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Periurban Water Security

Climate change, peri-urban water security, conflict and cooperation: Case study from Hyderabad and Gurgaon, India

Periurban water security

Conflict and cooperation over natural resources in developing countries (CoCooN)

Conflict and cooperation in the management of climate change (CCMCC)

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Abbreviations

AP	Andhra Pradesh
BC	Backward Caste
CAD	Command Area Development
CC	Climate Change
CoCooN	Conflicts and Cooperation over Natural Resources in Developing Countries
CCMCC	Conflicts and Cooperation in the Management of Climate Change
CPR	Common Property Resource
EWC	East- West Centre
FDI	Foreign Direct Investment
GHMC	Greater Hyderabad Municipal Corporation
GWS	Gurgaon Water Supply
HFL	Hindustan Fluorocarbons Limited
HMA	Hyderabad Metropolitan Area
HMDA	Hyderabad Municipal Development Authority
HMWSSB	Hyderabad Municipal Water Supply and Sewerage
Board IDRC	International Development Research Centre
IWMI	International Water Management Institute
KPIs	Key Person Interviews
LPG	Liquified Petroleum Gas
MRO	Mandal (Block) Revenue Officer
MSC	Multimedia Super Corridor
NAPCC	National Action Plan for Climate Change
NCR	National Capital Region
NEERI	National Environmental Engineering Research Institute
NGO	Non-Governmental Organisation
NWP	National Water Policy
OC	Other Castes
PAPC	Patancheru Anti- Pollution Committee
PCA	Principal Component Analysis
PNG	Piped Natural Gas
RFC	Ramoji Film City
RO	Reverse Osmosis
RWSS	Rural Water Supply and Sanitation
SaciWATERs	South Asia Consortium for Interdisciplinary Water Resources
Studies SAPCC	State Action Plan for Climate Change
SC	Scheduled Caste
ST	Scheduled Tribes
SWP	State Water Policy
TRS	Telangana Rashtra Samithi
WASH	Water, Sanitation and Hygiene

Contents

Climate change, peri-urban water security, conflict and cooperation: Case study from Hyderabad and Gurgaon, India

Poulomi Banerjee, Vishal Narain, Monica Priya, Anamika Barua, Manoj Jatav, Manish Maskara

Abstract

Hyderabad and Gurgaon located in the semi-arid agro- climatic zones have been experiencing acute climate variability as perceived by actors in the form of temperature, rainfall, and soil moisture. In both the cities these changes are having a direct bearing on the water resources in the form of falling water tables, and drying of surface water bodies. This interconnection between climate variability and water is more precariously felt in the transitional spaces of peripheries of these cities also called as peri-urban areas which itself houses multiple actors at different scales in terms of political will, capacity, knowledge, interests and power. This acute water scarcity in the peri-urban areas often leads to conflicts, contestations and cooperation's due to conflicting interests of varied groups. This paper tries to identify peri-urban areas with the presence of such conflicts or cooperation in the rapidly urbanising cities of Hyderabad and Gurgaon through a mixed approach of quantitative and qualitative data analysis. While the unit of analysis for Hyderabad is a village, for Gurgaon it is wastewater canal. Anajpur, Peddapur, Edthanur, Chitkul and Bowrampet are the five peri-urban villages selected for the study that fall within the jurisdiction of Hyderabad Metropolitan Development Authority, HMDA. Each of the five villages present a unique case of conflicts. In Gurgaon the study focused on three canals that represent the flows of water from rural to urban areas, and vice versa. These canals are (1) the Gurgaon Water Supply Channel; (2) the National Capital Region (NCR) Channel; (3) the Gurgaon Jhajjar Wastewater Canal. The four selected peri-urban villages for study along these canals are Chandu, Budhera, Kaliawas and Iqbalpur.

Key words: *Peri-Urban, conflict, cooperation, water, climate change, urbanisation, industrialisation*

1. Introduction

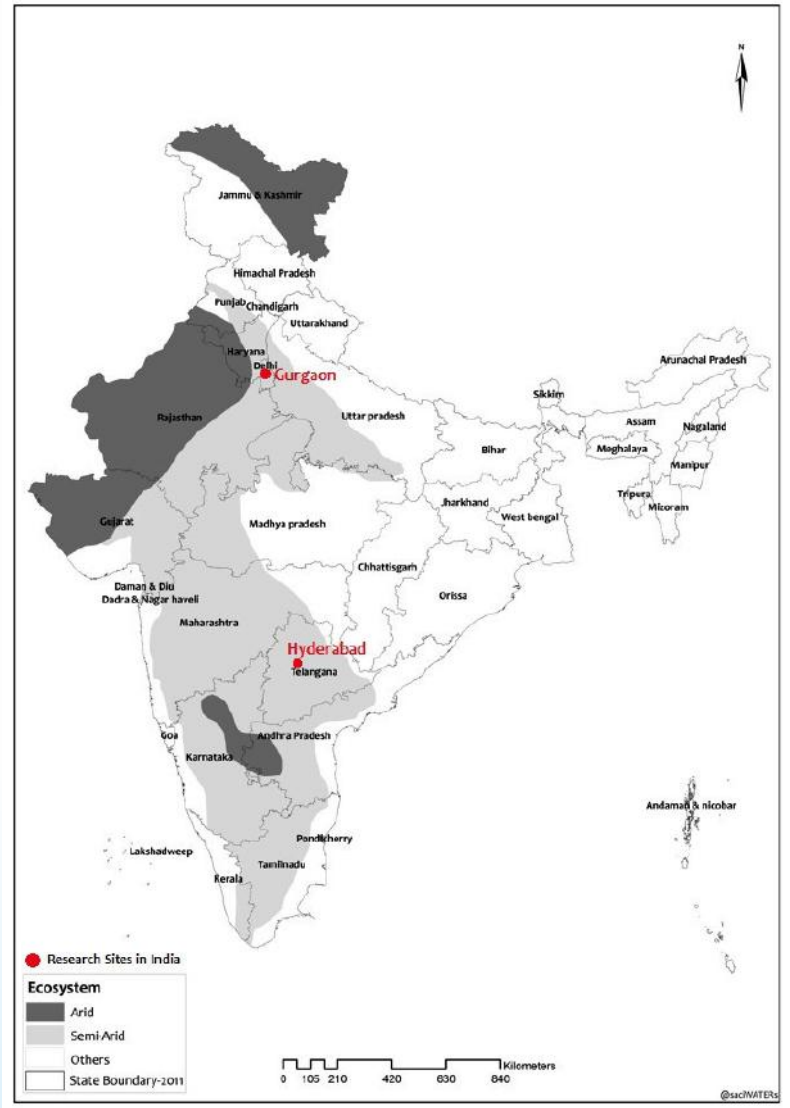
Peri-urban areas are witnessing insecurity of water resources (Ranjan & Narain 2012), majorly due to two factors – process of rapid urbanisation and climate uncertainty. Urbanisation is creating huge demand for natural resources such as land and water in the peripheral areas – especially in the South Asia, including countries such as India, Bangladesh, and Nepal. The village commons are diverted to infrastructure development such as water treatment plants, roads, residential and recreational facilities – the ecological footprint of the city spills over into the peri-urban areas. Due to land acquisitions and encroachment of water bodies, the water sources in peri-urban areas are stressed, leading to water insecurity (Narain *et al.* 2013), often creating a potential for conflict.

The on-going research by SaciWATERs, under the CoCooN –CCMCC program aims to assess incidences of climate change induced conflicts and cooperation in two study sites – Hyderabad and Gurgaon (map 1, page 2). It also aims to assess the adaptation strategies and climate policies associated with amplified climate variability and urbanisation process in the management of peri-urban water resources in India. This scoping report forms a part of Activity 3 of the proposal, which entails to understand the dynamics of peri-urban water security, conflicts and cooperation in the study sites of Hyderabad and Gurgaon. The study was conducted between October-December 2014 and April-September, 2015 to gain an overall understanding of the theoretical approach, research framework, methodological tools, literature review, and the case selection that lays a basis for the research to be carried forward. This combined country level report gives an in depth insight on the dynamics of climate

variability and urbanisation processes which act as stressors on peri-urban water security. The literature review and the field survey create a space to understand four interrelated dynamics of peri-urban water security, first how peri-urban community perceive water scarcity, interests, rights and equity. Second, how emerging network and ties across actors gets shaped by vulnerability (hydrological stress, shocks and rapid urban expansion) on one hand and institutional context (structure, process, policy) on the other. Third, to what extent the renewed relation results in the creation of patterns of conflicts and cooperation, building community's resilience. Finally, how resilience can feed into the climate change and water urban policies at macro level.

Hyderabad and Gurgaon located in the semi-arid agro climatic zones have been experiencing acute climate variability as perceived by actors in the form of temperature, rainfall, and soil moisture. In both the cities these changes are having a direct bearing on the water resources in the form of falling water tables, and drying of surface water bodies. This interconnection between climate variability and water is more precariously felt in the transitional spaces of peripheries of these cities which itself houses multiple actors at different scales in terms of political will, capacity, knowledge, interests and power. Therefore, this places a need towards creation of an informed understanding among the actors towards adapting to such situations through different conservation measures, as well as to inform the government and institutional policies framework to adapt to changing dynamics created by climate variability and urban influence.

Map 1: Location of research sites in India



Source: Constructed by Authors.

2. Theoretical approaches and analytical framework

Within the larger scope of political ecology, the study takes hybrid of approaches to understand the interactions between physical, socio-economic, and political structures and systems around water use (figure 1; page 4).

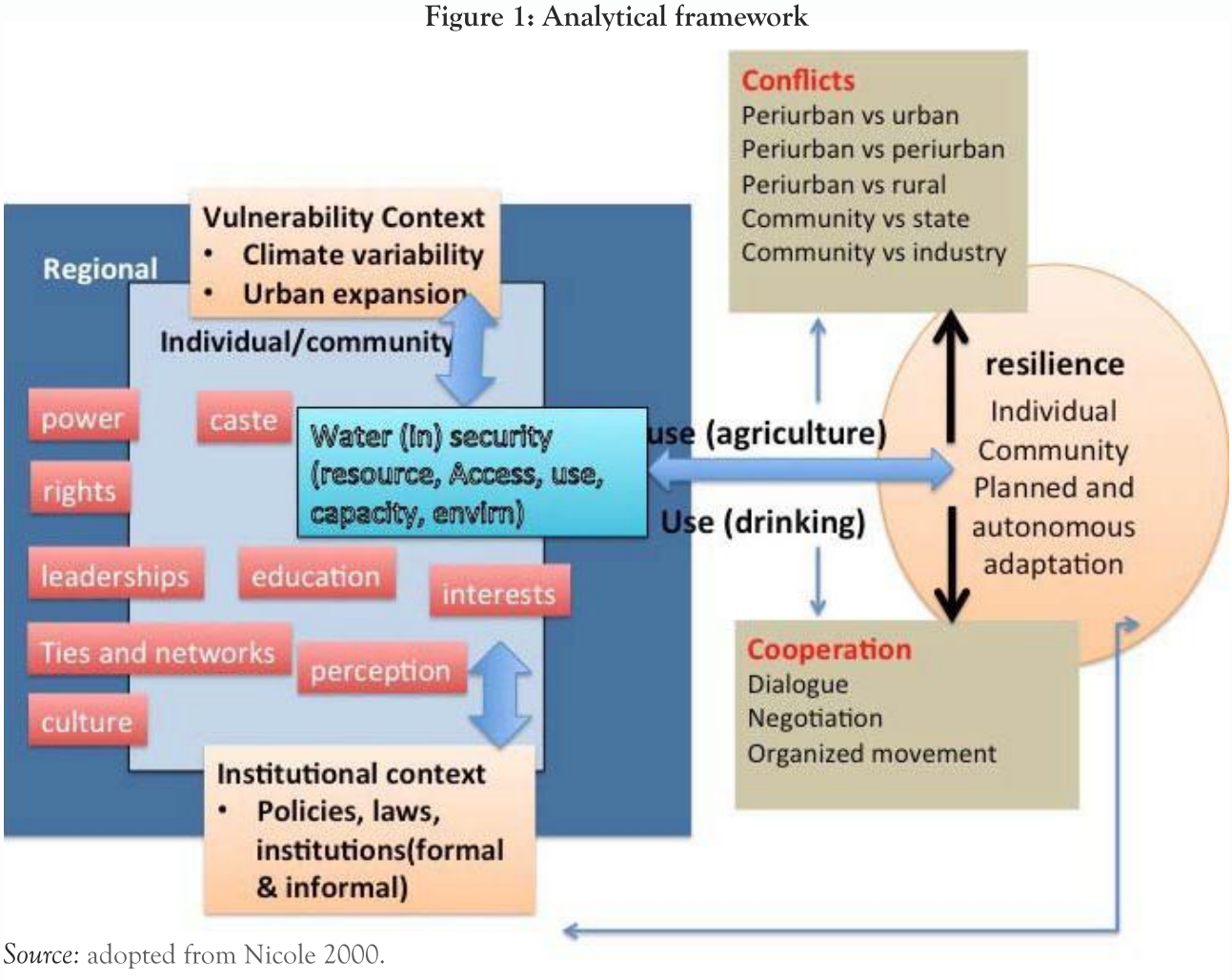
Human agency and structuration theoretical approach has been used to understand the processes, and behaviors leading to conflict/contestations or creating pathways of cooperation for a water resilient peri-urban community particularly in Hyderabad. The approach has been propounded by Giddens, where he argues that human agency and social structure are not two separate concepts or constructs, but these are together produced by social action and interaction. In sociological analysis, their separation may be a result of how sociologists examine and interpret social reality, with agency and structure being two ways that social action can be studied and understood sociologically. There is a duality of structures in society – on one side there are individuals as actors in particular situations, who enter into knowledgeable activities and participate in social action and interaction in these situations. At the same time, the social world is composed of social systems and structures – these are the rules, resources, and social relationships that actors produce and reproduce through social interaction. The study of structuration means examination and analysis of the ways in which social systems are produced and reproduced in social interaction (Giddens 1984). Giddens defines structuration as "the structuring of social relations across time and space, in virtue of the duality of structure" (Giddens 1984).

