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Report on case study selection

Shifting Grounds

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June, 2016

Declaration: Following note provides a detail account of the case study selection process under the project "Shifting Grounds: Institutional transformation, enhancing knowledge and capacity to manage groundwater security in periurban Ganges delta systems" funded by the Urbanising Deltas of the World programme of the NWO, Netherlands Organisation for Scientific Research under grant number W.07.69.104. The note is a compilation of the quantitative analysis done by South Asia Consortium for Interdisciplinary Water Resources Studies (SaciWATERs), Hyderabad, India and the field work carried out by The Researcher, Kolkata, India and Jagrata Juba Sangha (JJS), Khulna, Bangladesh.

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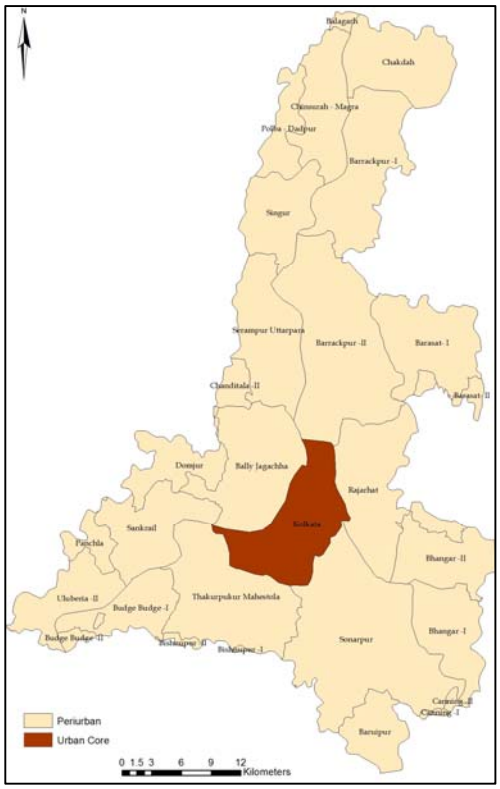
I. Introduction

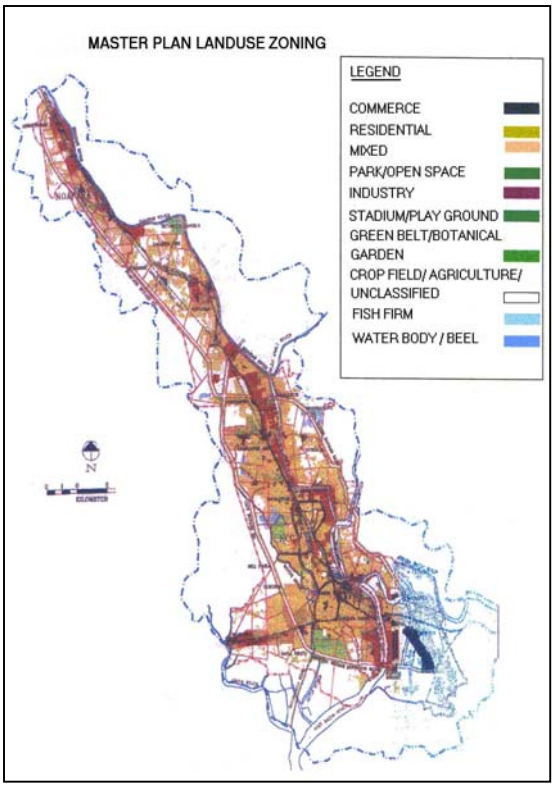
Following report provides a detail account of the case selection process in identifying study villages from periurban blocks of Kolkata, West Bengal, India and Khulna, Bangladesh respectively. A mixed methodological approaches of quantitative (k – mean cluster), and

Map 1 – Kolkata metropolitan area



Source: Constructed by author

Map 2 – Khulna development area



Source: KDA Master Plan 2002

qualitative (rapid rural appraisal consisting of group discussions and key person interviews) techniques have been used to select the study sites in West Bengal and Khulna (see annex 1 and 2) respectively. The zone that lies between Kolkata metropolitan area[1] (KMA) and metro core[2] has been considered as 'periurban Kolkata' for socio-economic and institutional system

[1] Kalyani-Budge Budge on east bank and Bansberia-Uluberia on the west bank of the river Hooghly containing the whole of the Kolkata urban agglomeration along with rural pockets. This is almost similar to the Kolkata standard urban area as defined by the census authority.

[2] Twin city of Kolkata and Howrah; with intensively built up surrounding areas spreading from Bally-Dakhineswar-Kamarhati to Andul-Garden Reach-Garia occupying about 34 percent of the KMA area

mappings (map 1). The area consists of 39 municipalities and 24 Gram Panchayat Samitis and experiencing higher population growth compared to its metro core. Map 2 depicts Khulna development area (KDA) or Khulna conurbation spreading about 451 sq. km from Noapara in the north to Mongla in the south and Rampal in the east to Koiabazar in the west. KDA has 46 sq. km. of Khulna City Corporation (KCC) area, Nowapara Municipal area, 1961 KDA Master Plan area, almost entire area of Phultala, Dighalia and Rupsha upazilas, part of Abhoynagar, Dumuria and Fakirhat upazilas. The study considered 'periurban Khulna' as the entire zone lying outside Khulna City Corporation (KCC) area. The secondary data sources for both the cases are Primary District Handbook, Census of India 2011 and Census of Bangladesh.

The blocks (Kolkata), Upazillas (Khulna) and the villages were selected taking seven criteria –

1. Periurban nature of the blocks and villages
2. Importance of groundwater as a major resource for local stakeholders
3. Tensions (recent, actual or imminent conflicts) over groundwater resources (quantity and/or quality)
4. Willingness of key players to engage with Shifting Grounds researchers
5. Ability of key players to engage (Existence of nucleus for self-organisation or platform, such as presence of NGO, CBO or village committee who has already identified the problem)
6. Practical feasibility: accessibility of location, documentation, data
7. Diversity in the full set of sites, befitting the more exploratory nature of our research efforts

The periurban characteristics are essentially adopted from the literature, and these are-

1. Higher percentage of non-farm families (Rigg, 2006).
2. Higher percentage of migrant population (Narain, 2009).
3. High incidence of daily commuting to the nearby industries and towns for employment, education etc. (Narain, 2009).
4. Feminisation of labour force (Ranjan & Narain, 2012).
5. Prevalence of high value commercial agriculture and allied activities e.g. horticulture, aquaculture, floriculture (Narain, 2010).
6. Larger area under irrigation.

7. Mixed land use pattern (Narain, 2010).
8. Degradation of forest lands (Narain, Banerjee, and Anand, 2014).
9. Disappearance of surface water bodies (Ramachandraiah, Westen and Prasad 2008).
10. High valuation of building and land (Periurbanisation in Europe, Plural, 2010).
11. Political hotspots.
12. Dumping of solid wastes (Shaw, 2005).
13. Change in the behavioural pattern of population, breaking of the traditional networks, creation of new associations (formal and informal).
14. Larger expenditure in education, particularly girl's education (Narain, Banerjee, and Anand, 2014).
15. 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).
16. Connected with the nearby cities by means of transport corridor (Narain, Banerjee, and Anand, 2014).

In case of periurban Kolkata two blocks namely Sonarpur and Barrackpore II have identified through cluster analysis method (K-mean clusters). While for periurban Khulna, Batiaghata and Phultala upazillas have been identified through observation, focus group discussion prior experience of the partner NGO. From the selected blocks/upazillas, unions and villages are identified through Rapid Rural Appraisal (RRA). Following section provides detailed account of the site selection process in periurban Kolkata and Khulna respectively.

II. Case study selection: Periurban Kolkata

The periurban Kolkata is the major source for groundwater irrigation and drinking water supply for the city and its populace. Occurrence of groundwater in the area of Kolkata is controlled by geological set-up. Several studies indicate that flow of groundwater is from deep south and southwest Kolkata to south-central Kolkata. A single unconfined aquifer system open themselves in the peripheries extending outward in all directions from Kolkata Municipal Corporation Area. The principal productive aquifers generally occur within a depth span of 50 to 160 m. and the groundwater, which is in a confined condition within the periphery of greater Kolkata, is usually tapped for municipal water supply within the depth range of 80 to 160 m. below land surface. Abstraction of groundwater is thus very high in the periphery not only to meet the city's thirst but also to support various water based livelihood systems

practiced in this transitional and mixed space. With an aim to identify blocks showing periurban features with multiple uses of groundwater resources following steps have been taken-

(i) K-Mean clustering, and

(ii) Group discussions and key interviews with CGWB, SWID, KMDA, *mandal* development officers.

Cluster analysis or clustering is the 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). K-mean clustering 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 $k$cluster centers and assign the objects to the nearest cluster center, such that the squared distances from the cluster are minimised. The study has used K-mean clustering to differentiate the thresholds across urban, periurban and rural. The list of indicators used for k-mean clustering is given in table 1.

