capable of paying for water are the ones who do it and are only able to avail of the private sources that are the most expensive; in the lean seasons, when the prices of these private sector enterprises are at their peak, many of these households fall back on groundwater related untreated and unsafe sources.* The purely public and free sources of safe water provide very limited support to the peri-urban residents, unless they are informally accessed. The lack of coverage of the public sector sources and the highly polluted ground water aquifer increases demand for the semi-private and private priced sources of water. Interesting cases of adaptation to lack of access to water is visible in the most disadvantaged village, Malkaram, and these are driven by mutually beneficial collective actions. However, some of these strategies do not provide adequate coverage in the lean seasons, for the most part, and is absent among the poorest of the poor, who have very limited bargaining capacities.

The scarcity of water, therefore, is central to defining both the magnitude and nature of distress. While the rainfall conditions explain at a very broad level the ground water status, it is unable to explain the differences observed in urban, peri-urban, and rural contexts. The peri-urban show the maximum depletion that increase at a rate higher than its spatial counterparts, in spite of there being insignificant rainfall variations across these spaces. The scarcity that shape the distress in the peri-urban context is thus not driven by climate variability, which at best, adds to a prevailing problem that is a product of the current political economic context. An examination of the institutional forms emerging in the study areas reveal that the problem is not only to do with a pure effect of privatization, but the ways in which the state aligns itself with the private sector on the one hand and the informality of governance, on the other. The problem appears to partially stem from the way the public interacts with the private, visible in case of the PPP models that are run through decentralized and informal ways. Though we have come across one case of successful bargaining of the *panchayats* with the private sector, with the latter was a small informal player. More often, the formal private sector has not borne any risk of the ‘scarcity’ created by the spatial outflow of water from the peri-urban space and the mechanics of the marketized drinking water system itself; the risk is almost always borne by the residents, more often by those that are already economically disadvantaged.

The formal and informal private sectors are intertwined closely with and superimposed over the public institutional arrangements, and this fuzziness poses a constraint in future management of ground water. By definition, the informal sector cannot be regulated easily, which, as our study reveals, influence the formal sectors, both the public and the private. Additionally, the informal arrangements followed on regular basis within the formal sector make it hard to implement decisions that could protect the residents, even if the political will for it was present. Also, the lack of higher level government involvement and preponderance of decentralized engagements of the state, allows plurality of institutional forms and functions to prevail in a manner that is difficult to comprehend, draw genarizations from and hence, govern. The Mission Bhagiratha that aims for a large scale public sector provisioning of safe drinking water has the potential to provide enormous relief in the prevailing circumstances, its implementation problems notwithstanding.

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Acknowledgement

This work is a partial outcome of the project, "Ensuring Water Security in Metropolitan Hyderabad", undertaken by SaciWATERs funded by Bordeaux Métropole, France and Arghyam, India. Some of our understanding has also been shaped by another closely related project being carried out by SaciWATERs on "Climate Policy, Conflicts and Cooperation in Peri-Urban South Asia: Towards Resilient and Water Secure Communities" funded by the NWO, The Netherlands. We are thankful to all three donors. We also acknowledge the valuable efforts of Poulomi Banerjee, Sumit Vij, Manish Maskara, Shreya Chakraborty, Monica Priya, SaiKiran and Venu Gopal, our colleagues at SaciWATERs.

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[i]The normal or the peak season depicts the situation in the post monsoon to winter months while the lean season depicts the summer months when water resources are scarce. In our case, the data the lean season has also been followed by a year of drought, while the normal season has been followed by a normal monsoon in 2016.

[ii] This is operative in Telangana as of date till the state government comes up with a revised version.

[iii] The AP WALTA Act 2002, states, 'Notwithstanding anything contained in any law for the time being in force the Authority may, on the advice of the Technical Officer, that any existing well is found to be adversely affecting any public drinking water source, after giving the owner a reasonable opportunity of being heard by an order, prohibit the extraction of water for commercial, industrial, irrigation or any other purposes from such well for a period of not more than six months which after review may be extended for a further period of not more than six months at a time. Provided that irrigation well with standing crop shall be taken as last priority for such purpose' (pg 6).

[iv] http://india-wris.nrsc.gov.in/wris.html

[v]From this one instance it is difficult to come to the conclusion that the coverage of the private RO plants declines with distance from the city core. Also, Malkaram, which is the not the closest to the city centre, but within comparable ranges as Mallampet and Kokapet, has a large number of private RO plants located within the village. This has, in all probability, more to do with the particular nature of *panchayat* than anything else.

[vi] For Malkaram, the supplementary source in lean season is not available due to unavoidable circumstances. This will make a difference in the total for the relevant category and has to be interpreted accordingly.

[vii]It is clear from a subsequent section, however, that the extent of payment made does increase in the lean seasons.

[viii]The untreated sources of water are a sum of three sources in Table 6,direct piped water (temporary) managed by the community, common taps/ stand-posts managed by the community and others. The latter includes primarily includes borewell or well water, own, borrowed or even purchased at a low price.