Structuration theoretical approach considers peri-urban as a zone of degeneration and opportunity creation depending on the power politics, rights, leadership, culture, language, education, caste, networks, ties, money, negotiation and governance structure. It recognises that both the processes of positive trickle down and negative under development do take place but the magnitude and direction in any given context depends largely on the extent to which actors (both local and regional) respond to the challenges. While explaining the significance of some of these aspects, Maxwell *et al.* (1998) pointed out to the local leadership as an instrument of contestations/contradictions or cooperation in accessing resources. He suggested that where local leadership (local government leaders/community) is well informed and willing to act in the best interest of the community, the increase in the value of land or livelihood diversification arising from commodification of peri-urban activity can have a positive impact on the community. However, where this is absent, loss of land, water and livelihoods will occur, which in turn will have negative impact on poverty reduction measures. This points to the need for investigation and investment in informed awareness, local capacity building and governance: a view shared by Devas and Korboe (2000).

Similarly access to natural resources like land and water is also a product of power dynamics and rights of the peri-urban community. Giddens (1984) explains the role of power as an instrument to achieve outcomes and to influence events. Considering the two faces of power (Bachrach & Baratz 1962) there is also the dimension of power as control over aspects of the periurban resources; issues of how power is achieved; sources of power (Savage *et al.* 1992); channels through which it is deployed and the nature of outcomes (Giddens 1984). Community's consciousness about its rights to resources also determines the access and use of the natural resources. Studies on livelihood diversification and peri-urban change imply to the concepts of power as a political capital that determines peri-urban contestations and contradictions in accessing natural resources, its usage and finally to poverty reduction. Such analysis would explore the nature and impacts of responses taken by institutions and various socio-economic interests and alliances to the changing peri-urban circumstances.

The socio-technical approach understands society to include both the human and the non-human elements 'bound together in networks, and also constituted and shaped in those networks' (Bijker & Law 1992). It ties the study to the premise that technologies as outlets for irrigation from the canal, tube-wells, submersibles and pipelines, are important determinants of access to water and are not 'neutral' in terms of the social relations and practices that shape this access. Indeed technology is seen as a condensed expression of social relations. In case of Gurgaon, socio-technical approach helps to understand the naked power relations based not only upon caste or land ownership but rather find themselves in mutually conflicting positions because of technical, agro-ecological and topographical factors.

Figure 1: Analytical framework



Source: adopted from Nicole 2000.

Political economy approach is applied to both Hyderabad and Gurgaon in order to capture the subtleties of the social reality of conflict and co-operation, and could be susceptible for instance, to misrepresenting socio-technical factors of conflict as largely political. Hydrosocio approach is used to understand how the socio-environmental consequences of scarcity in water are socially unevenly distributed, and the cycle comprises the political and institutional organisations which determine water entitlement and water rights, and hence govern access and exclusion (Swyngedouw 2009).

The research in Gurgaon also looks at the symbolic aspect surrounding the use and access to resources, taking a socio-cultural lens where utilitarian explanations are found inadequate to address social perceptions and realities. Being central to life and livelihood, resources like water and land constitute important loci for social organisation. The relationship between these resources and society extends beyond a materialistic mundane relationship, to incorporate a "symbolic" orientation (Singh 2006). Hence the interaction with land and water needs to be looked at not only through a "rational action"

model but also studied with a view to cultural orientations towards them. For instance, the interaction of farmers in Budhera with wastewater is an issue coloured by symbolic notions of wastewater and food that produces a narrative of deteriorating values in the village and a breakdown of the moral economy.

Legal pluralism approach explains the existence of multiple legal systems within one (human) population and/or geographic area. Case study in Gurgaon takes legal pluralism approach to assess the dynamics of resource access, use, and the challenges that different users and legal systems pose. It suggests that greater awareness of the existence of alternative legal forums by resource users can help to bring common understanding and even use to create flexibility in establishing legal institutional arrangements. Figure 1 (page 4) gives an analytical framework of the study based on Human Agency and Structuration theoretical approach. It is an adopted version of Nicole's livelihood framework.

3. Water security, urbanization and climate change policies

Taking from the larger research questions set in the project, the report attempts to address the following research questions particularly for Hyderabad case.

I. What have been the traditional linkages between the community and water, and how is this interdependence being impacted by climatic variability?

ii. How has the interrelationship between the community and water changed due to 7 spreading of city limits?

iii. How climate variability and spreading of mega cities are creating renewed patterns of relationships among actors in terms of access and usage of water resources, and how these changed relationships are getting manifested in the form of conflicts and cooperation?

iv. Whether these changed roles are leading to adaptation or are creating space for a need of informed awareness building towards water security? The objective of the scoping study for the Gurgaon case is:

v. To study practices around peri-urban water use along the canals that cut across the rural and urban frontiers focusing on specific forms of interfaces among water users: conflicts, cooperation, emerging insecurities and vulnerabilities, farmers' cropping and irrigation choices.

vi. To look at narratives around water conflict and to see if and how they relate to climate change and urbanisation.

4. Methodology for case study selection

The site selection methodology for both the study regions namely Hyderabad and Gurgaon is discussed in this section. It is worth mentioning here that site selection methodology for both the sites varies as the unit of analysis are different for both the study sites. For Gurgaon the unit of analysis is 'canal' while for Hyderabad the unit of analysis is village. Hence the site selection methodology is different for both the cases.

4.1. Gurgaon study site

Gurgaon is a district located in the North-West Indian state of Haryana, which has traditionally been India's food basket. Starting from the 1980s, it has witnessed rapid growth and land use change, transforming what was once a sleepy village into a modern city. Land has been acquired by the state and by private real estate developers to build high rise residential buildings, shopping malls and recreation centers, as well as to provide infrastructure to support urban growth. Several multinationals and corporate giants have their offices and headquarters located in the city. This process of land acquisition has been mainly from the neighbouring villages and rural areas; in the process of acquiring lands, water sources located on those lands have also been usurped.

The proposed research on water conflicts and cooperation is located along canals that represent the flows of water from rural to urban areas, and vice versa. These are the 1) Gurgaon Water Supply Channel that is the source of water to the city of Gurgaon; it cuts through several peri-urban villages and carries water to the water treatment plant at Basai that supplies water to the city of Gurgaon 2) the NCR channel that was built parallel to it more recently to augment the supply of water and 3) the Gurgaon Jhajjar wastewater canal that carries the urban wastes of the city; the wastewater is used widely as a source of irrigation in the peri- -urban villages. A detailed map of all the three canals will be prepared & enclosed, highlighting the villages and area of study, along these canals.

Though the study was situated in four peri-urban villages in Gurgaon district – Chandu, Budhera, Kaliawas and Iqbalpur, the primary unit of analysis was not these four villages but the 3 canals that pass through these villages, namely – the GWS (Gurgaon Water Supply) Channel and the NCR (National Capital Region) Canal and the Gurgaon-Jhajjar 'Wastewater' Canal, The GWS and the NCR canal run parallel and adjacent to the Badli Road throughout the study area and both originate from the same source of River Yamuna in Kakroi Village in Sonepat District. The study area also comprises the Chandu-Budhera Water Treatment Plant located within Budhera village which treats the water from the NCR canal. The entire research area is about a 5 kilometre stretch of these canals, however with great agro-ecological and topographical diversity it makes for an excellent site to studying social relations around water. The villages as secondary fields of study are important locations in understanding other dynamics of peri-urbanity and land acquisition.

The study was qualitative in nature. An ethnographic approach was taken with multiple interactions with the community over 27 field visits to the study area of 4 villages. Theoretical sampling was employed so that respondents were selected on the basis of their relevance to ongoing theoretical analyses. 66 semi-structured interviews were conducted during the course of the study, with majority (46) interviews conducted in Budhera village alone. There were key informants who the researcher kept referring back to on different issues so that the actual number of unique respondents interviewed was 53. Besides this, 6 focus group discussions with groups of at least 3 people on various subjects as co-operation around wastewater, land acquisition, impact of the water treatment plant were conducted during the course of the

fieldwork.

4.2. Hyderabad study site

Hyderabad Metropolitan Area, HMA that falls under the jurisdiction of Hyderabad Metropolitan Development Authority, HMDA has been selected as the larger study area. HMDA is vested with the responsibility of planning, co-ordinating, supervising, promoting and securing the planned development of HMA under its purview. Geographically, this area majorly falls in Krishna and Godavari River basins, with a number of smaller sub-basins such as Musi and Manjeera River (annexure map 1). Spread over an area of 7,100 sq km the HMA consists of 40 blocks in which 30 blocks are included in the Greater Hyderabad Municipal Corporation, GHMC for various administrative and planning purposes. HMA also has 23 Census Towns, 3 Municipalities, 790 Gram Panchayats and 1 Cantonment Board. With the process of urban growth, number of villages has come down to 827 during the period 2001 to 2011 (annexure tables A1 and A2). Socio-economic and demographic characteristics of present villages and census towns largely reflects growing peri-urbanisation within the HMA. With regard to identification of the case study sites within HMA, two broad criteria were kept taken into account, first the area (i.e. block and village) should be peri-urban in nature and second, there should be presence of conflicts or any cooperation relating to water. Both quantitative and qualitative methods have been used to identify peri-urban study blocks and villages respectively.

4.2.1. Identification, measuring, and mapping of peri-urban blocks

Extent of peri-urbanity, as the first unit of this research, has been identified at block level within the HMA boundary. The study has used K-mean clustering to differentiate the thresholds across urban, peri-urban and rural. The list of indicators used for k-mean clustering[1] is given in annexure table A3. Description of final cluster centres is given in annexure table A4. To ensure efficiency of available data by reaching maximum level of statistical significance, these indicators have been integrated in various subsets depicting essential characteristics of periurbanity of the region i.e. HMA. Shortlisted indicators, subject to availability of data, are reduced to broad dimensions using Principal Component Analysis (PCA) e.g. level of urbanisation, population density, and non-farm employment were the indicators reduced to index of macro-economic growth process. Similarly, indicators related to the usage of e-facilities i.e. landline and mobile phones, television, computer and laptop with internet connection, have been reduced to the index of e-Readiness. WASH, housing and micro-living indicators i.e. drain connection in the house for waste water disposal, use of kerosene, LPG/ PNG and electricity for cooking purpose, and type of roof of the house are reduced to the index of WASH, housing and household's micro-living environment. Indicators relating the use of ground water i.e. gross cropped area under non-food crops, gross cropped area irrigated through ground water and the overall state of ground water development (net ground water use/ net ground water availability * 100) are reduced to index of ground water use. All these indicators are first arranged in unidirectional way to ensure robustness in k-mean analysis. These four broad indicators/ indices were used to cluster the blocks around HMA.

To understand the peri-urban interface more clearly, the core urban area of Hyderabad were kept out of

[1] K-Mean cluster analysis is a task of grouping a set of objects in such a way that objects in the same group (called cluster) are more similar (in some sense or another) to each other than to those in other groups (clusters). It is centroid based clustering where clusters are represented by a central vector, which may not necessarily be a member of the data set. When the number of clusters is fixed to k, k-means clustering gives a formal definition as an optimisation problem: find the cluster centres and assign the objects to the nearest cluster centre, such that the squared distances from the cluster are minimised.

Map 2: Peri-urban interface within HMA, year 2011

Source: Constructed by the authors.

the analysis and number of k-mean clusters were set to 3 to identify the level of peri-urbanity at three levels in relation to the core. Exceptionally, one block, named Sadasivepet in Medak district, has also been included in the analysis due to its worth characteristics in depicting similar types of issues to be focused and its geographical adjacency to nearby industrially and climatically affected two blocks i.e. Patancheru and Sangareddy. The village is also unique in reporting water related issues over the use of drinking water pipeline passing through the block to core Hyderabad. Also, water security in the block and agriculture practices are badly affected in the peri-urban process. Hence the 40 blocks, except the core, were categorised into three major heads of which characteristics are- (1) peri-urban to urban comprised of 11 blocks, (2) peri-urban to peri-urban comprised of 13 blocks, and (3) rural to peri-urban comprised of 16 (map 2; annexure table A5).