Table 1 - Indicators used in the k-mean cluster analysis

Set of indicators	Description
Broad indicators of socio-economic development (principal component 1)	Exponential growth of population between 2001 and 2011
	Female literacy, year 2011
	Sex ratio (in favour of males), year 2011
	Per of non-agriculture sector in total main workforce, year 2011
Index of e-Readiness (principal component 2)	Percentage of households owing both landline and mobile, year 2011
	Percentage of households television, year 2011
	Per of HHs having computer/ laptop with internet connection, year 2011
Index of WASH and housing (principal component 3)	Percentage of households having drain connection, year 2011
	Percentage of households using treated tap water for drinking, year 2011
	Percentage of households using kerosene, LPG/PNG and electricity for cooking, year 2011
	Percentage of households having roof made of GI/ metal/ asbestos and concrete, year 2011
Indicator of ground water use	Percentage of households having tubewell/ borewell (i.e. ground water) as principal source of drinking water (k-mean clusters), year 2011

Source: Census of India, 2001, 2011; Reports of Ground Water Department.

To ensure efficiency of available data in reaching maximum level of statistical significance, these indicators have been integrated in various subsets depicting essential characteristics of periurbanity the region i.e. KMDA. Shortlisted indicators, subject to availability of data, are reduced to broad dimensions using principal component analysis e.g. population growth, female literacy, sex ratio and non-farm employment were the indicators reduced to index of socio-economic processes indicating status of economic growth/ development. 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, use of treated tap water, use of kerosene, LPG/ PNG and electricity for cooking purpose, are reduced to the index of WASH and housing.

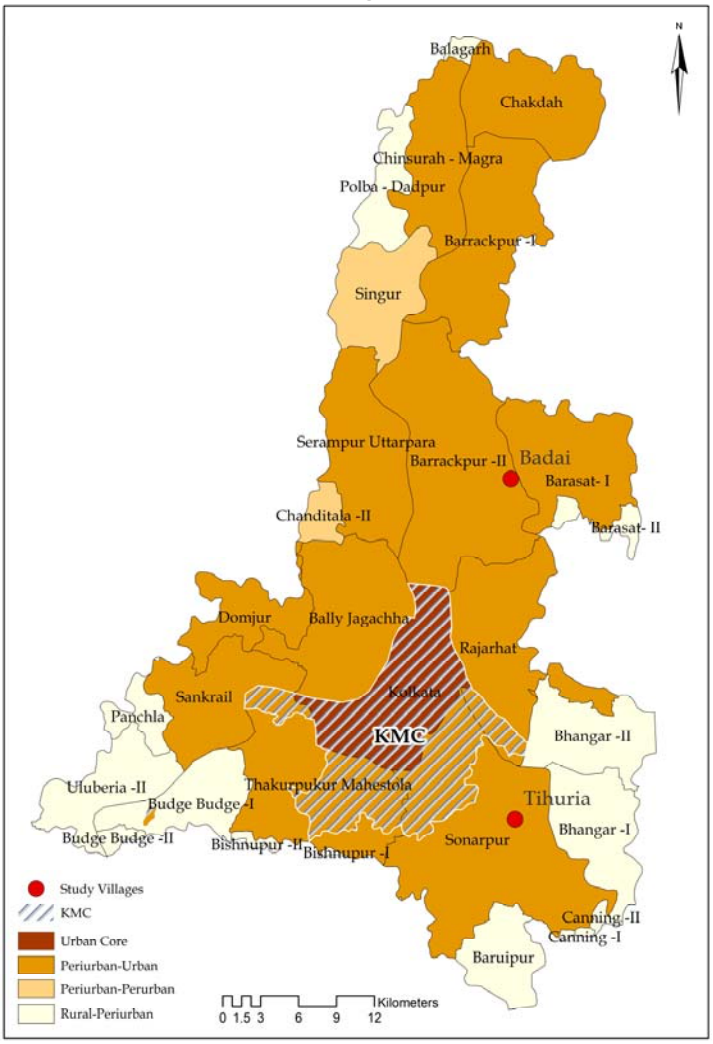
Table 2- Periurban interface within Kolkata metropolitan development area, year 2011

S. no.	District	Block	Cluster name
1	Kolkata	Kolkata	Core urban
2	Haora	Bally Jagachha	Periurban - urban
3	Haora	Domjur	
4	Haora	Sankrail	
5	Hugli	Chinsurah - Magra	
6	Hugli	Serampur Uttarpara	
7	North twenty four parganas	Barrackpur - I	
8	North twenty four parganas	Barrackpur - II	
9	North twenty four parganas	Rajarhat	
10	South twenty four parganas	Sonarpur	
11	South twenty four parganas	Thakurpukur mahestola	
12	Nadia	Chakdah	
13	North twenty four parganas	Barasat - I	
14	Hugli	Chanditala - II	Periurban - periurban
15	Hugli	Singur	
16	Haora	Panchla	Rural - periurban
17	Haora	Uluberia - II	
18	Hugli	Balagarh	
19	Hugli	Polba - Dadpur	
20	North twenty four parganas	Barasat - II	
21	South twenty four parganas	Baruipur	
22	South twenty four parganas	Bhangar - I	
23	South twenty four parganas	Bhangar - II	
24	South twenty four parganas	Bishnupur - I	
25	South twenty four parganas	Bishnupur - II	
26	South twenty four parganas	Budge budge - I	
27	South twenty four parganas	Budge budge - II	
28	South twenty four parganas	Canning - I	
29	South twenty four parganas	Canning - II	

Source: Constructed by the author using k-mean cluster analysis.

All these indicators are first arranged in unidirectional way to ensure robustness in k-mean analysis. Except the three subsets, information on percentage of households using tubewell/ borewell as major source of drinking water has been collected from census and has been used in in the analysis after making it unidirectional using k-mean. Hence, using these four variables (i.e. the three indices and indictor of ground water use) were used to cluster the blocks around KMDA. To understand the periurban interface more clearly, the core urban area of Kolkata were kept out in the analysis and number of k-mean clusters were set to 3 to identify the level of periurbanity at three levels in relation to the core. Hence the blocks, except the core, were categorised into three major heads of which characteristics are- (1) periurban to urban, (2) periurban to periurban, and (3) rural to periurban (table 2; map 3).

Map 3 – Periurban interface within Kolkata metropolitan development area and study villages



Source: Constructed by the author.

Cluster analysis, literature review and experience of the local research partner, guided our choice of selecting two blocks namely, Barrackpore II of North 24 Pargana and Sonarpur of South 24 Pargana. Both of these blocks belong to periurban-urban cluster (map 3). Subsequent task was to shortlist villages for Rapid Rural Appraisal RRA. KPIs with block level officers and Panchayat members have helped in selecting 6-7 villages from each block. Table 3 provides the list of shortlisted villages from Barrackpore II and Sonarpur. Village statistics on demography and occupational structure supported by field insights grounded our case study selection.

Table 3- First round of shortlisted villages from Barrackpore II and Sonarpur blocks

Block	Village/ Town	Gram Panchayat	Entity Type
Barrackpore - II	Bhatpara Noapara	Bilkanda - 1	Village
	Bodai	Bilkanda - 1	Village
	Ishwaripur	Bondipur	Village
	Ruia (Nalir Math)	Petulias	Census Town
	Mohanpur	Sewli	Village
	Sewli	Sewli	Not in the list
	Telani Para	Sewli	Census Town
Sonarpur	Bidyadharpur	Sonarpur - II	Census Town
	Sahebpur	Kalikapur - 2	Census Town
	Kalikapur	Kalikapur-1	Census Town
	Chak Baria	Kalikapur-1	Census Town
	Joykrishnapur Chairi	Bonhooghly - 2	Census Town
	Radhanagar	Kamrabad	Census Town
	Tihuria	Tihuria	Village

Source: Census of India.

Barrackpore II and Sonarpur are among the most urbanised and industrialised part of the periurban Kolkata. Barrackpore II recorded maximum growth in the percentage of urban area to the total area between 2001 and 2011. It is in the older part of the metropolitan city with high concentration of household and medium scale hazardous industries. Groundwater has its varied and often conflicting usage in this side. Evidences of latent tensions and contestations been reported during RRA particularly between irrigators and industrialist. Massive withdrawals of groundwater has led to changes in groundwater flow patterns, declines in quality, land subsidence and increased areas.The region once dotted with numerous wetlands is reportedly suffering from acute water crisis in lean period for meeting domestic and irrigation needs. More than the quantity, water scarcity is more of a function of quality in

Barackpore II. Dumping of heavy industrial wastage on the surface water bodies like Nangla Beel, Bari Beel, Duma Beel, Kankan Beel has not only degraded some significant water sources but its easy mobility was detrimental enough to leach into the groundwater, contaminating the aquifer. Increase in the number of shallow tube wells has caused high abstraction and rapid seasonal drawdown of water levels. In this case, although aquifers may be fully recharged at the end of each monsoon, increases in the number of wells has simply increased the rate of seasonal depletion with little or no increase in the actual amounts of water extracted.