4.2.2. Identification criteria for short listing study villages

Having mapped the blocks, the next stage of selection involved the identification of peri-urban villages in these blocks through Key Person Interviews (KPIs) at the State and block level using snowball sampling accompanied by visual observation in the villages that was carried out based on 17 indicators derived from the literature (figure 2, page 11). The selection of the periurban villages in these blocks was based on consultation with experts and government officials at the State and the block level through snowball sampling. At the state level the officials of Hyderabad Municipal Water Supply and Sewerage Board, HMWSSB were consulted to know the extent of coverage in terms of drinking water supply in each of the blocks. In addition to this, the officials of State Irrigation Department and the Ground Water Board were consulted to identify those areas that are predominantly dependent on agriculture for their livelihood and the extent of water (in) security in terms of ground water availability respectively. Further, those

villages that have been exhibiting a predominant urban character but are still governed by a Gram Panchayat were identified, through consultation with the same officials. This was followed by a similar kind of interaction with the Mandal Revenue Officer, MRO at the block level. The inputs obtained through these consultations were taken forward and visual observation of each of the villages were carried through a set of 17 indicators, so as to ascertain the results obtained through key person consultations. These indicators are-

i Identifying peri-urban based on census criteria (Shaw 2005).
(Census of India identifies census towns, outgrowths and urban agglomerations as peri-urban areas)

ii. Higher percentage of non-farm families (Rigg 2006) as in Chitkul village wherein more than 70% households are involved in non-farm activities.

iii. Higher percentage of migrant population (Narain 2009). Chitkul, Anajpur and Bowrampet houses a number of in-migrant population, highest being Bowrampet wherein 50% of the resident population now are in-migrants. Migration into these villages is driven by combination of distress pushed and demand pull factors, mostly in search of employment.

iv. High incidence of daily commuting to the nearby industries and towns for employment, education etc. (Narain 2009). Chitkul, Edthanur and Anajpur have showed an increase in travel to the nearby industries where they are engaged as daily wage labours.

v. Feminisation of labour force (Ranjan & Narain 2012). Peddapur and Anajpur villages have witnessed an increase in the number of working females in the past years. Majority of them work as agricultural labourers, and few work as daily wage labours in industries. Around 50% of the females in Chitkul work as labours in the industry report the villagers.

vi. Prevalence of high value commercial agriculture and allied activities e.g. horticulture, aquaculture, floriculture (Narain 2010) which is evident in Peddapur village where a majority of the population does nursery farming and horticulture.

vii. Larger area under irrigation, as in the case of Peddapur.

viii. Mixed land use pattern (Narain 2010). Diverse land uses co-exist in Bowrampet periurban village. Along with agriculture, the village is a home to real estate ventures, industries, and educational institutes. The village is characteristically peri-urban to urban but still does not have a status of Village Panchayat.

ix. Degradation of forest lands (Narain, Banerjee, & Anand 2014). 2000 acres of hillock and forest land was converted for the building of Ramoji Film city in Anajpur.

x. Disappearance of surface water bodies (Ramachandraiah, Westen and Prasad 2008), as observed in Edthanur village where Turkam Cheruvu which once was the major source of water for the village is dry.

xi. High valuation of building and land (Peri-urbanisation in Europe, Plural 2010). Post industrialisation the villagers report a steep rise in the land prices from 6,000 per acre which was given as a compensation during acquisition to a current rate of 50,00,000/acre.

xii. Political hotspots.

xiii. Dumping of solid wastes (Shaw 2005). A huge mound of uncleared accumulated garbage has been observed in Peddpur. With no urban civic status and the Peddapur Gram Panchayat declaring that solid waste management is outside its purview, the village is facing a problem that epitomises the state of environmental management across much of peri-urban India.

xiv. Change in the behavioural pattern of population, breaking of the traditional networks, creation of new associations (formal and informal).

xv. Larger expenditure in education, particularly girls education (Narain, Banerjee, & Anand 2014), as observed in all the peri-urban villages.

xvi. Higher dependence on private sources for basic service delivery due to absence of state provided services as in the case of Bangladesh (Global Monitoring Report 2013). This has been observed strongly in the case of Bowrampet which is heavily dependent on tanker water primarily due to low water tables and the incapacity of the Panchayat in providing sufficient water to all its residents.

xvii. Connected with the nearby cities by means of transport corridor (Narain, Banerjee, & Anand 2014). All the 5 study sites selected are in proximity to the National Highway except Bowrampet which is located along the Outer Ring Road, ORR of Hyderabad.

Thus, through a combined approach of expert consultation and field observations, cluster of villages in Sadasivpet mandal, Patancheru and Sangareddy mandal, Anajpur village in Hayatnagar mandal, and Bowrampet village in Qutbullapur mandal were identified. One of the principle criteria for the site selection is the presence of water conflicts, the next stage involved the identification of peri-urban villages that showed the presence of conflicts or cooperation over water triggered by urbanisation and climate change.

4.2.3. Identification of peri-urban villages based on the presence of water conflicts and cooperation

Finally, a combined approach of key person's consultation, grey literature review and review of works done by SaciWATERs was adopted to identify the presence of conflicts in the peri- urban villages. These diverse qualitative tools were therefore used to identify the 5 different study sites (annexure maps 1 and 2). Key features of selection of the study villages are given below stepwise-

4.2.3a Consultation with officials at the state level

State officials of HMWSSB, Irrigation department, Rural Water Supply and Sanitation RWSS, and the Ground Water Board were consulted. The basic objective behind these consultations was to know about the conflicts in villages that do not have access to piped water supply, those villages that majorly continue to depend on agriculture and have some degree of conflicts over irrigation water, and those peri-urban areas that have been identified to be vulnerable and water insecure. These objectives were limited to few blocks that have been chosen through random sampling but with a greater focus on those 5 peri-urban blocks that were identified based on the above criteria.

Through this interaction, Peddapur in Sadasivpet mandal was identified as one study site which showed the presence of conflicts between the stakeholders and the state over the provision of piped water supply

which was absent inspite of the village being home to one of the largest filter bed that supplies water to the city. Based on interaction with the Irrigation Department issues over irrigation water sharing in Anajpur village, Hayathnagar block had come to light.

4.2.3b Consultations with block level officials and other key persons

At the Block level the officials of the RWSS and Irrigation Department and the MRO were consulted. Similar kind of interaction was done with these block level officials.

From the previous study done by SaciWATERs the presence of conflicts in Edthanur over industrial pollution had come to light and the key contacts were established. This was taken forward and the key persons involved in the Patancheru Anti-Pollution Committee (PAPC) Prof. Vijay, Dr. Kishan Rao and Prof. Purushotham were consulted to understand the kind of conflicts prevalent in the Industrial Area. Through this interaction Edthanur and Chitkul were identified as peri-urban villages which bore the brunt of industrial pollution and in response were actively involved in the Anti-Pollution Committee.

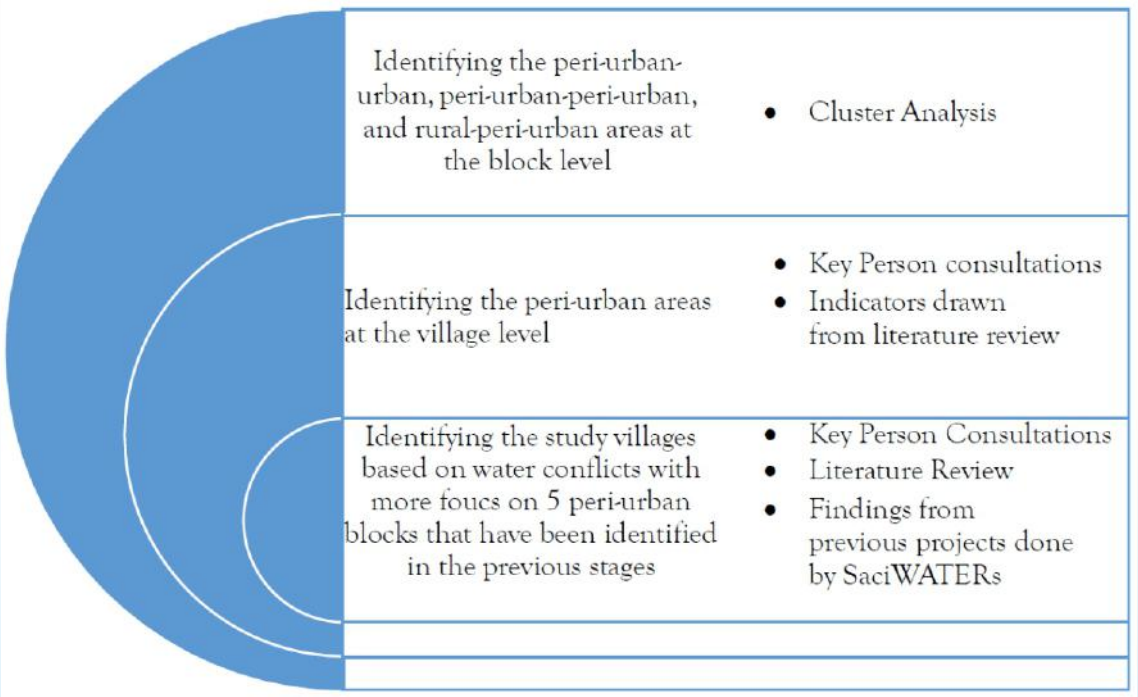
5. Literature review

Newspaper Articles and Research Publications that had reported conflicts in peri-urban villages of Edthanur, Chitkul and Peddapur were referred to which further formed a base for the selection of these study sites[2].

Findings from previous works done by SaciWATERs

A Project done by SaciWATERs entitled "Peri-urban Water Security in South Asia: Adapting to Climate Change and Urbanisation", funded by IDRC, identified few critical issues relating to strong operation of water tankers and the presence of latent conflicts among people in and around peri-urban village of

Figure 2: Methods used in the selection of study villages



Source: Constructed by the authors.

[2] http://www.thehindu.com/todays-paper/tp-national/peddapur-supplies-manjeera-water-to-hyderabad/article5054344.ece

Bowrampet. Similarly in another project entitled "Rural to urban transitions and the peri-urban interface: identifying, mapping, and understanding peri-urban areas in India and Pakistan" funded by East- West Centre, EWC, conflicts in Edthanur between various stakeholders over the impact of industrialisation on the surface water bodies came into light. Since these projects did not have scope to do further research on the prevalent conflicts, these cases were taken up.

Hence by employing quantitative and qualitative tools the following study sites have been identified for further study-

1. Peddapur village in Sadasivpet Mandal,

2. Edthanur in Sangareddy Mandal,

3. Chitkul in Patancheru Mandal,

4. Anajpur village in Hayatnagar Mandal, and

5. Bowrampet in Qutbullapur Mandal.

6. Understanding climate change, water security and urbanisation nexus: specifics from Hyderabad and Gurgaon

Rapid urban spread, withered ruralities and decentralised governance structure are features of India post liberal development policy framework. The spatial expansion of Indian megacities is reflected in specific processes of peri-urbanisation, subject to multiple transformations of physical, morphological, socio-demographic, cultural, economic and functional (Dupont 2007). Albeit, differences in the way such process operates in developed and developing world, unprecedented growth in the numbers of "transitional areas" interspersed with rural areas, and the changing nature of state intervention for development and poverty alleviation in the light of structural adjustment programmes have particularly influenced the resource utilisation capacity of the Indian megacities (Roy 2006). Areal spread of the cities beyond its metropolitan boundaries cannot be underscored enough particularly with respect to its water security. It has created conflicting stakes on the use and access of water jeopardising the rights and entitlements of the vulnerable residing in some of the most affluent urban neighbourhoods. Following section gives an account of the intricate relationships between climate variability and water resources, emerging contestations, cooperation and community resilience felt in the fast changing peripheries of Hyderabad and Gurgaon.

Today peripheries are no longer been seen as a repository of various geographical and functional phenomena (Sosea 2013) but a self-contained entity quite distinct from its rural and urban counterparts. They exhibit specific characteristics that make their governance a distinctive challenge. They are constructed primordialism (Arovindo 2006), determined by urban metabolism. They are challenging (Sosea 2013), degenerated (Kundu, Pradhan & Subramanian 2002), transitory, subsidiary, movable, vulnerable, fast paced, ephemeral space that lacks adequate politico-administrative jurisdiction (Milbert 2006). Although 73rd and 74th constitutional amendments of India have granted civic status to these transitional areas by constituting nagar panchayats or town panchayats in India, most Indian states have yet to accept them (Shaw 2005). Consequently, most of these areas continue to be governed by gram panchayats. As a result many a times governance and management mechanism of these "transitory areas",

has failed to maintain the balance between the policy prescriptions and ground realities. They are often saddled with responsibilities that are neither within their jurisdiction nor they are equipped to handle (Roy 2006). Large scale dependence on private bore wells as principal means of water supply for drinking and agricultural purposes for the peri-urban residents testify to the lack of formal service system in these areas.

Strengthening the unity between revenue raising and fund expending authority through decentralisation service delivery system has been strongly recognised since 1990s. Advocacy on accountable and responsible development processes, less wastage of scarce resources and less scope for patronage elements can be seen worldwide (Roy 2006). Consensus has been reached where governance and development are not merely viewed as provisioning resources and physical infrastructure but about responsible institutions designed to promote self-reliance and self-confidence, and not enhance dependence. Such ties, called, Wicksellian connections (Breton 1996), between duty-bearers and rights-holders finds its expression more in the urban and rural water governance and much less precariously in the peri-urban spaces.

6.1. Case of peri-urban areas in Hyderabad

Hyderabad, one of fastest growing cities in India is undergoing rapid changes in its morphology and character since mid-1990s. From its modest beginning as a small town (Golconda) founded in 1591 with an area of about 650 km^2, today, it is one of the most populous Indian city with an aerial coverage of 7228 km^2 (Census of India 2011). The city has undergone phenomenal change under the vision of Chandrababu Naidu, ex-chief minister of united Andhra Pradesh. The post fordist developmental approach of TDP government has made Hyderabad into a world class city with knowledge enclaves' similar to Malaysia's Multimedia Super Corridor (MSC) and Silicon Valley of United States (Sen & Frankel 2005). Emphasis was made to spearhead service sector particularly IT and pharmaceuticals along with ancillary developments of gated residential complexes, ultra-modern shopping malls and multiplexes. Cleaning cities, creating road network, acquiring land and bringing market based municipal reforms were steps taken by the government towards making Hyderabad a smart city. Such city centric growth process no doubt has brought Hyderabad into limelight attracting FDI, and creating growth enclaves but with a serious environmental tradeoffs and exclusion precariously felt in its peripheral areas. A village located closed to the city has slowly withered away its traditional livelihood system, demographic composition environmental serenity giving rise to mixed landuse, heterogeneous population structure and multitude of infrastructural problems particularly with regard to water security.

The peri-urban community though provided with new pipelines, are often inadequate and differently accessed based on land tenure, settlement type, socio-economic conditions, and provider. The Hyderabad Metropolitan Water Supply and Sewerage Board obtains 735 million litres per day of fresh surface water from the Musi river, as well as from the neighbouring Manjira river basin. A study by Hyderabad's City Development Plan states that the peri-urban areas which make up the greater Hyderabad metropolis, the network of water supply covers only 65 per cent of the area and about 40 percent of the population (Water-Excreta Survey 2006). The traditional water harvesting structures, namely cheruvus, ponds etc. which once supported the drinking and irrigational needs of the city and its peripheries are either disappearing or in a very poor condition. SaciWATERs study in collaboration with the Department of Science and Technology (2012) reported that between 2004 and 2012, 13 lakes disappeared within Mir Alam Basin located in the metropolitan area of the city. Deficit in the official supply forces, peri-urban communities to rely almost completely on groundwater for their drinking and domestic needs. Poorer groups rely exclusively on municipal sources of groundwater provided through

borewells and mini water tanks, and wealthier groups rely on private tankers or personal borewells. The water tankers which play a critical role in filling the vital gap for city, transport raw water from agricultural wells in peri-urban villages into the city for commercial establishments, construction sites and city residents (Janakarajan *et al.* 2007; Prakash 2014). Unsustainable pattern of development induced by growth of IT sector has created water insecurity among marginalised social groups residing in peri-urban areas. In addition, privileged classes with a higher capacity to pay for water resources have putted pressure on governments to ensure regular supply and promoted informal and formal water tanker economy (Prakash 2014). Since groundwater is practically free and unregulated, those with land and the proper documents can indiscriminately sink borewells, obtain electricity connections and pump water either for their own consumption or for sale.

The water stress is further aggravated by shorter rainy seasons with reducing rainfall since 1980s — increasing the reliance on groundwater in the catchment areas surrounding Hyderabad (Ramachandraiah, Westen & Prasad 2008). SaciWATERs' case study in Mallampet reveal that farmers are selling water in peri-urban areas to the private water companies on a large scale to make profit. As agriculture is diminishing, farmers allow the tanker companies to draw water from their pumps, making for a rapidly declining groundwater table. The situation worsens, especially because the extraction is often being done illegally and is controlled by strong and powerful stakeholders (Prakash, Singh & Brouwer 2015; Joy, Paranjape & Bhagat 2014). Creating insufficient irrigation facilities, the wastewater irrigation has become a major source in the peri-urban areas, wastewater flows from the industries and the city. There is a reverse transfer of environmental costs in terms of wastewater to the periphery (Prakash 2014). This polluted water causes swelling of hands and feet with blisters on the skin (IWMI 2003).

In the process of development, there is a large-scale encroachment of surface water bodies and ground water recharge worthy area due to land transfer from common to private control by the government, resulting into disappearance of traditional cascading system of surface water bodies, creating threat to irrigation, agricultural productivity, livestock and sustainable livelihoods among peri-urban communities within HMDA (Prakash 2014).

With this background on the issues related to water insecurity in the peri-urban areas of Hyderabad, there are emerging evidences of conflicts due to urban growth and variability in climatic factors. Number of incidences of conflicts has been reported at different levels e.g. ruralperi- urban-urban conflicts at the user level, conflicts on use of waste water (for irrigation) emerging from rural-urban interface and conflicts between the users and the state.

6.2. Case of peri-urban areas in Gurgaon

Starting from the 1980s, the city of Gurgaon has witnessed rapid growth and land use change due to spillover effect of near Delhi metropolis. Land has been acquired by the state and by private real estate developers to build high rise residential buildings, shopping malls and recreation centres, as well as to provide infrastructure to support urban growth. Several multinationals and corporate giants have their offices and headquarters located in the city. This process of land acquisition has been mainly from the neighbouring villages and rural areas; in the process of acquiring lands, water sources located on those lands have also been usurped. Stress due to urban growth and land acquisition could be aggravated by the loss of common property resources to support urban expansion, on which landless tenants and sharecropper may depend (Vij, forthcoming). Water conflicts emerge in the peri-urban villages located along with the canals that represent the flows of water for drinking and domestic purposes from periurban to urban areas (i.e. Gurgaon Water Supply Channel and National Capital Region Channel)

and waste-water from urban to peri-urban areas (i.e. Gurgaon Jhajjar wastewater canal). The canals that are built to bring water from the country side to the city are the physical embodiments of rural-urban resource transfers.

Understanding conflicts around peri-urban water sources requires an understanding of changing land use, the bases of claims and contestations around land and the perceived fairness of the land acquisition process. These conflicts take place, for instance, over scarce water supplies being used to augment urban water supply. A good example of this form of conflicts occurred when peri-urban farmers made a breach in the NCR channel that was built to bring water to the city of Gurgaon (Narain 2009). Another conflict specific to the peri-urban contexts is around the use of wastewater. Its role in peri-urban agriculture is emphasised as a low cost, perennial source of irrigation and source of nutrients for the crops as well as an environmentally safe means to dispose-off urban waste. While wastewater provides several benefits to peri-urban crop growers, not all can benefit from its use, as access to it depends on the location of agricultural fields. One specific case of conflict over the use of wastewater is documented by Narain, Banerjee and Anand (2014). Farmers in Budheda village, about 15 kms from the city of Gurgaon, use water from a wastewater canal. Conflicts emerge when the irrigator forgets or omits to seal the outlet from which wastewater flows over to the fields, after the irrigation is over. This causes his fields to be flooded and the wastewater to overflow to the neighbours' fields, often at a time when the latter's crops do not need water. This results in the neighbours' crop being severely damaged or harmed, culminating often in conflicts and verbal confrontations.

Another aspect of conflict around water is in the context of common property resources, auctioned to non-residents of the village. An important feature of peri-urban contexts is that locus of control over resources often shifts to outside the village, to residents of nearby towns who may take part in the auction of the village resources (Narain & Nischal 2007). One such incidence was reported among residents of the village Budheda over the unfair practices resorted to by the village Panchayat – the village level governance authority to auction the village's ponds to residents of the neighbouring village of Nuh for fishing purposes. Apparently, the village Sarpanch or elected head misused his high caste status to evade accountability to other members of the village community in the auction of the village pond (Vij forthcoming).

7. Research gap identified during scoping study

There is a considerable research gap in understanding urbanisation and climate induced water (in) security in the peri-urban spaces of the developing world. Although peri-urban literature has talked about water conflicts, actor negotiating their access, rights, entitlements towards building water resilience, understanding scalar dynamics of the actors are important to appreciate the climate-water-urban nexus. It is important to assess how different actors are positioned in the socio-economic ladder, and how their awareness and knowledge, power dynamics, politics, their exposure to climatic vulnerabilities and urbanisation shocks shapes conflicts and cooperation particularly with regards to access and usage of water. The findings of the ongoing research conducted by India team will definitely play a significant role to bridge this research gap.

There also exists a knowledge gap in understanding the direct and indirect impact of such sudden shocks posed by urbanisation and climate change on the lives of the poor and vulnerable whose capacity to adapt to such change are low. Building their resilience by enhancing their capacity to adapt, to the sudden

changes by empowering them through various awareness generating activities is crucial in the peri-urban context and an important gap that was identified during the scoping study.

As peri-urban areas are subject to institutional neglect by the state, policies have either proved to be inadequate to deal with an increasing and competing demand for water or incurred trade-offs, leading to conflicts and contests. The existing institutional structures are not able to cope with the rapid urbanisation and impacts of climate either because of overlapping roles and responsibilities or due to lack of institutional capacity. It was also found during the discussion with the state level officials that, policy makers as well as service providers are not sensitive to peri-urban issues, mainly because of lack of understanding of the impacts of rapid urbanisation and climate change and the kind of implications it might have on peri-urban communities particularly with respect to water. Hence, while there is a need for institutional innovation to deal with urbanisation and climate change induced water insecurity particularly in peri-urban spaces, at the same time it is important to generate awareness among policy makers to make them sensitive to the agony of the peri-urban communities so that an effective management strategy of the water resources in the peri-urban context can be developed.

The research conducted by the India team aims to bridge these gaps to be able to add to the existing knowledge as well as generate new knowledge on peri-urban water security in the context of urbanisation and climate change.

8. Policy analysis

The correlated processes of climate change and urbanisation have been influential in rearranging boundaries of human settlements and hence blurring the rural-urban divide. The same processes have been identified in the cities of Hyderabad and Gurgaon in India. Such rearrangement and blurring has led to the creation of periurban spaces in both cities which are currently identified as spaces in transition. The above two processes have exerted undue pressure on the availability and access of water as a natural resource[3][4], which has rather been more prominent in the peri-urban areas as is evident from various other published works as well as the past work of SaciWATERs. Such prominence of water insecurity has been attributed to the lack of institutions/ overlapping institutions/ limited institutions with poor or limited capacity to deal with the challenges of peri-urban space. Moreover, the approaches of governance for water security and efforts made to address the issue of water insecurity in such areas are often traditional and sectoral. The approaches adopted and efforts taken are further victimised by the administrative, policy and institutional landscapes concerning water, urbanisation and climate change.

8.1. An overview of National and state policy on water and climate change in India

The following sections explores the approaches adopted for framing policies concerning climate, water and their inter-relations.

[3] With a growing population and rising needs of a fast developing nation as well as the given indications of the impact of climate change, availability of utilisable water will be under further strain in future with the possibility of deepening water conflicts among different user groups (http://www.dowrorissa.gov.in/ActsnPolicies/NWP/2012/NationalWaterPolicy2012.pdf).

[4] India's water sector is facing persistent challenges like uneven regional distribution, vulnerability to climate change, over-use and exploitation of groundwater, water use inefficiencies, water pollution, and fragmented institutional framework (http://www.iwaponline.com/wp/up/wp2015086.htm).

The policies concerning climate change fall under the climate change division of Ministry of Environment, Forests and Climate Change. Climate change is a central subject but the states in India have been directed to formulate State Action Plans for Climate Change after the National Action Plan for Climate Change (NAPCC) being drafted in 2009. Water, on the other hand, is largely a state subject except the inter-state disputes on water. National Water Policy (NWP) for India first formulated in 1987, revised in 2002 and re-revised in 2012 gives way for each state in India to draft its own state water policy (SWPs) to address state specific concerns on water, the responsibility of which lies on the Irrigation and CAD Department of the concerned state government. During 2002-2012, 13 states in India (out of 30 states) have developed their state water policies[5].

NAPCC highlights a number of steps to simultaneously advance India's development and climate-related objectives of adaptation and mitigation hence adopting the approach of co-benefits. In principle, NAPCC aims at protecting the poor and vulnerable sections of the society through an inclusive and sustainable development strategy sensitive to climate change. NAPCC also envisions effective linkages with multiple government institutions and civil society and through public private partnerships. But if we take the case of State Action Plans of the first five states viz. Himachal Pradesh, Sikkim, Karnataka, Madhya Pradesh and Orissa as a reflection of NAPCC, which were formulated by Oct 2014 it has been either the nodal departments or sectoral working groups who have been involved in the plans leaving out again the scope for creative integration between the departments and sectoral groups. Due to the hitherto utilised support of external agencies for brainstorming on drafting the plans, a state's long term goal of developing their own capacity and know-how on CC never got realised. When it comes to implementation of SPACCs, efforts from the states have only been preliminary, reasons being reluctance to secure finance and limited institutional capacities for implementation[6].

Looking at the State Action Plan for Climate Change (SAPCCs) it is seen that they would provide an institutional platform for climate change policy at state level. However, at the nascent stages itself it is quite visible that the states have limited institutions for implementation of those plans. Additionally, the capacities of the institutions too are limited in order to implement climate change plans. At the same time, since there was no integration between the nodal departments and sectoral groups for formulating the plans, the institutions concerning climate change are still seen to be working in silos. This largely points to the disconnect between the existing institutions which will hinder the co-benefits approach for looking at climate change as envisaged under NAPCC.

NAPCC too argues for institutional convergence among the multiple ministries responsible for the 8 missions listed under the plan that includes Ministry of Water resources (responsible for National Water Mission) and Ministry of Urban Development (responsible for National Mission for Sustainable Habitat). Hence close convergence is needed between Ministry of Environment, Forests and Climate Change; Ministry of Urban Development and Ministry of Water Resources, River Development and Ganga Rejuvenation (earlier Ministry of Water Resources).

National Water Policy 2002 (post the first National Water Policy 1987) mentioned about institutional rearrangement in the water resources sector so as to give importance to maintenance of water resource schemes since they fall under nonplan budget of the government. The objective of the National Water Policy 2012 (NWP), formulated through a participatory approach, was to take cognizance of the existing

[5] ibid

[6] Dubhash N K, & Joseph A. 2014. 'From Margin to Mainstream? State Climate Change Planning in India', Economic and Political Weekly 49 (48): 86-95.

situation of water and, to propose a framework for creation of a system of laws and institutions and for a plan of action with a unified national perspective. The policy additionally mentions about institutionalising community based water management and highlights the significance of institutional arrangements to evolve consensus, cooperation and reconciliation among states on water security. Most of the state water policy (SWPs) followed the guidelines of NWP 2002 and placed significance on a coherent institutional arrangement for water management for efficient water security.

More than the content of the policy, it is the way the policies are formulated that matter. The framing of state water policies (SWP) depicts lack of translation of scientific knowledge into policy formulation. The XII Five Year Plan (2012-2017) highlights the need to move from engineering-construction perspective to a multidisciplinary understanding of water. Hence, it is visible that efforts are being made for a paradigm shift in the approach adopted to look at framing water policies.

8.2. Recognition of peri-urban in climate change and water policies

Having seen the broader overview of both climate change and water policies at centre and state level it would be crucial to highlight in brief as to if each of the policy brings peri-urban spaces into consideration as far as water security is concerned and also if each of the policies highlight the interdependency of climate change and water security. It is seen that NWP 2012 recognises impact of climate change on water resources and hence the need to adapt the same. This has been made possible due to taking cognizance of NAPCC 2009. When it comes to SWP and SAPCC, it is seen that some of the state water policy does highlight or rather recognise the impact of climate change but largely there is a disconnect between a state's water policy and action plan on climate change in terms of implementation for water security.

What is striking is that water security in peri-urban areas does not even find a mention in any of the policy documents. Accounting for the increase in the population does shape the requirements of water and hence peri-urban spaces which is a space slowly and gradually picking-up, demands attention. Since the policies mention about institutional arrangements for water security on one hand and on the other hand there is lack of institutional focus for peri-urban areas rather almost no institutions for the same. Hence there is a felt need for expanding the outreach of existing institutions around water management for peri-urban spaces. In trying to do so, building capacities of existing institutions would be extremely critical, so that instead of creating new institutions, existing institutions can be empowered to cater to the needs of the peri-urban spaces. In addition to this, since Govt. of Telangana is yet to draft its own state water policy apart from the SAPCC, the ongoing research would inform the need for inclusion of institutionalising water management for peri-urban spaces too.

9. FINDINGS OF THE SCOPING STUDY

This section discusses the conflict and cooperation cases in Gurgaon and Hyderabad based on the scoping study. The case studies try to address the research questions mentioned in the first section.