North 24 Pargana is one of the nine most arsenic affected districts of West Bengal. They are potential areas for naturally-occurring Arsenic and could be a major threat to groundwater system. More than 95 percent of the population in North 24 Pargana and Barrackpore block in particular use hand tube-well water for drinking purposes. Most of the tube-wells are of shallow depth (15–50 m). Part of the water supply that comes from the Public Health Engineering Department (PHED) and Rural Water Supply Schemes (RWSS), government of West Bengal are groundwater dependent. Thousands of shallow big diameter tube-wells (discharge 20 cubic meter of water per hour) are in use for irrigation and their numbers increasing every year. These wells in general are sunk without maintaining the minimum safe distance between one and the other to avoid interference, which has resulted in a sharp decline in water level. Installation of a hand tubewell of one pipe and one filter (about 8 m) is quite cheap and costs about 50 US dollar. In many families there are more than one hand tube-wells for their use. Such massive increase in the shallow tube well has increased the incidence of arsenic contamination.

Sonarpur of South 24 Parganas on the other hand forms part of the newly expanded city of Kolkata with massive growth in housing complexes, educational institutes, hospitals etc. Here aquifers are leaky and often pumping of fresh aquifer caused migration of saline water in the fresh water system. Lack of regulation, particularly to install shallow tube wells about 8 m depth, has caused indiscriminate increase in the number of hand-pumps and shallow tube wells in Sonarpur area making it susceptible to salinity issues. Since purified water supplied by the Kolkata municipal corporation is inadequate, the community is heavily dependent on vended water. However the access to this water source is dependent on financial and social capital of the individual households. Lack of regulatory framework to control the fast growing drinking water market and inefficiency in governing its quality has made periurban community of Sonarpur susceptible to health hazards. Following section gives a detailed account of the status

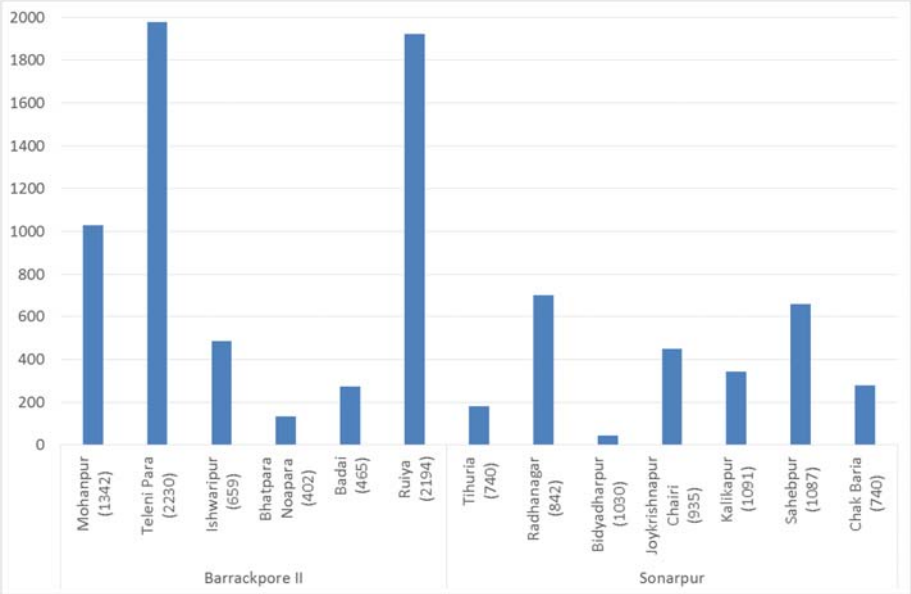
of the villages in terms of demography, occupational structure, groundwater usage, awareness, capacity and willingness to participate with the shifting ground researchers.

a. Periurban nature of the blocks and villages

Below figures 1 and 2 show the absolute change in total number of households and population density between 2001 and 2011 for selected villages of Barrackpore II and Sonarpur. If we look into the demographic profile of villages in Barrackpore II there is a positive increase in the household numbers and density indicating city's rapid spread. Although Telenipara and Ruyia recorded maximum increase in the total number of households, highest density is recorded in Mohanpur. Group discussion with the villagers unraveled the historical account of these settlements and its recent growth at the onset of rapid urbanisation. Most of the villages are on the threshold of the city, situated along the newly developed transport corridor. For instance, Bodai experienced rapid change in population, landuse and livelihood pattern with the coming of the 40-kilometre-long, two-laned, Kalyani express highway connecting Kolkata with Kalyani town. Being an en-route village, land prices scored up drastically, with residential land selling at 4 lakhs INR per cottah (1.65 decimal) and cultivable land selling for 2.5-3 lakh INR per 1.65 decimals. Increased land value, rising input cost for *boro* paddy have made selling of fertile agricultural land much more profitable in Bodai. Large-scale conversions of fertile agricultural land to heavy industries and small-scale factories supports such argument. Such a trend is not only particular to Bodai, Ruyia presents a similar case of industrialisation and rapid land use change. Located about 4.5 kilometers away from Barrackpore railway station, Ruyia has emerged an important residential and commercial suburb within last 20 years. Agriculture is restricted to low lying part of the village called Nalirmath, where around 100 acres of cultivable boro land are either owned or leased in by Bangladeshi immigrants. Village has a history of land acquisition where state Government acquired about 6-7 decimal of land for a school and animal treatment centre. However the school had closed down and the animal treatment centre is in a verge of closure. Swelli is a ruralised periurban village with pridominant agarian population. Swelli is an old village close to the municipal towns of Barrackpur, Titagarh, Khardah and Panihati. In spite of its nearness to the urban centers it has largely remained agrarian due to ban on the transaction of agricultural lands in the command area of the government managed public deep tube well. All the selected villages have sizable Muslim population and Bangladeshi immigrants. Axis of differentiation in terms of assets ownerships is clearly visible between the original inhabitants and Bangladeshi immigrants. Such differences

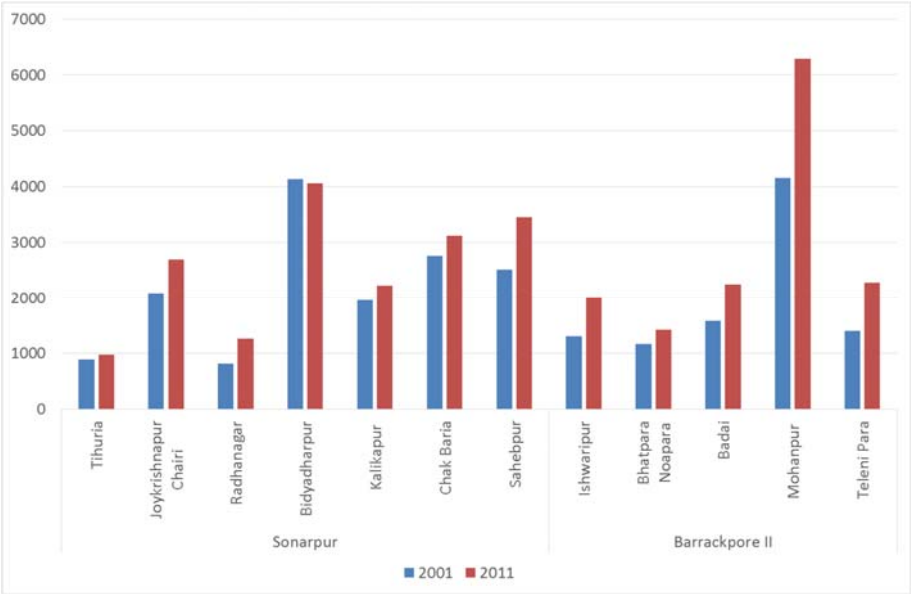
in entitlements has its impact on livelihood strategies taken by these two groups in Barrakpore II.

Figure 1 - Absolute change in total number of households from 2001 to 2011



Source: Primary census abstract, Census of India. *Note*: Total number of households in 2001 is given in parentheses.