9.1. Case of Gurgaon

We start with the Gurgaon case, the case study discusses about the conflicts that has emerged in the study site due to three waste water canals which passes through four villages and the kind of cooperation that exists for the access and usage of the wastewater. As mentioned earlier for Gurgaon the unit of analysis is the canals, which has led to conflicts as well as cooperation among the villagers to access as well as use the wastewater. Based on the objective and research questions (see page 5) the following sections discusses the findings of the scoping study.

9.1.1. Cooperation in the use of wastewater; legal pluralism in wastewater access

Wastewater is an important aspect of rural-urban water flows. Ongoing research provides evidence of cooperation, 'forced cooperation' as well as conflicts in the use of wastewater. There exist multiple repertoires in the use of wastewater; both statutory and non-statutory forms of water allocation and distribution can be found in the field, pointing to the existence of legal pluralism. Farmers access wastewater by applying for the installation of a pipe outlet. This outlet is sanctioned by the Irrigation Department (the state) and water users pay for the outlet a meagre amount on an annual basis (Rs. 80 per acre of irrigation). A wastewater 'right' is thus created and this has an element of legitimacy in the institutions of the state[7]; applying for this wastewater pipe outlet is a way of legitimising the claim over the use of wastewater. However, once this outlet is approved and wastewater is released in the canal from the pipe outlet, the wastewater is distributed among the irrigators based on *bhaibandi* (a sense of mutual cooperation). This is done by diverting the flow of wastewater across the water courses to the adjacent fields. These fields can be located as much as a kilometre away from the pipe outlet. Local norms of cooperation govern the distribution of wastewater below the outlet. Once annually or biannually, members of a bhaibandi network contribute to the repairs and maintenance of the watercourses. The basis of this cooperation is physical proximity to the fields, rather than social relations. Many members are farmers who are not original inhabitants of the village, but have bought lands here and have given these lands out on tenancy or sharecropping arrangements.

Bhaibandi, or a feeling of mutual brotherhood based on social relations, represents a form of cooperation. Thus, wastewater allocation is sanctioned by the state, but its actual distribution is shaped by normative repertoires that have their legitimacy outside the institutions of the state. This is akin to the distinction between the concretisation of a water right and the materialisation of the water right in the water rights literature.

9.1.2. Forced cooperation' in the use of wastewater

There is also however 'forced cooperation' in the use of wastewater. The common perception about the use of wastewater is that on account of its high organic content, farmers prefer to use it for 2-3 years, after which they anticipate that the productivity of the land declines. This has been the experience of many

[7] By definition, a right has to do with some element of legitimacy, as against water acquisition, that could be through means recognised as legitimate or illegitimate (Pradhan and Pradahan 2000).

farmers interviewed in the course of this research. Given the content of wastewater, its use is associated with notions of impurity; though wastewater is understood to be used mainly on account of its impacts on agricultural productivity, most farmers interviewed were forced users of wastewater, on account of the loss of tubewells that happened when lands were acquired to build the NCR canal and the GWS channel. Among the four villages where the scoping study was carried out, only one had widespread use of wastewater, mainly for topographical reasons; the fields are low lying in a depression, and wastewater can be accessed through pipes at the bed of the canal; in the other three villages, the wastewater would have to be pumped to the fields, which may not make economic sense.

Wastewater is used mainly for the cultivation of paddy and wheat and the wastewater irrigated produce finds its way into the wholesale market. Farmers, however, who cultivate mainly for self-consumption, crops such as bajra (pearl-millet) avoid the cultivation of crops using wastewater. There are nevertheless cases where farmers would ordinarily not use wastewater but are forced to do so, as their neighbours irrigate using wastewater, so there is a possibility that the wastewater would anyway seep into their fields. All farmers have the autonomy to decide what crops they will grow; a common narrative in the field is "meree zameen, main kucch bhi boun (it is my field, I can grow whatever I like)". This autonomy in cropping choice is respected.

Wastewater is normally used for wheat or paddy and for commercial cultivation, and neighbouring farmers who grow for self-consumption must either allow the wastewater to seep into their fields, or force themselves to adopt its use. This can be seen to represent a case of 'forced cooperation' in the use of wastewater. There is of course, here, a case of a conflict of interest, if not an overt conflict, when a farmer who wishes to grow pearl-millet has his agricultural fields located adjacent to a farmer who uses wastewater for the cultivation of paddy. Since paddy requires standing water, this wastewater would typically seep into the fields of an adjacent farmer cultivating pearl-millet, who would have to accept it as a way of respecting the autonomy of crop choice of his neighbour. There would be a conflict of interest here, which would eventually become a case of 'forced cooperation'.

Some farmers interviewed in the course of this research were "forced" late adopters of wastewater irrigation, having to do so simply because their neighbours did so. Farmers whose lands are adjacent to the wastewater canal also have no choice but to use wastewater as a source of irrigation, because that water would anyway seep into their fields. Many farmers whose land is adjacent to the wastewater canal have reported decline in yields on account of the seepage from the wastewater canal. However, during the course of this research, an encounter was made with one farmer who would resist the use of wastewater since he only grew for self- consumption.

9.1.3. Conflicts in the use of wastewater

Conflicts and cooperation are not mutually exclusive. Conflicts can occur within overarching contexts of cooperation. With the use of wastewater, while there is cooperation within the framework of the bhaibandi norms, there can be occasional conflicts. These conflicts happen when the farmer who is irrigating using wastewater forgets to seal the outlet after the irrigation is over, causing the wastewater to spill over to his neighbours' fields. This results in quarrels and altercations. These however do not normally assume a very violent form and are resolved in a couple of minutes. These are, nevertheless, overt conflicts.

9.1.4. State policy and conflict with state authorities

Many farmers interviewed in the course of this research feel cheated by state policy regarding the supply of

wastewater. They had installed the pipe outlets assuming that this would be mainly the sewage water from Gurgaon. However, soon the industrial waste from Manesar was also mixed with this sewage water. Every third or fourth day, when there is a rich foamy discharge, farmers avoid irrigating from the wastewater canal, as this seems to be a sign that there are chemicals from the factories of Manesar (though officers of the Irrigation Department deny this claim). For farmers whose fields are damaged by seepage from the NCR channel, it is an important issue to seek compensation from state authorities, and a subject of some tension.

9.1.5. Impact of climate change: relationship between sudden changes in temperature and wastewater use decisions

Changes in climatic pattern add to a sense of water insecurity as they create some uncertainty about the watering days. With the change in climatic patterns, it is now difficult to decide on the watering days. For instance, during the course of this research, one farmer was interviewed who had intended to open his pipes towards the end of February for irrigating wheat. However, because of a sudden rise in temperature in the middle of February for about 3 days, he decided to open his pipes immediately; otherwise the wheat would wilt. If the sudden 3 –day hot period were, however, to revert to cold temperatures - characteristic of February - then the standing water in the fields would damage the crops and the soil. Because of this 3-day period of heat in the middle of February, many farmers who would have otherwise irrigated periodically now had to irrigate during those three days and faced the dilemma of what would happen if the temperature would revert to the low temperatures characteristic of February.

9.1.6. State policies and changes in rainfall patterns; exacerbating vulnerabilities of tenants and sharecroppers

State policies in the event of crop failure or damage caused by changes in climatic factors actually deepen inequity and the vulnerability of the tenants and sharecroppers. The research locations witnessed sudden rainfall in the months of February and March[8]. Rainfall at this time of the year is absolutely unusual and harmful for the Rabi (winter) harvest of wheat. Farmers interviewed in the course of this research reported a negative impact on their yield. The situation is even worse off for sharecroppers who have taken land on lease (in local parlance, these are known as kann-batai or peshagi arrangements). When land is taken on lease, sharecroppers make an up-front payment to the land-owner. In the case of crop damage or failure, they are unable to recover the amount. In a peri-urban context, tenancy arrangements are quite common, especially with the peri-urban elite, who often migrate to the city but maintain a hold on their rural assets – notably land – by giving them out on tenancy arrangements. When the crop fails, the impacts are borne disproportionately by tenants/sharecroppers.

Thus, in case of crop failure, the land-owners actually gain doubly; from the tenants who have already paid them while taking the land on kann, as well as receiving compensation from the state on account of crop failure. Thus, state policies for compensation in times of sudden high rainfall further exacerbate inequity between land-owners and sharecroppers.

9.1.7. New transactions along the canals and emerging forms of cooperation and conflict

The NCR channel and the GWS channel have been built to carry water to water treatment plants to meet

[8] Several media reports refer to this rain as freak rainfall attributed to global warming and climate change.

the needs of the city; residents of the villages through which these canals pass are not allowed to use this water. However, peri-urban communities have devised their own ways to gain from the presence of the canals and innovate technologically to benefit from this. Though in principle, farmers are not allowed to use this water for irrigation, in order to benefit from the rise in the local water table, tubewells are located near these canals. Water is then transported through underground pipes to far-off fields. Though farmers, in principle, allow these pipes to pass beneath their fields, as an aspect of their bhaichaara, very often there are conflicts and resistance around this, based on animosity.

An important new practice that has emerged is in renting out these tubewells for use of other farmers who can use the tubewell by paying for the diesel cost plus around Rs. 80 per hour of pumping. A common practice is also to buy a small plot of land adjacent to the canals that allows access to the sweet water. However, based on bhaibandi or social relations, farmers may also install tubewells on the fields of their friends or relatives without having to buy those lands, when these fields are located over 'good quality water', or next to the NCR channel or the GWS canal. This Represents another form of cooperation in the use of groundwater in peri-urban contexts. For some farmers, the rent for the use of the tubewell is also waived off, based again, on social relations. Increasingly, however, land-owners along the NCR channel and the wastewater canal are reluctant to sell of these small plots of land. These forms of cooperation, therefore, are actually in a state of flux and are weakened.

9.2. Case of Hyderabad

For Hyderabad, as discussed in methodology section 5 peri-urban villages were identified to conduct the scoping study. As the research questions discussed in section 3 guided the scoping study, therefore the findings of the Hyderabad case study are discussed to answer the research questions. The first three research questions are being addressed at the individual case level, and the study addresses the fourth question on adaptation and informed awareness towards water security combined for all the 5 peri-urban villages of Hyderabad.

9.2.1. Climate variability and water sharing across agriculturists

Telangana state falling in the semi-arid region has been frequented with droughts for the last two consecutive years. Coupled with rainfall of 444 mm in 2015 less than the annual average rainfall of 585 mm, Hyderabad region has witnessed a rainfall deficit of 38 percent, which together has led to the shift from land and water based livelihood to commercial livelihood or non-agricultural livelihood. This is found to be more visible in the villages next to the city where there is a rising demand for non-agricultural products. This scenario has been observed in all the 5 study sites.

Peddapur village, which is a part of the Peddapur gram[9] panchayat[10] in Sangareddy mandal[11] of Medak District, has 70 percent population that is dependent on agriculture. The village has experienced shift from traditional and rain fed farming to commercial farming just like other villages of India. Uniqueness of the village is that despite severe water scarcity there has been this shift to commercial farming. Only 5 percent of the land has been converted to nurseries, whereas the remaining 95 percent continue to do rain fed farming or grow crops like paddy, cotton and maize. This 95 percent includes both small and medium farmers and big landlords.

[9] Gram is a Hindi word which in English is translated as a village
[10] A village council in India
[11] An administrative division in India

The vulnerability dynamics indicate that it is the big farmers who are at stake. Commercial farming has high input costs and is capital, labour and water intensive which is practiced by big landlords or the medium and big farmers making them susceptible to losses. Climate variability, which is observed in the form of uncertainty in the rainfall, has affected the water resources, which is more pronounced in pockets where agriculture is the main source of livelihood. This village, which is predominantly an agrarian economy, was heavily dependent on surface water for irrigation till 1990's. Canal flowing from Malkapet Cheruvu[12] served as the major source of water for irrigation along with other cheruvus and kuntas. Peddakaluva cheruvu, Raavula kunta[13], Mazeed kunta, Kotha kunta, Thummu kunta, Kandha kunta, Thurma kunta are among the other sources of surface water. Visited by good and seasonal rainfalls these sources gave water adequate to meet the irrigation demand and the other village water needs.

As discussed earlier surface water sources served historically as the principal source of water. Hence there were traditional institutions in place, which historically governed the surface water sources and dictated the amount of water to be transferred to each land. Every villager abided by the word of these institutions whose heads were called neeradis[14]. But slowly with diminishing of water bodies these institutions also lost significance and now have completely dissolved. In the recent past there have been various schemes by the government to revive the traditional water bodies, but due to non-availability of water in these bodies such schemes have not received much interest and support from the people.

Around 400 acres and 350 acres of farmland in Peddapur was irrigated by Peddakaluva, and the canal water respectively in addition to the land served by kuntas. Apart from farming, these surface bodies were also the source of water to feed the livestock. Potters, washer men, and aquaculturists were among the others who were directly and indirectly dependent on these water bodies for livelihood. Apart from being as sources of livelihood, they were a source of water for sustenance. The villagers used water from kuntas for other domestic purposes whereas they depended on wells for drinking water. However with increasing climate variability, resulting in water scarcity had an impeccable bearing on these diverse communities and livelihoods that were dependent on these water resources.

9.2.2. Impact of climate variability, rise of latent conflicts and changing vulnerability dynamics

In the last 4 decades the village witnessed a rise in the nursery farming and also a shift from the traditional farming practices to commercial farming which were more profitable. There had been a major shift in the type of crops grown from paddy, green gram, Bengal gram, Red Gram, and Mug gram to chillies, cotton, paddy and corn. Since these high yield varieties were water intensive there was an extensive dependence on surface water for irrigation. Over the years drying up and vanishing of CPRs due to variations in climate conditions and encroachment of tank catchment areas led to the dependence on ground water and so there was a shift from dependence on CPRs.

Villagers report that for the past 6 years the canal from Malkapur cheruvu has remained dry, due to low rainfalls, thus restricting the farming done at these lands to rain fed crops. The land parcels on the ayicut[15] were given as gifted lands to the SC population and around 300 acres of this Ayicut land has remained fallow for the last 6 years or only rain fed farming is done. Rajaratnam who belongs to SC community says

[12] A tank or an artificial lake
[13] A pond
[14] Head of an informal institution that govern surface water bodies
[15] Land area that is supplied with irrigation water from the tank

that farming has now become an alternative source of livelihood and labour work is the main source of income. The other surface water bodies have either run dry or have water at shallow depths thus not serving the major purpose of irrigation. Few kuntas have already been filled and closed. The major reason attributed to this dismal condition according to the villagers is changing intensity in rainfalls, called in local language as athivristi[16] and anavristi[17]. Therefore this led to the decline in CPR dependence and led to extensive dependence on bore wells. By 2005 ground water was the major source of water for irrigation and domestic use.

Over the last 30 years heavy extraction of ground water not supplemented with sufficient rate of recharge has led to the lowering of water table. However the small and marginal farmers in the village who cannot afford to dig a bore well continue to practice rain fed farming. Therefore there is a presence of latent conflict between the two groups of those who continue to practice traditional farming and those who are commercial crop cultivators over dissatisfaction and differential access to water governed by the financial capacity of the individual. This kind of conflict is aggravated by conditions of drought as the states of Telangana and Andhra Pradesh have been severely affected by drought in the last two years.

Though it is known that both the groups are vulnerable to such drought situations it is the big farmers who are more vulnerable to these climatic variations. Since there is huge capital investment in this kind of farming, these farmers by any mean try to get the returns to cover their investment and therefore are more vulnerable to such variations in climate. Unseasonal rainfalls, late onset of monsoons and high temperatures are affecting the crops reports a farmer who currently cultivates cotton, and chilly in his farm. In addition to this he says the profitability is very uncertain, as untimely rainfalls are affecting the crop growth and the duration of monsoon has reduced from 4 months to 1 month. The villagers report that the cropping seasons have reduced from 3 to 1, and for those who cannot afford to dig a bore well in the farm are forced to do only rain fed farming or to leave the land fallow. This condition has led to diversification into other activities such as nurseries, as they are found to be more profitable.

Nursery farming is also not any more profitable say the villagers. Peddapur village was once the major supplier of mango crops in different variants to Karnataka, Orissa and other states. There were bulk purchases made by these state governments. From last year the sales have gone down say the villagers and because the crops are being stationed in the nursery for long the water requirement is also huge and there is no place for the other small crops, thus affecting the business.

Apart from farming the other livelihood dependent activities have suffered. Non-availability of water for livestock is the major reason report villagers for decline in the number of cattle and livestock in the village. All these factors have impacted the livelihoods of the villagers. There has been a significant rise in tenant farming especially in the case of marginal farmers for whom cultivation in small parcels of land is not profitable any more. Few of them have shifted to working as labours in industries, and a very small percentage of population have moved to the city.

The village has also witnessed drought driven in migration from the surrounding villages and rural areas, which find work as laborers in the nurseries thus competing with the local villagers in terms of employment. Though not expressed in the form of conflict the small and the marginal native farmers who find it difficult to make a living express their dissatisfaction over the presence of migrants in the village who get employment.

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[16] Excess of rain or flood

[17] Drought

9.2.3. Community versus industry over the pollution of water sources by industrial effluents

Edthanur Gram Panchayat and Chitkul Gram Panchayat form a part of Sangareddy and Patancheru Mandal of Medak District respectively, and are located at a distance of 4 km and 1.5 km from NH 9. They fall under the jurisdiction of Hyderabad Metropolitan Development Authority, HMDA. Gram Panchayat of Edthanur comprises of Edthanur village, Edthanur Thanda[18], and Ippalagadda Thanda, whereas Chitkul Gram Panchayat comprises of Chitkul village and the Mulogi Hamlet. This area which was predominantly an agricultural landmass had experienced rapid transformations in the 1970's, as a consequence to the government's initiative of setting up an industrial area to bring in Foreign Direct Investment, FDI. These villages are located in the Patancheru Industrial belt and house a number of industries dealing with the production of pharmaceuticals, cotton and synthetic yarn, and engineering goods. This area forms a part of the catchment of Nakkavagu, a tributary of the Manjira River, and lies along the banks of two other streams i.e. Pamulavagu and Peddavagu.

These villages were basically agrarian societies, while livestock farming was also a source of livelihood for few. They majorly cultivated paddy along with other rain fed crops. Falling under the tropical semi-arid climatic zone, since the area receives low and unreliable rainfall, they were traditionally dependent on surface water sources i.e. Nakkavagu and cheruvus as the only source of water for irrigation, drinking and other domestic purposes.

Anajpur in Hayatnagar mandal also stands as an example which bore the brunt of industrialisation. Being home to one of the largest film city of Asia, and Sanghi industry, the water sources in the village have suffered in terms of quantity and quality. With waste water from Ramoji Film City, RFC being diverted into the village and the effluents released from the industries has affected the farm yields and made the water unusable for drinking. The impact of the industries on the water resources of the village quantitatively has an interesting background. A check dam was constructed upstream near Sanghi industry in 2005, at a level above the permissible height. The villager's upstream report that it was a political play due to which the approval was given for construction. Villagers report that because the dam is constructed at a greater height water doesn't flow down to cheruvus in the village unless there are heavy rains for long periods of time.

In Chitkul water from Nakkavagu was directly tapped and used for irrigating lands that were along the stream. Peddacheruvu was another major source of water for Chitkul. Likewise Edthanur was majorly dependent on Turkam Cheruvu to meet the water demands in addition to four kuntas. The history of this cheruvu can be dated back to 200 years and since then these have been serving as the fundamental source of water to the natives. In Edthanur around 2000 acres of farmland was irrigated by the Cheruvu and kuntas, whereas in Chitkul the farmland that was irrigated by Nakkavagu, Peddacheruvu and the kuntas was 500 acres. Apart from being as sources of livelihood, they were the only source of water for sustenance. The villagers used the cheruvu and Nakkavagu water for drinking, and other domestic purposes.

9.2.4. Impact of climate variability and industrialisation

These villages who were once rich in water sources slowly became victims to climate variability which was exacerbated by industrialisation. The villagers have reported low rainfalls, high temperatures, late onset of monsoons, decreased duration of monsoon to the falling water tables and low water level in Turkam Cheruvu and Peddacheruvu. The complete vanishing of Turkam Cheruvu has resulted in lands being left

[18] A Place where only Banjara or Lambada community live

fallow, and the village reports also show a steep fall in the cultivable area over the past 10 years. Few farmers had begun to depend extensively on ground water for cultivation which over the recent years has brought forth issues of water quality. In Chitkul the impact of climate variability is strongly felt in the form of falling water tables, and has been increasingly felt by the aquaculturists who were heavily dependent on Peddacheruvu. These climatic changes accompanied by the negative impacts of industrialisation had brought see through changes in the landuse and livelihood dynamics in the village.

The advent of industrialisation had completely changed the dynamics of these villages. Industries started coming up in the village surroundings, and within the village boundaries. This led to the acquisition of large parcels of village land that was under cultivation. Hindustan Fluorocarbons Limited, HFL a central government undertaking in 1981 and Al Kabeer Exports Private Limited in 1991 were set up near Edthanur that led to a major change in the dynamics of Edthanur. Chitkul is engulfed by three industries Gem Cables and Conductors and GTN cotton industry that were set up in 1982, and Aurobindo Pharmaceutical Limited in 1987.

Around 63 acres of agricultural land was acquired by the industries in Chitkul village at a price of Rs 8000/ acre. The villagers report that they haven't shown much resistance because they were heavily dependent on Nakkavagu for irrigation which was already polluted by then because the major source of its contamination was the industries in Patancheru which had come in early 70's. By early 80's the water was very polluted and farms started giving low yields and initially they lost complete yield for 3 consecutive years unaware of the fact that the foam floating on Nakkavagu was chemical and toxic. With a perception that there will be no buyers for these lands and that farming in such lands was not any more profitable, they sold away their lands to the industries.

Cheruvus and kuntas in the vicinity of these industries over the years turned into cesspools of waste. Al Kabeer Slaughter house and Toshiba located next to Ippalagadda thanda release their waste into the kunta located in the thanda which flows downstream and joins Turkam Cheruvu, which further flows downstream to join Nakkavagu. Polluted water from Paashamailaram industrial estate flows into Isanpur cheruvu and from there water was released to Peddacheruvu, thus heavily contaminating the water while drainage water and influx of the rejects of Aurobindo into Gullakunta and Yerrakunta made the alternative source for Chitkul unusable. High levels of toxic substances and metals such as copper, arsenic, lead and mercury were found in the stream. Degradation of water quality coupled with low rainfalls added to the woes of farmers. Therefore dependence on these common property resources slowly started degrading, that had put people's livelihood on serious threat.

As a response to this people started depending extensively on ground water. Over time there was a realisation that the ground water too was polluted with toxic chemicals, which has led to lands being left fallow, paddy plants getting infected before harvest, high burnt rate of seedings and only rainfed crops or those like jowar are majorly grown. Not just irrigation but livestock and aquaculture have suffered equally. There are records of death of cattle due to the consumption of polluted water in Edthanur. Currently the villagers need to a travel a distance of 3 to 5 kms to water the livestock, and these area have seen a significant decrease in the livestock dependent population, because of the threat posed by water.

Villagers whose major source for sustenance and other domestic needs was these CPRs have suffered terribly due to their degradation. They initially started using ground water to meet their drinking and domestic needs. When the ground water became unusable, in the interim period there was heavy dependence on water tankers in Edthanur, whereas in Chitkul a well was dug that served the drinking purpose, which was later supplemented with piped water supply after staging a number of protests. Since

the Manjeera water is not adequate, they continue to use ground water for other domestic purposes. In Chitkul the area has witnessed a steep rise in population since 2005, due to in migration of labour. The pipelines (1½ inch) that were laid in 80's for Manjeera water was not sufficient to meet the drinking water demand. A RO plant was therefore set up that purifies the ground water, and around 150 bottles of 20L capacity are consumed by the villagers. For domestic needs they continue to depend on ground water.

9.2.5. Changes in livelihood

Prior to industrialisation those people that owned large parcels of land have now become marginal farmers. Acquisition of land for industries, and selling away of land due to its low productivity and financial stress in the families, left majority of villagers with few cents of cultivable land. Ramulu, who was a dhobi and a resident of Edthanur village, says that "I do multiple jobs of tenant farming, aquaculture and washing of clothes in order to feed me and my wife. Our lives here are miserable and the next generation here will see no water if this situation continues."

Currently large parcels of farmland in Edthanur village and Chitkul are owned by elites who live in the city. Among the local population there are only 5 to 6 big land owners in Chitkul that still hold around 10 acres of land, the remaining are left with just few cents. In Edthanur these lands are being cultivated by the tenant farmers who are none other than those who have sold their own land to these elites.

Chiktul has experienced a rise in the feminisation of labour force, with around 50% of local women working in the nearby industries. This whole process has led to the emergence of illegal practices for making a livelihood. A number of local villagers are involved in sand filteration along Nakkavagu. In Edthanur a small brick making plant has been set up in CPR area of the Panchayat, in nexus with the local Panchayat without the possession of license. On the health front though the evidence is anecdotal, abortion rates have increased, stunted growth has been reported among children, and increased incidence of skin diseases. Dr. Kishan Rao said that toxic chemicals were found in mother's milk.

9.2.6. Conflicts and contestations

The genesis of people's movement can be dated back to late 1980's in Patancheru. A local medical practitioner Dr. Kishan Rao along with Prof. Purushottham launched an awareness campaign in the presence of representatives from affected villages in Patancheru industrial belt. Along with the affected communities they formed the Pantancheru Anti- Pollution Committee, PAPC. In the initial years the committee very actively protested against the illegal dumping of industrial effluents, staged dharnas and asked them to curb the pollution.

In the year 1987, around 2000 people from Patancheru marched from Tank Bund to the AP State Assembly and presented a list of demands to the then chief minister N.T. Rama Rao, recalls the ex sarpanch of Chitkul, Mr. Mallareddy. Some of the demands included the construction of an effluent plant for each industrial unit, adequate compensation for degraded agricultural land and supply of safe drinking water to effected villages. PAPC's continued pressure resulted in the District Magistrate serving notice to 22 industries in Patancheru, and the committee was asked to make an estimation of the monetary loss borne by the farmers. The High Court set a deadline for September 1987, to build individual treatment plants, and the order was not complied with. The PAPC then started its second phase of protest by staging a dharna on NH9 by blocking the route with 500 bullocks. In October, the farmers filed a petition in the Andhra Pradesh High Court against 20 of the 22 polluting industries, and the judgement went in favour of the industries.

In 1992 the committee approached the Supreme Court. After a decade long battle the Supreme Court appointed National Environmental Engineering Research Institute, NEERI to conduct a thorough study of pollution in Nakkavagu basin and evaluate the losses to the affected villages. They followed a scientific method for evaluation by considering crop damage, loss of water resources, cattle loss, equipment damage, and loss to fishermen and washer men and the evaluated amount was 32,00,00,000 for a period of 7 years from 1984- 1991. But their evaluation was not considered, and the District Judge was asked to reassess the loss, and the amount evaluated was Rs. 1,00,00,000 for 4 years, which was dispersed in 14 villages. The criterion followed by them for assessment was all those farm lands within a distance of 100 metres from Nakkavagu would be compensated. This was an unscientific way of assessing the loss and impact, and it is not compensation but a transient monetary relief says Dr. Kishan Rao. The Court then ordered compensation to the affected families has to be paid by the polluting industries, and directed the local authority to supply safe drinking water to the affected villages.

The representatives of Chitkul and the then sarpanch Mr. Sudhakar Reddy were actively involved in the movement. Mr. Sudhakar says that only 13 of 120 land owners eligible for compensation had applied due to a fact that the amount evaluated was meagre and it would involve number of tedious activities. Compensation for 120 acres of farm land in Chitkul was evaluated at a price of Rs. 1300/ acre for a period of 3 years from 1987-1989. Dr. Kishan Rao says that the amount didn't even cover the seed cost, and the compensation was evaluated only for patta holders, and others including tenant farmers were ignored. After a series of protests the villagers were supplied Manjeera water by RWSS. There was also an effluent plant that was constructed but discussion with few key informants has revealed that this plant was designed to treat domestic waste into which industrial waste is being pumped and treated, which is a gross violation. This kind of conflict between the villagers and the industries has given rise to an organised dialogue and therefore has led to co-operation due to which to some extent their pleas have been answered.