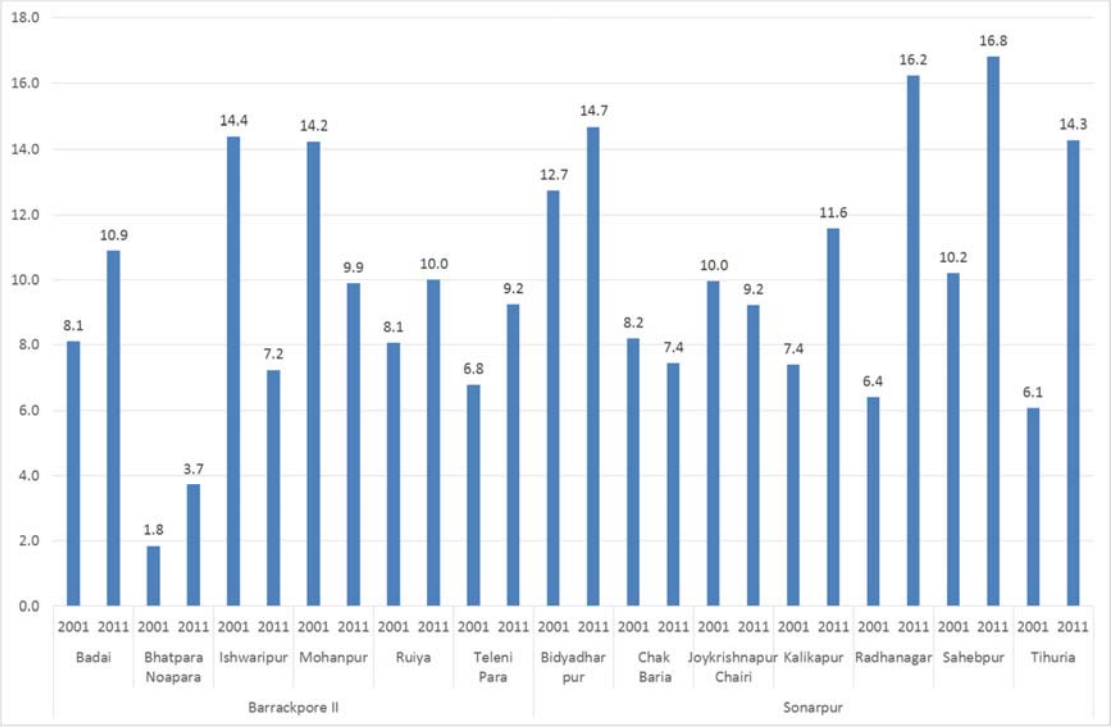
Figure 2 - Population density (persons per sq. kms.) in selected villages, Kolkata, from 2001 to 2011



Source: Primary census abstract, Census of India. *Note*: Total number of households in 2001 is given in parentheses.

Sonarpur on the other hand has major Hindu dominated local residents practicing either rainfed or canal based irrigation. Like Barrackpore, villages recorded high growth in population density (figures 1 and 2) with insignificant decline in Bidyadharpur. Changes in the administrative boundaries might explain to such a fall. Growth in the households and population of Tihuria, Joykrishnapur, Chakberia can be attributed to expansion of transport axis (roads and railway connectivity), real estate boom and tertiary sector development. However unlike Barrackpore, which has sizeable number of upper caste Hindu and Muslim population, villages of Sonapur has majority of scheduled caste residents. Such social differentiation has its implication on community's asset ownership and occupational strategies.

Figure 3 - Change in worker population ratio (workers per thousand population) among females, from 2001 to 2011

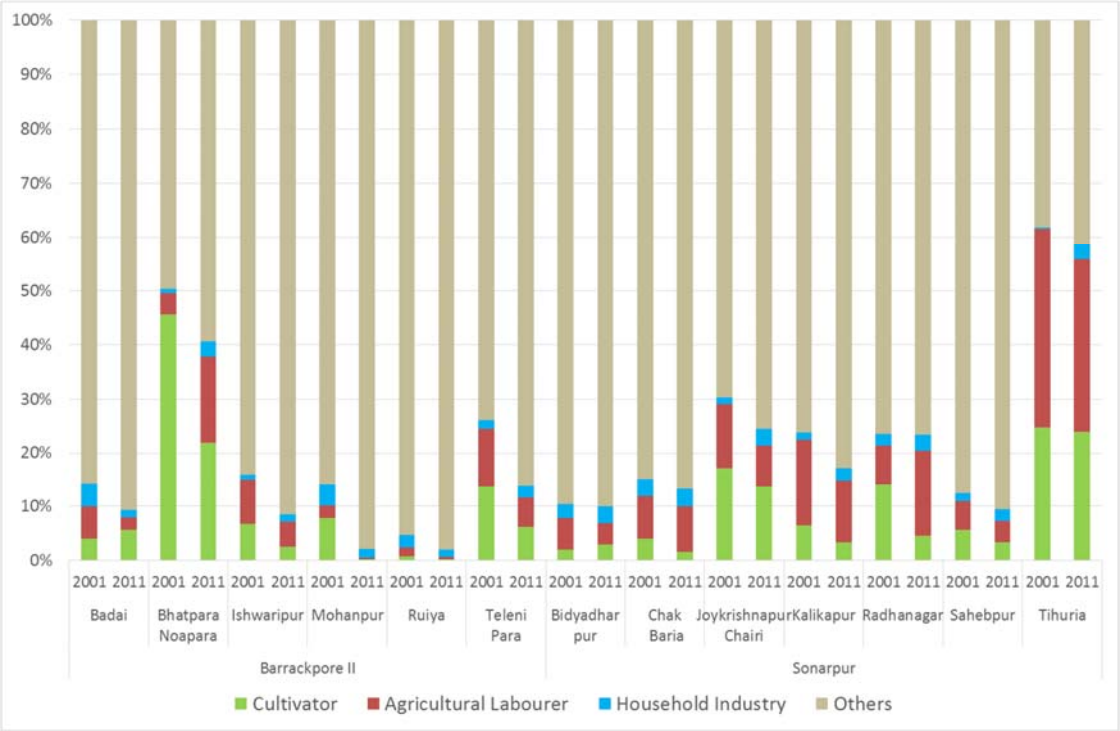


Source: Primary census abstract, Census of India.

Figure 3 gives an indication of the change in the working population of selected villages between 2001 and 2011 respectively. For the last 10 years worker population ratio (workers per hundred population) has shown a positive trend in both the blocks. This to a large extent denotes diversified livelihood options available in these areas. Field investigation surfaced mark differences in the livelihood pattern between these two blocks. Sonarpur has large section of non-farm wage labourers working on daily basis in construction sites, factories, MGNREGA schemes etc. Women are mostly employed as low paid workers in household industries like

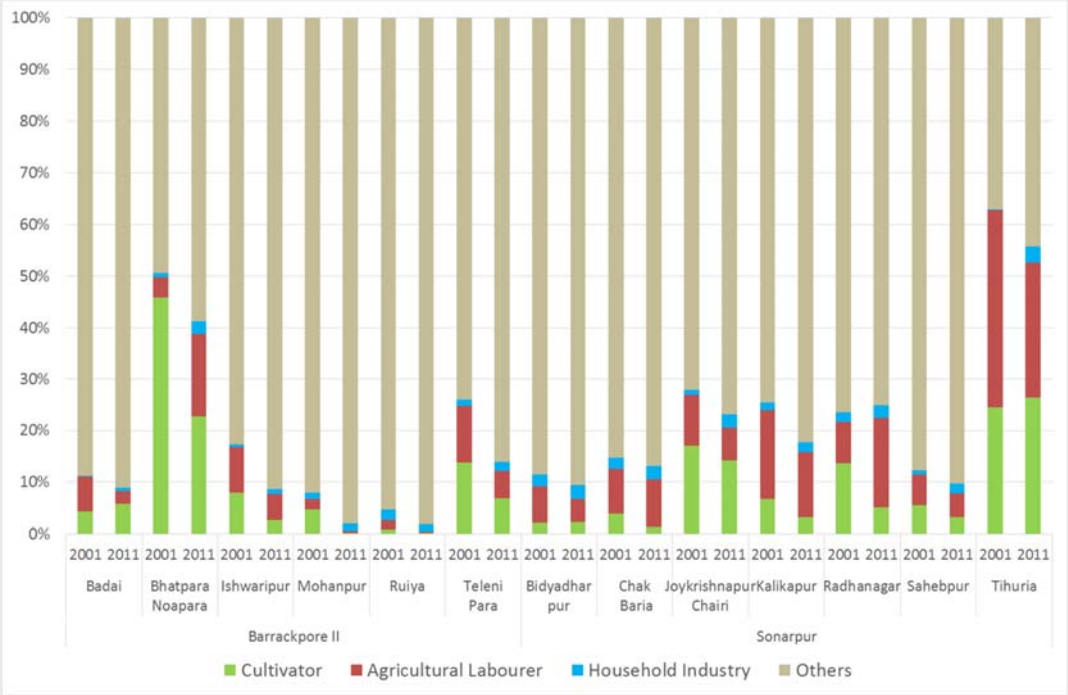
garlands and crackers manufacturing units, blouse making, soft toy manufacturing, *jori* works (designing on *sarees*) and in other small cottage industries. Involvement as maid servant in Kolkata city has been most prefered options for poor women in Sonarpur villages. Increasing trend of female work participation ratio in Tihuria, Sahebpur, Radhanagar, Kalikapur and Bidyadharpur points out towards changing women's role in a periurban economy. For Barrackpore II the trend is not uniformly positive across all the villages. Bodai stands out significantly in terms of change in female work participation ratio between 2001 and 2011. Focus Group Discussions and key person interviews in Bodai reported large scale involvement of women as wage labourers in local small scale industries like jori works, knitting, blouse making, bag making etc. Figure 4, 5 and 6 explain the occupational pattern of selected villages in both the blocks.

Figure 4 - Percentage change in occupational pattern (total employment), from 2001 to 2011



Source: Primary census abstract, Census of India.

Figure 5 - Percentage change in occupational pattern (total employment) among males, from 2001 to 2011



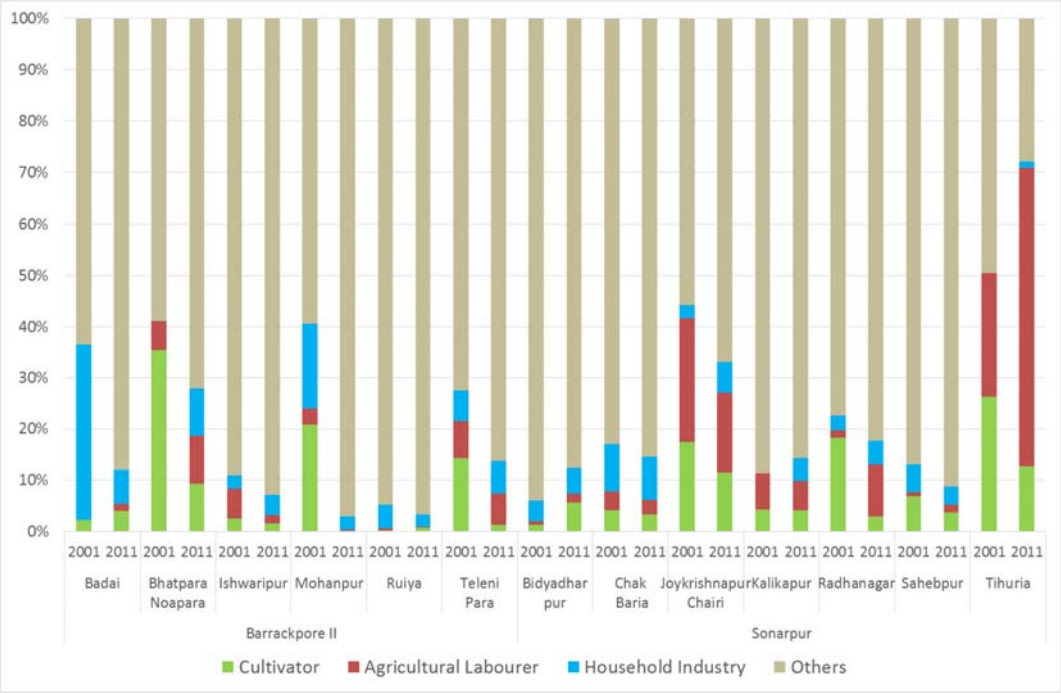
Source: Primary census abstract, Census of India.

For the population as a whole the share of cultivators, (those who work either on their own land or on the land leased in on rent), has shown a persistent declining trend while that of 'others' (servants, municipal employees, teachers, factory workers, plantation workers, those engaged in trade, commerce, business, transport banking, mining, construction, political or social work, priests, entertainment artists, etc.) increased substantially between 2001 and 2011 in all villages. Change in the percentage of agricultural labourers also showed negative growth. The pattern supports periurbanisation processes at large, where more profitable non-farm activities are replacing mainstream agriculture. However, whether households been able to engage to this process change effectively and move upwards in the poverty ladder depends on their assets ownerships, and decision-making power. Comparative assessment of the change in the occupational structure between men and women provides better insights to this argument.

In Sonarpur, Tihuria and Jaykrishnapur has largest share of cultivators in 2011. There are very few cultivators who owns their land, mostly sharecropping and lease in agreement operates in these villages. Field investigation in Chakberia reported high labour cost particularly during boro season where the rate goes to 250 INR plus food (morning tiffin and lunch). Such high cost followed by low irrigational facilities is major factors leading to decline

in agricultural labour requirement and progressive increase in daily, permanent and contractual wage labourers in non-farm sectors like construction works, petty manual works, etc. In Barrackpore II the trend remains same where Bhatpara noapara registered maximum fall in cultivation. Presently Bhatpara Noapara has around 230 acres of cultivable land. Boro is cultivated in and around 130 acre of land while Amon paddy and vegetable gardening is practiced for 100 and around 67 acres respectively. Jute cultivation is done in very small scale. There are some banana orchards in this village. As the cost of agricultural labour has risen considerably, many of the landowners are either leasing out their lands or practicing sharecropping. Percentage of male workers in household industry shows more or less persistent trend, with substantial increase in service, and business sector.

Figure 6 - Percentage change in occupational pattern (total employment) among females, from 2001 to 2011



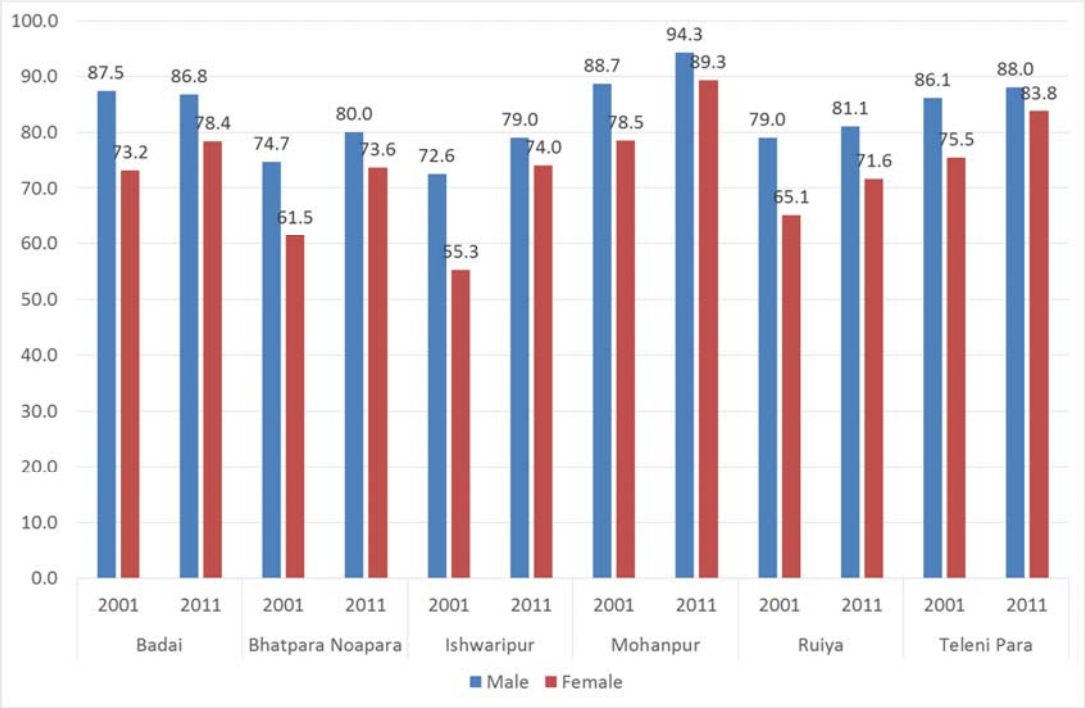
Source: Primary census abstract, Census of India.

Analysis of female occupational pattern gives a very interesting insight largely explaining the periurbanisation processes. Female occupational pattern (figure 6) in periurban space illustrates greater engagement in non-farm sector. Low paid employment in household industries remained consistently high between 2001 and 2011. Low demand for female agricultural labour confirms to the general agrarian crisis, changing values and aspirations of

the society. However one significant exception to this trend can be seen in Tihuria where demand for female agricultural labourer showed a rising drift. Tihuria exhibits a drastic change in the cropping pattern from summer boro paddy to mono-cropping of Thai cat fish locally called as hybrid *Magur*. It is one of the several villages that forms part of *Tolly's Nalla*, carrying the sewerage of the Kolkata city, and providing livelihood source for wastewater cultivators. Such a shift on one hand has opened up new opportunities for agricultural labourers and local vendors selling fresh vegetables and dairy products to the city market challenges. Increase in female agricultural labour partly explains to such opportunities created by wastewater aquaculture.