After a protest for 2 decades the committee and the activists have become passive. Prof. Vijay comments that the authorities have been safeguarding and passing judgments in favour of the industries, and the villagers who are seen as weak, ineffective and small proportion of population are being ignored.

The case of Anajpur represents the presence of latent conflicts between the village community and the industry. The construction of check dam near Sanghi industry at a level higher than the permissible height was the reason of this conflict, which according to villagers was the reason for water not flowing down to the surface bodies in the village. There had also been strong contestation by the owners of farm land along the highway which was affected due to the flow of contaminated water from the same industry. They staged a protest at the industry demanding for a solution to the problem. The issue was later subsided when the industry offered compensation to the owners and later bought those land parcels from the villagers. In another case of cooperation in Anajpur the villagers built a check dam on chinnavagu after taking consent from the upstream and the downstream land owners. This later turned to a conflict between the upstream and the downstream farmers.

9.2.7. Water sharing and water transfers from peri-urban to urban areas

The transformation of peri-urban areas from rural to a more urban character is characterised by change in the employment from agricultural allied activities, changes in the land use, feminisation of labour, disappearance of surface water bodies, prevalence of commercial agriculture etc. In addition to these the peri-urban areas are source of water for urban areas, and also house the major service lines going to the city, such as water mains. An example of this is Peddapur Village situated along the National highway 9

located in Sangareddy Mandal of Medak district in Telangana and Bowrampet village in Qutballapur Mandal of Rangareddy district.

Peddapur village is home to one of the biggest filter station set up by Hyderabad Metropolitan Water Supply and Sewerage Board, HMWSSB way back in 1975. It receives water from the Manjeera reservoir and the treated water is supplied to the Hyderabad city. Spread over an area of 165 acres which was once a fertile cultivable land, the huge plant which is a source of drinking water for the entire city does not supply water to the village in which it is stationed.

Bowrampet is an example of a peri-urban area which has witnessed large quantities of water being transferred through tankers. Big landowners and the affluent community belonging to the Reddy caste have dug borewells in their agricultutral farms and plots from where the water is extracted. Hundreds of tankers carrying this water go out of the village daily, supplying water to the surrounding residential urban areas, industries, educational institutions as well as for agriculture. Over the years, farming became a secondary source of livelihood, and the tanker business was the main livelihood source as it was more profitable. Majority of this was sold outside the village as it was more profitable. Such extraction and selling of water outside the village, led to dissatisfaction for those who had limited access to water.

These villages over the years have become water stressed due to drying up of both surface and ground water sources. Thus this situation has given rise to conflict between the supplying station and the water deprived villagers as in the case of Peddapur and between the water tanker suppliers and the other villagers who have limited access to water in Bowrampet.

9.2.8. Changing dependence for domestic water, water shortages and the resultant conflicts and cooperation

Climate variability observed in the form of late onset of monsoons, low and scanty rainfalls and seasonal shift in and around Hyderabad area has led to the shrinking of surface water sources, and fall in the ground water table. This has posed severe implications on domestic and drinking water availability in these areas with a greater stress on such peri-urban villages which have been serving as the source of water for the urban areas, thus declining their own residents from sufficient water availability. These general observations have been verified through interactions with the residents of Peddapur which revealed that by the year 2005 dug wells completely vanished, and the major source of domestic water was borewells, and so is the case with Bowrampet.

In order to cope with the severe water crisis, in the recent past Bowrampet panchayat has dug new bore wells around the village. With only 3 bores being functional Panchayat is trying to supply water by supplementing with tanker water bought from outside. The sources of drinking water are RO plants, one run by the Panchayat and the other by a private company. Water is purchased from these plants at the rate of Rs. 5 and Rs. 7 per 20L can from the govt. and the private RO respectively. Their demand for water is not being fulfilled nor are their needs met. The water supplied is just enough to survive as the supply is erratic and once in 6 days, while in summer seasons the problem is more intense.

Major source of water in Peddapur is ground water, tapped through bore wells. While the supply is regular, villagers complain of the quality due to higher fluoride content, and also there have been records of kidney disorders. 80 percent of the villagers fetch drinking water (25 L cans) from the filter plant, through a single tap. It is men who go to fetch water, given that the filter station is at a distance of 4 km from the village. For those who don't have any means of transport this act of fetching becomes cumbersome, and the aged and no vehicle owners depend on ground water for drinking.

Severe drought conditions prevalent in the state in the past 2 years have led to the intensification of the ongoing negotiations and conflicts, and the conversion of latent conflicts into violent ones. An event of borewell seizure in Peddapur after a quality check performed by RWSS was the starting point that initiated the conflict. With a realisation that came in slowly of the poor water quality in the village, the struggle and negotiations with the filter plant started 10 years back which is still underway. Though the HMWSSB has agreed to lay a pipeline in the village, the plant is now only partly operational due to water shortages and it is expected to shut down shortly. Through interactions with the villagers it is known that the villagers with the support of local MLA have laid an illegal pipeline by tapping from the water mains.

Dalit women also report of conflicts between them and the upper caste men at the filter station, on their turns to fill water from the tap. They submissively give way to the men to fill first. The struggle that had started 10 years back shows an example of cooperation among the villagers which has resulted into an organised dialogue with the water board, and which has intensified in the last two years due to water shortages.

The case of Bowrampet shows violent conflicts between the water tanker sellers and the other villagers over water being extracted from the village and sold in the surrounding areas. Though the practice of water selling started 5 years back, the dissatisfaction and internal conflict has shaped into violent conflict only in 2014, with increase in water scarcity. These conflicts have taken shape in the form of protests and blockage of tankers from moving out of the village. After several protests the water vendors and the Panchayat entered into an agreement, wherein the vendors agreed to supply tankers free of cost to the Panchayat on a weekly basis. This supply was done only for a few months post which they stopped the supply. This initially subsided the conflict which again revived in 2015 when there was acute water shortage. This conflict is clearly along the lines of power and wealth with the poor losing out of both their right and access to water.

9.2.9. Role of adaptation and the need of informed awareness building towards water security

This is the fourth research question of the scoping study. The discussion below tries to address the issue of adaptation and need for awareness building for all the five cases of per urban Hyderabad.

Perception based investigation on the issues suggests that the indigenous residents of peri-urban areas have followed some coping strategies to overcome the water related problems, rather being adapted to certain situations. However, there are evidences that the farming practices in these villages, undergone drastic changes due to climate uncertainty and growing demand of goods and services in the two twin cities. As an adaptation strategy, on some extent, these villages have experienced technological and biological innovation in farming system through heavy mechanisation and excessive use of chemical fertilisers and pesticides respectively, though not sustainable for agro-ecology of the region in the long run. Also, there has been a shift from agricultural practices to other alternatives of livelihood among villages collectively due to climate change, urbanisation, industrialisation, land acquisition and resulted decay of CPRs including water resources. As a result, livelihood pattern has diversified many fold in previous two decades. To increase the purchasing power, influenced by urban inflation, villagers have now coped up with the commercialised farming system through heavy production of vegetables, flowers,nurseries, cotton and other cash crops which has led to further degradation of ground and surface water resources. Also, climatic uncertainty has increased the dependency of farmers on ground water and alternative irrigation systems such as community based wastewater irrigation system, as it was observed in

Peddapur village. For domestic and drinking water farmers have followed coping strategies at various levels. For instance, as the traditional water bodies (i.e. wells and surface water bodies interlinked with each other in a cascading system) has disappeared collectively due to climate change, urbanisation, industrialisation, land acquisition and encroachment, the villagers are now readily using water through tankers in all the four peri-urban villages. It was reported that in peri-urban villages of Peddapur and Bowrampet, village community has both public and private water purifiers which are partly paid by Gram Panchayats and partly by the villagers at minimal cost. In Bowrampet, as a short term coping strategy, have brought changes in their way of living and daily routine due to sever water problem. A 65 year old man from the village stated, "We have money to pay for water but do not have access to it. In this year the problem has been so acute that we do not have water even for daily routine work. In summers, it becomes Even more sever."

Situation analysis accentuates for a need of informed awareness building towards water security in peri-urban villages as it seems that villages are in the initial phase of coping up with severe problems related to water supply. There is a need to bring the village community together to participate in the awareness programmes. All sections of rural society has to be a part of community based initiative to rejuvenate, then protect the surface water bodies and traditional wells. One alternative long term sustainable coping strategy could be the construction of rainwater harvesting system within the household and at the community level to prevent surface runoff and ensure restoration of surface water bodies and aquifers.

10. Conclusions

Based on field observations, multi-stakeholder consultation meetings, discussions and interviews with the government officials, researchers, practitioners in the selected case sites of Gurgaon and Hyderabad following conclusions have been derived.

Gurgaon

Cooperation and 'forced cooperation' in the use of wastewater

- Wastewater is an important aspect of rural-urban water flows. There is evidence of both cooperation, 'forced cooperation' and conflicts in its use, under multiple legal-institutional repertoires; both statutory and non-statutory forms of water allocation and distribution can be found (legal pluralism). Farmers access wastewater through pipe outlets, sanctioned by the state Irrigation Department. A wastewater 'right' is thus created with legitimacy in the state. However, once wastewater is used, it is distributed among irrigators based on bhaibandi (brotherhood; mutual cooperation). Members of a bhaibandi network cooperate in maintenance of the watercourses, on the basis of physical proximity to the fields.

- There is also 'forced cooperation' in the use of wastewater. On account of its high organic content, farmers prefer to use it for 2-3 years, after which they anticipate that the productivity of the land declines. Its use is associated with notions of impurity. Most farmers felt forced to use wastewater because of the loss of tube wells. Among the four villages where the scoping study was carried out, only one had widespread use of wastewater, mainly for topographical reasons (low elevation of fields).

- Wastewater is used mainly for the cultivation of paddy and wheat. The wastewater irrigated produce finds its way into the wholesale market. However, farmers who cultivate mainly for self-consumption tend to avoid using wastewater. There are also cases where farmers would ordinarily not use wastewater but are forced to do so; for instance, if their neighbours irrigate using wastewater, the wastewater may seep into their fields as well.

Conflicts around the use of wastewater

- Conflicts around wastewater tend to develop in a broader overall context of cooperation, such as when irrigating farmers forget to seal the outlet after irrigating their land with wastewater, causing the wastewater to spill over in other farmers' fields. These are usually not very violent or protracted conflicts, that can be solved relatively easily.

- Many farmers feel cheated by state policy regarding wastewater supply. They had expected to receive sewage water from Gurgaon. However, soon this was mixed with industrial waste from Manesar (though officers of the Irrigation Department deny this). Farmers whose fields are damaged by seepage from the NCR channel regularly seek compensation from state authorities, a subject of some tension.

The impact of climate change

- Perceived changes in climatic patterns and climate variability add to a sense of water insecurity, as they may create uncertainty about the crop watering days. With the changes in climatic patterns experienced and interpreted as such by farmers, it is difficult to decide on the watering days. Sudden rises in temperature may induce farmers to immediately irrigate, while a reversal to cold temperatures

in combination with water in the fields may severely damage crop and soil.

- State policies for crop failure or damage caused by changes in climatic factors actually deepen inequity and increase the vulnerability of tenants who lease or sharecrop land in particular. In a peri-urban context, tenancy arrangements are quite common, especially with the peri-urban elite, who often migrate to the city but maintain a hold on their land through tenancy arrangements. Sudden rainfall in February / March ('freak rainfall', often associated with climate change) damages the winter crops. The impacts are borne disproportionately by tenants. Landowners actually gain doubly: from the tenants who have already paid them, and from compensation for crop failure by the state. Thus, such policies exacerbate inequity between land-owners and sharecroppers.

New transactions along canals: conflict and cooperation

- The NCR and GWS channels have been built to carry water to treatment plants to meet the needs of the city; residents of the villages through which these canals pass are not allowed to use this water. However, peri-urban communities have devised their own ways to benefit from the water. Though, in principle, farmers are not allowed to use this water for irrigation, tubewells have been installed near the canals in order to benefit from the rise in the local watertable. Water is then transported through underground pipes to far-off fields. Though farmers, in principle, allow these pipes to pass beneath their fields (bhaichaara), often there are conflicts around this, based on animosity.

- An important new practice is renting out these tubewells by other farmers, against payment for the diesel cost plus around Rs. 80 per hour of pumping. A common practice is also to buy a small plot of land adjacent to the canals that allows access to the sweet water. Based on bhaibandi or social relations, farmers may also install tubewells on the fields of their friends or relatives without having to buy those lands, when these fields are located over 'good quality water' or next to canals. This represents another form of cooperation around groundwater in peri-urban contexts. Increasingly, however, landowners along the NCR channel and the wastewater canal are reluctant to sell plots of land. These forms of cooperation, therefore, are in a state of flux and are weakening.

Hyderabad

Water-related contestation, conflict and cooperation

- Differential use, access and sharing of surface and groundwater water resources have resulted into contestations, potential conflicts and cooperation in peri- urban Hyderabad. Contested water use across different caste, class and occupational groups are more latent in nature in the case of irrigation. Such conflicts seldom take an aggressive turn, particularly if it is between upstream and downstream users of a check dam or between commercial and traditional farming groups. Many conflicts get resolved temporarily with the intervention of village doras (landlords), or forcefully suppressed by more powerful parties through compensation and informal agreement.

- Violent agitation and protest movements can be seen with potable and non- potable water use between peri-urban and urban areas, particularly across farmers, industries and local governments. Resolution of such disputes often involves statutory laws, punishments, and compensation by court. Cooperation, on the other hand, ranges from informal groupings of particular communities or households to secure their water needs, to more 'informed cooperation' inthe form of formal petition,

consultation, dialogue and negotiation undertaken by NGOs and civil activist groups. However whether conflicts will remain as petty fights across different contending uses or will be transformed into 'informed cooperation' depends on power politics, caste and leadership.