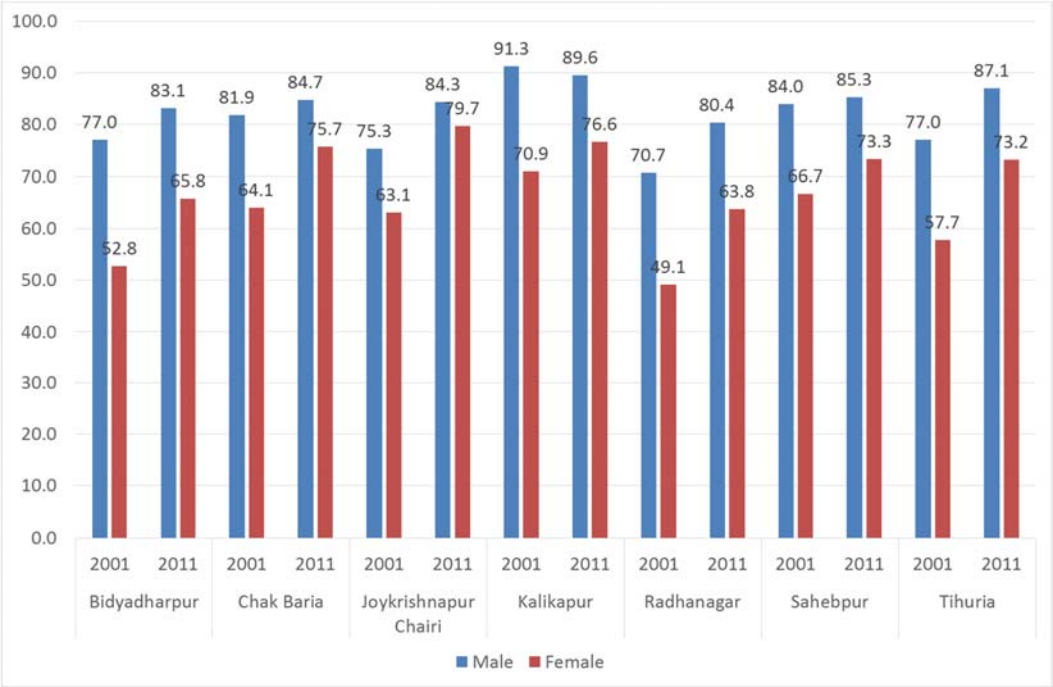
Increased women participation in services and other manual work in all the selected villages also explain women's empowerment. Discussion divulged increasing awareness about girls' education in all the villages. Households in Bodai, Bhatpara Noapara, Bidyadharpur reported that most of the girls in the villages are going for secondary and higher secondary education. This is supported by positive change in the female literacy rate as depicted in figures 7 and 8 for Barrackpore and Sonarpur respectively.

Figure 7 - Change in male and female literacy (percentage) in selected villages of Barrackpore II, from 2001 to 2011



Source: Primary census abstract, Census of India.

Figure 8 - Change in male and female literacy (percentage) in selected villages of sonarpur, from 2001 to 2011



Source: Primary census abstract, Census of India.

While comparing women's occupational pattern, literacy rate and sex ratio a very interesting observation emerges in Bodai and Tihuria village. In Bodai, increase in women literacy is leading to rise in work participation rate in 'others' category. However there is subsequent decrease in sex ratio. Field observation reveals that most of the female working force have moved out with their families to the city of Kolkata. Quite contrasting observation can be seen in Tihuria of Sonarpur block. In both these cases increase in literacy didn't ensured their participation in high-end service sector. Villagers reported high incidence of early marriages. Increased income has made conscious households has made them Reduced sex ratio in Tiharia confirms to such observation. High literacy rate worked more for opening up avenues for marriages in tis periurban village. Such insights supports discursive gender studies on women work participation in general, however the periurban context adds to this complexity.

Periurbanity, measured in terms of population growth, change in occupational structure, work participation and female literacy rate creates a heterogeneous space where individuals have their own goals and interest to survive. Whether a farmer continues cultivating land or decides to work as a construction workers and a part time rickshaw puller

depends on the available opportunities, household history, perceptions, and aspiration. It is less common for people to collect all their income from any one source, or hold all their wealth in the form of any single asset. It is also rare to see household decisions as conscious or intentional and directly related to the opportunities available in a periurban space. Two villages namely Bodai in Barrackpore II and Tihuria in Sonarpur are prospective cases where assets, access, rights, power and decision making of the periurban urban households can be assessed.

b. Importance of groundwater as a major resource for local stakeholders

The population dynamics, literacy and occupation diversification discussed above have given discursive understanding of the periurban nature of the selected villages. Against this it was critical to understand the degree and pattern of groundwater usage which is our second most critical selection criteria. Lack of secondary data at the village level for 2011 has restricted our analysis to literature review, FGDs and KPIs conducted during RRA. Among the selected villages from Barrackpore II, Bodai has entirely groundwater dependent irrigation system. Small and medium scale dying, knitting, garments factories are other major extractors of groundwater resources. Urban expansion has its consequence on the land use and cropping pattern. Boro paddy cultivation forms the mainstay of Muslim minority while Hindus essentially engaged in non-farm activities. The village has 66 acres of agricultural land cultivated for boro paddy and banana farming. The irrigation is primarily done through government managed deep tubewell, installed in 1983. Dependence on groundwater irrigation increased with rapid industrialisation and dumping of the pollutants in Noai Khal, an important traditional surface water source for the village. Degradation of the Noai Khal followed with rapid boom in groundwater irrigation has resulted drastic change in the cropping pattern from jute and traditional rainfed paddy to groundwater intensive summer boro and horticultural crops. Change in cropping pattern in most of the villages selected has placed considerable stress on groundwater aquifer. However villages like Bodai faced the further stress of extraction and pollution by small scale hazardous industries. The stress is further aggravated with increase demand for drinking water in summer. Groundwater forms only source of drinking water supply for the village. Public Health engineering department has installed hand-pumps and heavy-duty tube wells from which water gets supplied to individual households through direct piped connection. Extraction through private shallow tube wells by the residential estates and industrial complexes are not only common to Bodai, other villages like Bhatpara-Noapara, Ishwaripur have both PHE and private tubewells of 250-300 feet deep boring. In Bhatpara-

Noapara Panchayet installed few 400 feet deep hand pumps and one 500 feet deep arsenic free tube well. Villagers in Sonarpur block reported about mounting drinking water crisis and emergence of private water markets. Tihuria present a case of fast developing vended water, rising contestation, agitation and poor water governance. The village like many other selected villages has supply inadequate to meet the increasing demand. The supply is through shallow and deep tubewells installed by the local government. However lack of maintenance of these wells have made them defunct and/or affected by arsenic pollution. Many a times poor households continue to drink from the unsafe source as they don't have the means to purchase bottled water. Tihuria hosts a bottled water plant on an area of around 7.7 acres. Owned and managed by a Gujarati business man from Kolkata, it forms the only drinking water source for the villagers. Latent conflicts, agitation and contestations have been reported between the plant owner and the villagers. Concerns were raised regarding the quality of this packaged water.

This village still critically depend on groundwater both for farming (on which still 50 percent of the population is dependent) and drinking and other household purposes, though groundwater depletion has not been perceived as an issue by the villagers. The village is witnessing increasing use of village lands for commercial purposes, like construction of private schools, colleges and hospitals, which are definitely boosting up the urbanisation process and putting pressure on the limited groundwater resources. Against aforesaid discussion Bodai from Brrackpore II and Tihuria from Sonarpur stands out significant in reflecting some of critical issues related to multiple uses of groundwater.

c. Tensions (recent, actual or imminent conflicts) over groundwater resources (quantity and/or quality)

Fast spreading urban sprawl and increasing periurbanisation processes collided with the groundwater irrigation boom of West Bengal. Agricultural production, particularly rice, experienced speedy rise in 80s. Part of this can be attributed to the increase in production due to transfer of ownership (*patta*), and permanent right given to the cultivators to cultivate their own land (*barga*) under left front government. But a larger chunk of this success can be explained by high yielding groundwater intensive boro rice cultivation. This form of cultivation became an extremely labour intensive form of rice cultivation carried out in small plots by small cultivators using mainly family labour. Conversely, rapid urbanisation processes started consuming most of the fertile agricultural land in and around high-visibility periurban villages surrounding big cities like Kolkata. Such a spread has opened up newer opportunities, like

employment in informal manufacturing sector, but has squeezed the agricultural productivity drastically. Small and marginal periurban farmers close to the big cities very often falls prey of power politics of industries and real estate agents. Many a cases access to assets is shaped up along political, caste and gender axis. Overt and covert contestations between boro farmers and wastewater aquaculturist in the village of Tihuria is a case in point. The village has 60 percent of its population engaged in boro paddy cultivation and wastewater monoculture of Thai Cat fish. Irrigation is completely groundwater dependent with majority of the farmers belonging to small and medium landholding size. Ravi cultivation in winter and Boro paddy in summer forms the major cropping pattern. Being lowland, rainwater stays back for more than 2 months preventing them to cultivate during post-monsoon. Fresh water aquaculture is practiced by filling the tanks with submersible pumpsets. Several activities like livestock rearing, government services, small scale business, water trading forms significant part of their non-farm strategic choices. KPIs and FGDs surfaced quarrel and visible tensions between the villagers and the private water vendors. Unregulated pricing and poor water quality of the packaged water has remained a serious concern for the villagers at large. Latent contestations can also be visible across households within the village. Poor households unable to cope up with rising prices of the packaged water during lean season often restored to unsafe arsenic affected drinking water sources. Several focus group discussions with women in Tihuria surfaced the increasing drudgery of the poor women in collecting drinking and domestic water. Inadequate and highly irregular supply has made collection extremely arduous for women. Longer distance and few points have increased the collection time, which has affected their social security. Many times they have to leave their children for longer duration alone at home. Women of Tihuria mentioned that they almost spend the whole day till 10.30-11.00 pm to collect water from the public deep tubewell. The fear and risk of keeping them alone or in custody of their neighbours forced them to use arsenic affected tube wells that are close by. Other villages in Sonarpur block have not overtly reported any conflict however evidences of tensions across households in accessing drinking water can be seen. Most of these villages are politically connected with the city, for instance Sahebpur village has Member of Parliament actively involved in the village politics and the resource access. In village of Bodai in Barrakpore II block covert conflicts have been reported between the boro cultivators and the manufacturing industries. Tables 4 and 5 provide an account of groundwater usage in selected villages and the issues emerged from the RRA.

Table 4 - Village-wise usage of groundwater (Sonarpur block)

Village	Drinking	Irrigation	Other usage	Issues
Bidyadharpur (Sonarpur II GP)	Main source PHE, which is inadequate. Partially dependent on Panchayat funded tube wells (900-1000 ft), only two of which are working.	Irrigation from canal and ponds. No groundwater irrigation is undertaken, as water at shallow aquifer is saline.	Private hand pumps with100-110 feet depth are used for household chores, have salinity and iron problem.	No conflict among the users of GW, but people are aggrieved over non-repairing of panchayat tube wells, which if repaired would alleviate drinking water crisis.
Chakberia (Kalikapur I GP)	Primary source of drinking water hand pumps, both private and panchayat-funded. PHE supply irregular and inadequate.	Irrigation is done with 6-7 private shallow tube wells and one Govt-funded deep tube well.	Private hand pumps (100-150ft) having high iron content and unsuitable for drinking purpose, are used for all domestic purposes and bathing.	No conflict situation perceived. Institutional problem regarding non-repairing of hand pumps by the panchayat.
Jaikrishnapur (Banhoogly II GP)	Villagers mostly depend on private and panchayat hand pumps. PHE connections are inadequate.	No groundwater irrigation as GW at shallow aquifer is saline. Irrigation is done by canal water.	Private hand pumps used to cater the need of household chores and bathing.	No conflicting situation. Institutional problem regarding non-repairing of hand pumps by the panchayat.
Kailkapur (Kalikapur I GP)	Main source of drinking water is PHE water supply, though inadequate.	Irrigation is mainly done with 4 shallow pumps. Canal water is also used to some extent.	Private hand pumps used to cater the need of household chores and bathing.	Private hand pumps have arsenic contamination and fail to extract water adequate water during summer season.
Radhanagar	Main source PHE supply, more or less sufficient.	No GW use for irrigation. Canal plus tank water used for irrigation.	Private and govt. hand pumps are used for household usage.	No issue found over the use of groundwater.
Sahebnagar	Inadequate supply from the PHE. Govt-funded tube wells do not work. Villagers face crisis of drinking water.	No GW use for irrigation due to salinity. Canal water used for irrigation.	Private hand pumps are used for household usage.	No conflict situation over GW. Only grievance is non-functioning of govt. tube wells.

Source: Compiled from field study report of The Researcher.

Table 5 - Village-wise usage of groundwater (Barrackpore II block)

Village	Drinking water	Irrigation	Other usage	Issues
Ruia (Patulia GP)	Main dependence on PHE supply and partially on govt. tube wells.	No use of GW for irrigation. Farmers use municipality sewerage-canal for irrigation.	Private tube wells earlier used for household chores, but now mostly defunct due to lowering down of water table, caused by heavy industrial use of GW.	Latent conflict over heavy use of GW by industries apparently causing GW depletion. Also the factory waste is polluting the channel water used for irrigation, causing tension between the cultivators and industries.
Seuli	Main dependence on PHE supply and a few govt. tube wells are secondary source of drinking water.	One govt. deep tube well is the main source of irrigation. STWs became defunct due to falling water table.	Private tube wells are used for household chores.	Fall in groundwater table has been compensated by installation of DTW for irrigation and PHE supply for drinking water.
Telenipara	Main source PHE not reliable, so depend on govt. tube wells that became defunct very often.	One govt. deep tube well is main source of irrigation. STWs became defunct due to falling water table, caused ostensibly by heavy GW drawing by DTW.	Villagers have installed private hand pumps in their houses for domestic purposes. This water cannot be used for drinking purposes.	Some grievance among farmers having land outside the DTW command area for not getting irrigation water and being unable to run STWs. Even tank water is supposedly depleting due to heavy extraction by DTW.
Sunjapur	Mainly three government tube wells are main source of drinking water. One is arsenic-free, while others are not tested.	No GW water irrigation at present. Previously one DTW was operated that became defunct.	Household water requirements are met by private hand pumps in the main.	No conflict perceived on water related issues.
Bhatpara	Main dependence on PHE supply while a few govt. tube wells are secondary source of drinking water.	No GW irrigation, river lift pump installed by the government to lift canal water.	Household water requirements are met by private hand pumps, but water became scarce during summer months.	No conflict on GW.
Bodai	Private tube wells are main source of drinking water. Falling water table causing crisis of water.	One govt. deep tube well is the main source of irrigation.	Apart from household usage, many industries have come up in and around the village extracting huge amount of GW.	Industrial extraction of GW apparently responsible for GW depletion and latent conflict over GW use by the villagers vs. the industries.
Iswaripur	Private tube wells are main source of drinking water apart from some panchayat tube wells and the PHE supply.	Only source of irrigation is one government deep tube well.	People mostly depend on private tube wells for all household chores. Some small industries also use groundwater.	Still the fall in water table is not significant to create any crisis situation or conflict among the different users.

Source: Compiled from field study report of The Researcher.

d. Willingness of key players to engage with Shifting Grounds researchers

This has been one of the important criteria that guided our choice. This is particularly so as advocacy and capacity building of the stakeholders through Negotiated Approach are two most critical pillars of this research. We assumed willingness is a factor of degree of dependence on the asset (groundwater in this case), level of traditional knowledge, awareness and concern, institutional arrangements, sense of community, understanding of the alternative institutions or options or the relative importance of these alternatives to other factors that influence community's participation patterns. Apart from Bodai, Tihuria and Chakberia none other villages have shown willingness to engage with the researchers. In Tihuria women were very much vocal about their problems and showed greater willingness to participate. Large number of women cultivators and agricultural labourers participated in the series of focus group discussion organised in different sections (paras) of the village. Concerns were raised about depleting groundwater for irrigation, increasing popularity of harmful waste water thai fish monoculture, drinking and domestic water crisis, salinity and heavy iron contamination of the shallow aquifer, several health issues like digestive disorders etc.

e. Ability of key players to engage (Existence of nucleus for self-organisation or platform, such as presence of NGO, CBO or village committee who has already identified the problem)

Civil society Organisations, NGOs, informal village committees plays very crucial role in building community's willingness and ability to participate in developmental activities. They support in enhancing and empowering community by strengthening positive social capital, reducing the information problems, allowing target communities to identify projects as well as eligible recipients of private benefits, like welfare or relief, expanding the resources available to the poor, via credit, social funds, capacity building and occupational training, strengthening the civic capacities of communities by nurturing organisations which represent them, and by enabling them to acquire skills and organisational abilities that strengthen their capacity for collective action. Remarkably, presence of civil societies has been very limited in the selected villages. Many villages like Bidyadharpur, Radhanagar, Kalikapur in Sonarpur block have reported increasing incidence of criminal activities, unemployment and drug addiction among youth, yet no collective action have been taken by either community or organised groups to combat these. In Tihuria, community has worked collectively in maintaining the Panchayat tubewell that serve more than 100 households. Leaders like Prabhas Mondal are social activist

involved in mobilising community in the village. Villages in Barrackpore II also depicts similar trend with very limited collective action.

f. Practical feasibility: accessibility of location, documentation, data

In this aspect all the selected stands a fair chance. They are close to the city of Kolkata and communicable through roads and some cases railways.

g. Diversity in the full set of sites, befitting the more exploratory nature of our research efforts

Diversity in terms of groundwater irrigation, freshwater and wastewater aquaculture, industrial use and drinking are best reflected in Bodai and Tihuria. Tihuria provides evidences of conjunctive use of surface and ground water, while Bodai is purely groundwater dependent irrigation system. Bodai is dotted with numerous ponds, once very important sources for irrigation and pisciculture. However encroachment by unregulated manufacturing industries and real estate construction has depleted these sources and thus adversely affecting the recharge. Evidences of wastewater aquaculture, livestock rearing and water trading are only seen in Tihuria. Fresh water aquaculture is practiced by filling the tanks with submersible pumpsets. One of the significant features of this village is wastewater monoculture of Thai Cat Fish, which is formally banned by the West Bengal government. Plankton rich waste water of Tolly Nalla coming from the city of Kolkata is the point of contention between boro cultivators and aquaculturist of Tihuria. Extensive wastewater irrigation of Thai Cat Fish although has been an important livelihood strategies of the villagers it has a detrimental effect on ecology and biodiversity. There is a strong and powerful nexus of illegal operators spreading across South Asia working along the supply chain of the Thai cat fish.