Climate, urbanisation and changing livelihoods

- The late onset of the monsoon and successive droughts for the last 20 years coupled up with rapid urbanisation and industrialisation from the 1990s has resulted in acute water scarcity for livelihood-related activities like agriculture, livestock, aquaculture, pottery, etc. Severe droughts have accelerated a job shift of the irrigation functionaries of dalit origin and other backward communities, following the rapid development of non-agricultural sectors. Two kinds of conflicts can be seen with regard to irrigation water use: first, between traditional paddy cultivators of tank irrigation system and borewells irrigators practicing water intensive commercial agriculture like floriculture and vegetable gardening; second, between farmers (Reddy and Velama community) essentially selling groundwater from their private borewell and farmers who does not have the access to groundwater as they do not have borewells.

- Traditional tank irrigation system started collapsing where in three to five out of every ten years tanks fail (with no water at all) and in two years tanks under- perform (with insufficient water for irrigating all the command area). Farmers in Anajpur village reported that Indirammasagar cheruvu, the most important source of water for the village reached its full tank level only in 2013, after nine years. Withering of such valuable surface water bodies has a direct bearing on the wet paddy irrigation system undertaken in the tank command area. Lack of water in the tank has resulted in reduction in the cropping season from three to one each year.

Water transfers, water quality and water allocation conflicts

- The expansion of water tanker markets is one of the critical means of rural- urban water transfer. Extensive mining of groundwater by big landowners in villages like Bowrampet has an adverse effect on the groundwater aquifer, affecting the life and livelihood of the majority of the villagers. Disputes andagitation often lead to contestations and conflicts between farmers selling water, who are often very few, and the rest of the villagers. Some households cope with the situation by depending on private water suppliers such as tankers. Those who are unable to cope with shortage dispute with the panchayat.

- Conflicts revolving around water quality are particularly observed in Chitkul and Edthnoor village, where industrialisation from the 1980s has resulted in heavy pollution of both surface water and subsurface aquifers. Water quality conflicts are more complex, as several stakeholders like the community, industries and local government are involved in the process, and compensation is never enough to cover the loss of life and property. Two decades of consistent protest by the villagers have resulted in securing water for Chitkul and Edthanur. However, compensation paid to 14 villages affected by heavy industrial pollution of the Nakkavagu river did not even cover seed costs for the farmers.

- Conflicts around drinking water scarcity in peri-urban areas are more prominent between communities and the local government, and reflect absence of clear-cut norms of equitable water allocation and distribution in these transitional areas. Allocation norms have evolved according to

local situations, size and nature of projects and historical socio-political relations. Such dynamic and transitory areas that lack government recognition and effective institutional arrangements, particularly with regard to water supply, fall prey to misallocation. Peddapur provides a classic example of conflicts related to equity, access and allocations by the Water Board of Hyderabad (HMWSSB). The struggle has been going for ten years. With the present TRS government there is hope among the villagers that their long-standing contestations will turn into an agreement with the municipal government.

Cooperation at the micro level is seen in the form of collective sharing of tanker water by group of households in Bowrampet and building a checkdam at Chinnavagu rivulet in Anajpur. More formal cooperation in the form of petition, revolt and movement can be seen with the demand for Manjeera water supply by the villagers of Peddapur and compensation for pollution of Nakkavagu river by Chitkul and Edthanur.

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Annexure tables

Table A 1- Status of towns and villages under HMDA/ HMA, Census 2011

District/ Area	Village	Municipality	GHMC	Census	Cantonment
			Blocks	Town	Board
Hyderabad	0	0	15	0	1
Nalgonda	111	1	0	3	0
Ranagareddy	383	0	13	18	0
Medak	248	2	2	0	0
Mahbubnagar	48	0	0	2	0
Total HMDA	790	3	30	23	1

Source: Primary Census Abstract, Andhra Pradesh, Census of India, 2011.

Table A 2 - Status of towns and villages under HMDA/ HMA, Census 2001

District/ Area	Village	Municipality	HMC	Census	Cantonment
				Town	Board
Hyderabad	0	0	1	0	1
Nalgonda	113	1	0	1	0
Ranagareddy	413	12	3	5	0
Medak	256	1	0	6	0
Mahbubnagar	45	0	0	1	0
Total HMDA	827	14	4	13	1

Source: Primary Census Abstract, Andhra Pradesh, Census of India, 2001.

Table A 3 - Variables used for mapping blocks/mandals in HMA

Description of Variables in PCA	Variables	Data Source and Year
PCA 1- Index of Macro-economic Growth	Level of Urbanisation (%)	Primary Census Abstract, Census of India, 2011
	Density of Population (per sq. km)	Primary Census Abstract, Census of India, 2011
	Percentage of Non-Agriculture Sector in Total Main Workforce	Primary Census Abstract, Census of India, 2011
PCA 2- Index of WASH, Housing and Household's Micro-Living Environment	Percentage of Households having Roof Made up of GI, Metal, Asbestos and Concrete	Primary Census Abstract, Census of India, 2011
	Percentage of Households having Drainage System for Waste Water	Primary Census Abstract, Census of India, 2011
	Percentage of Households using Kerosene, LPG/ PNG or Electricity for Cooking	Primary Census Abstract, Census of India, 2011
PCA 3- Index of e- Readiness	Percentage of Households having Computer/ Laptop	H-Series, Census of India, 2011
	Percentage of Households having both Landline and Mobile Telephone	H-Series, Census of India, 2011
	Percentage of Households having Television	H-Series, Census of India, 2011
PCA 4- Index of Ground Water Use	Percentage of Gross Cropped Area under Non-Food Crops	Agricultural Census of India, 2010-11
	Percentage of Gross Cropped Area Irrigated through Ground Water	Agricultural Census of India, 2010-11
	Stage of Ground Water Development (in Percentage)	Central Ground Water Board, Ministry of Water Resources, GOI, 2009

Table A 3 - Variables used for mapping blocks/mandals in HMA

Attributes	Cluster Mean		
	Periurban to Urban	Periurban to Periurban	Rural to Periurban
Index of Broad Economic Growth Attributes	2.85	1.09	-.59
Index of Housing and Household's Micro- Living Environment	1.38	1.20	-.58
Index of e-Readiness	1.64	1.24	-.61
Index of Ground Water Use	5.25	.01	-.20

Table A 5 – Peri-urban interface within HMA, year 2011

S. No.	District	Mandal	Area Name
1	Hyderabad	Hyderabad	Core Urban
2	Medak	Ramchandrapuram	
3	Rangareddy	Balanagar	
4	Rangareddy	Ghatkesar	
5	Rangareddy	Hayathnagar	
6	Rangareddy	Keesara	
7	Rangareddy	Malkajgiri	Urban - Periurban
8	Rangareddy	Quthbullapur	
9	Rangareddy	Rajendranagar	
10	Rangareddy	Saroornagar	
11	Rangareddy	Serilingampalle	
12	Rangareddy	Uppal	
13	Mahbubnagar	Kothur	
14	Mahbubnagar	Farooqnagar	Periurban - Periurban
15	Medak	Jinnaram	
16	Medak	Patancheru	
17	Medak	Sangareddy	
18	Rangareddy	Moinabad	
19	Rangareddy	Ibrahimpatnam	
20	Rangareddy	Maheswaram	
21	Rangareddy	Medchal	
22	Rangareddy	Shamirpet	
23	Rangareddy	Shamshabad	
24	Nalagonda	Choutuppal	

S. No.	District	Mandal	Area Name
25	Nalgonda	Bhongir	
26	Medak	Hathnoora	
27	Medak	Narsapur	
28	Medak	Wargal	
29	Medak	Sadasivpet	
30	Medak	Mulug	
31	Medak	Shivampet	
32	Medak	Tupran	
33	Rangareddy	Chevella	Periurban - Rural
34	Rangareddy	Kandukur	
35	Rangareddy	Manchal	
36	Rangareddy	Shabad	
37	Rangareddy	Shankarpalle	
38	Rangareddy	Yacharam	
39	Nalagonda	Bibinagar	
40	Nalagonda	Bommalaramaram	
41	Nalagonda	Pochampalle	

Table A 6- Caste wise population of Peddapur

Caste Group/ Caste		Population
SC		329
ST		10
Kammari		112
Kummari		28
Kamsali		27
BC	Vaddera	128
Golla		2500
Gowda		712
Chakali		127
OC	Reedy and Brahmins	87
Minorities		123

Source: Panchayat Office, Peddapur.

Table A 6- Caste wise population of Peddapur

SC	ST (Yerukulas)	B C	OC (Reddys)	Minority (Pinjaris)	Total
554	32	33 28	600	50	4564

Source: Panchayat Office, Anajpur.
Note: Yerukula is a sub caste under ST; their profession is weaving wooden baskets.

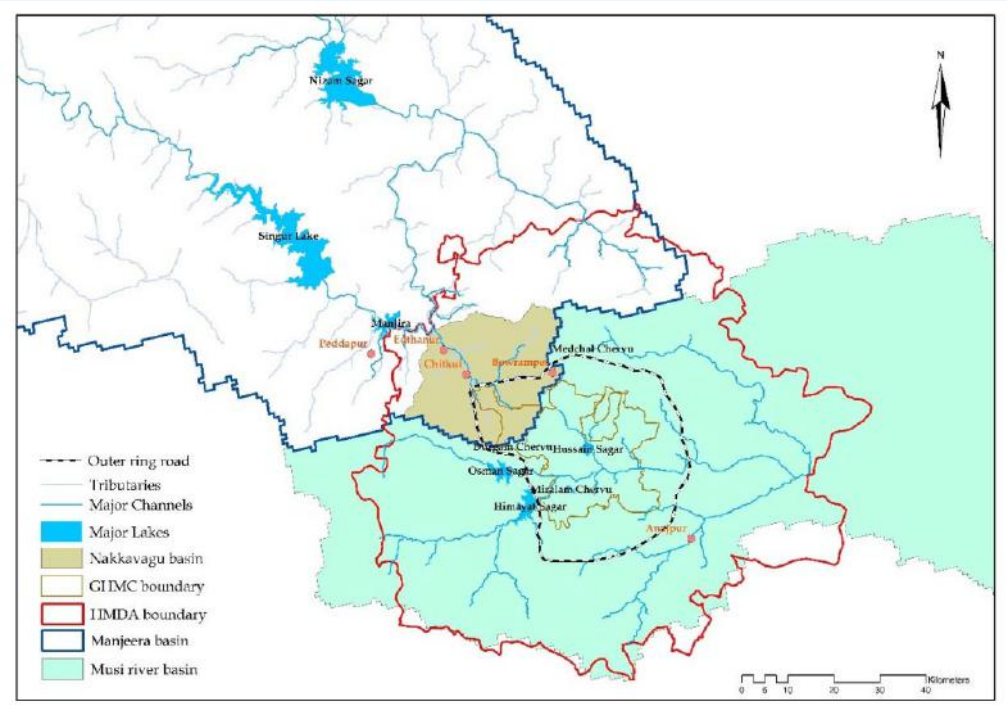
Table A 8 - Social composition of Bowrampet Gram Panchayat

Caste	Populati	Number of Households
SC	597	83
ST	24	5
BC	2091	529
Muslims	305	61
Others	2300	567
Total	5317	1245

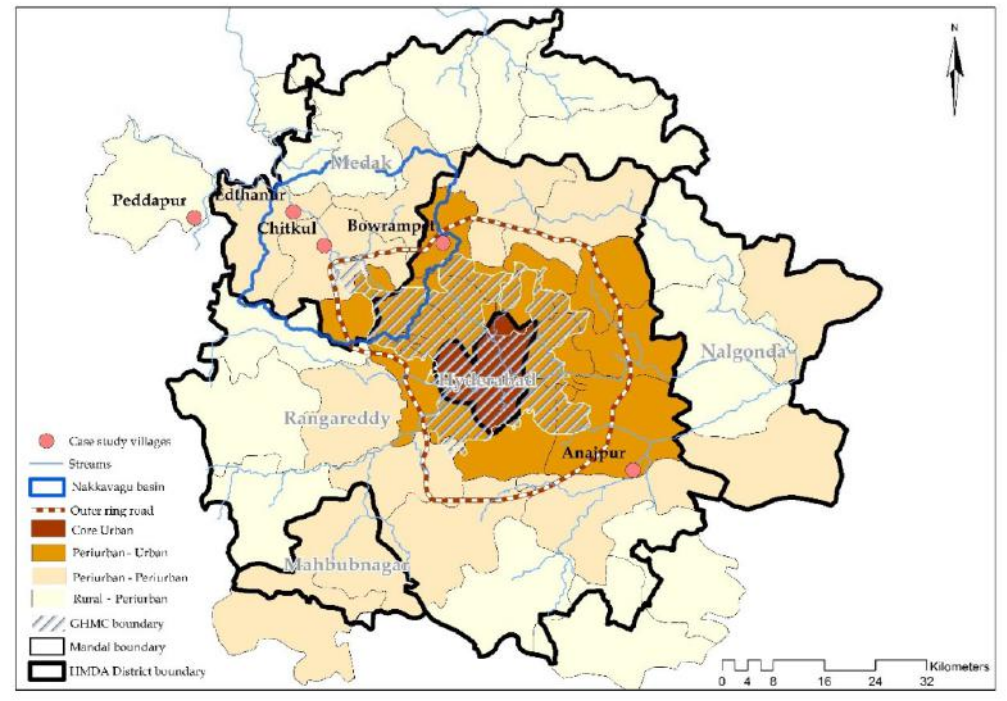
Source: Panchayat Office, Bowrampet.

Annexure tables

Map 1 – Geographical location of case study villages



Map 2 – Periurban interface within HMA, Year 2011



Climate policy, conflicts and cooperation in peri-urban south Asia: Towards resilient and water secure communities

The research project aims to improve mutual learning, strengthen institutional & community capacities to optimally manage water insecurity, and bolster resilience in periurban south Asia. It endeavors to support and empower communities to effectively use, manage and govern their water resources against a backdrop of water insecurity caused by climate change and urbanization. A consortium of north-south institutions brings together experience, skills and know-how in research, capacity-building and knowledge generation. This four-year collaborative endeavor will cover four cities:

- Khulna, Bangladesh
- Kathmandu, Nepal
- Gurgaon and Hyderabad, India

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