Problem of salinity and arsenic are both been reported by the villagers. Inadequate coverage of the public supply system from PHE has resulted in greater dependence on private sources from an illegally constructed water plant in the village. Availability of water from such a source does not guarantee its quality or accessibility. While affluent households are ready to pay upfront for vended water high prices forms a major barrier to access it particularly for the poor and marginalised.

III. Case study selection periuban Khulna

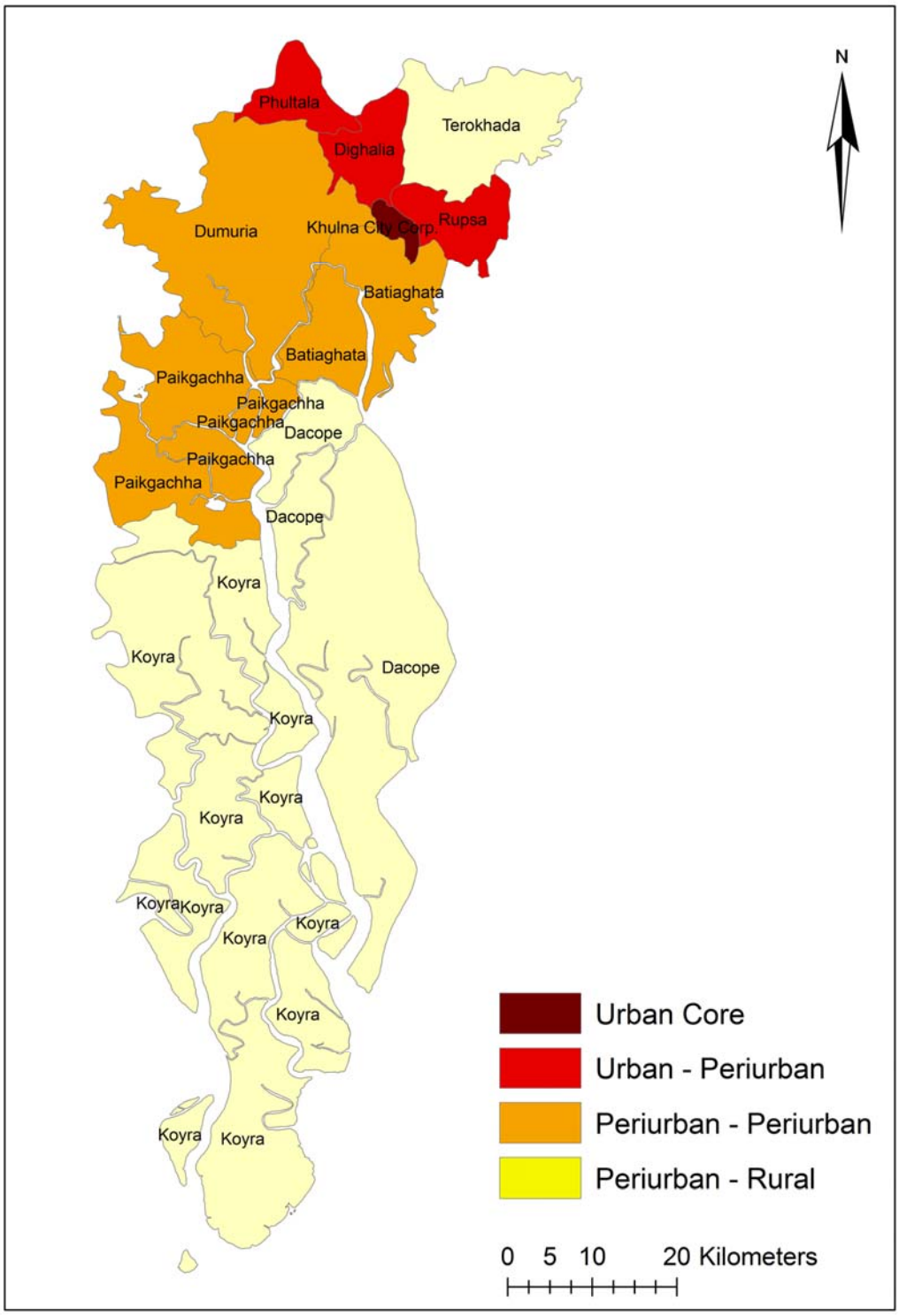
Khulna conurbation is expanding fast towards the fringe areas, getting the backup strength from the activities in the periphery. Growing in South to South-Western direction along

Khulna-Jessore bypass and Khulna University areas the conurbation portays the story of improved transportation, rapid industrialisation, real estate boom, migration, promotion of private housing schemes, community service facilities etc. Business activities are also flourishing in the north and north-western part and Rupsha bridge connects the eastern part of Khulna city experiencing frequent urban growth. Arguably, diversified livelihood patterns, conflicts and contestations with access to resources like groundwater are overtly felt in the peripheral space of the Khulna city. In Khulna, two upazilas namely, Batiaghata and Phultala have been selected. Both these upazilas form part of the Khulna Development Authority KDA and outside the jurisdiction of Khulna City Corporation KCC. Selection of the Upazilas followed the same methodology as Kolkata (table 6; map 4).

Table 6 - Delineation of periurbanity in Khulna region: Data and methodology

<table>
<tr><th>Level 1 - Initial attributes</th><th>Level 2</th><th>Level 3</th><th>Level 4</th><th>Level 5</th></tr>
<tr><td></td><td colspan="3">Reducing the dimensions through principal component analysis (PCA)</td><td></td></tr>
<tr><td>Female literacy rate (%)</td><td rowspan="2">Education and employment indicators (PCA 1)</td><td rowspan="3">Broad indicators of economic growth (PCA 3)</td><td rowspan="8">Broad indicators of economic growth, infrastructure and housing facilities (PCA 7)</td><td rowspan="12">Final clusters (k-mean analysis)</td></tr>
<tr><td>% Non-agriculture workers in total employment</td></tr>
<tr><td>Population density (per sq km)</td><td rowspan="2">Indicators of population dynamics (PCA 2)</td></tr>
<tr><td>Sex ratio (Male per thousand females)</td></tr>
<tr><td>% Share of metalled/ semi-metalled road in total road length</td><td rowspan="2">Village infrastructure (PCA 4)</td><td rowspan="6">Infrastructure and housing facilities (PCA 6)</td></tr>
<tr><td>% of households electrified</td></tr>
<tr><td>% of households having pucca house structure</td><td rowspan="3">Household facilities (PCA 5)</td></tr>
<tr><td>% of households having water sealed toilet facility</td></tr>
<tr><td>% of households having tapped drinking water facility</td></tr>
<tr><td>% of gross cropped area irrigated through low lift and deep tubewells</td><td colspan="3">Ground water use (Adjusted clusters)</td></tr>
</table>

Map 4 – Periurban interface within Khulna metropolitan area, 2011



Source: Constructed by the author.

Subsequent task was to shortlist villages for Rapid Rural Appraisal RRA. KPIs with Union officers and FGDs with community have helped in selecting unions and villages from each Upazila. Six Key Person Interview and 4 FGDs were carried out with different community members (list is attached in annexure tables). Table 7 provides the list of shortlisted unions, villages from Batiaghata and Phultala upazilas. Village statistics on demography and occupational structure supported by field insights grounded our case study selection.

Table 7 - List of villages selected in periurban Khulna

Upazila	Union	Villages
Batiaghata	Jalma	Holgadanga
		Nijkhamar
		Thikrabandh
		Ghola
Phultala	Atra-Gilatola	Pariadanga, Masiali, Matumdanga, dakatia
	Jamira	-
	Damodor	-
	Phultala Sadar Union	-

Irrigation is essentially groundwater dependent in both Jalma and Attra Gilatala unions. Most of the households abstract groundwater from shallow aquifer through submersible pumpsets. Hand tube wells are used for irrigating vegetables and minor crops on a very small scale. In lean period water crisis becomes very acute with ground water layer falling dawn at 1250-1280 ft in most of these areas. The drinking water sources are deep tube wells and are largely owned by local authorities. Lift irrigation techniques from Mayur and Kazi Bacha rivers are frequently practiced in Jalma. While Khal irrigation of a smaller scale is restricted within the few pockets of Jamira, Damodar and Phultala Sadar Unions. Problem of arsenic and salinity have been reported in all the unions. Water vending for drinking and domestic use are seldom noticed in Attra Gilatola union.

Paddy forms the principal crop in all the selected unions with three main seasonal varieties i.e. *aus, aman and boro*. Aus are rainfed, pre- monsoon rice, and are typically low yielding. Aman rice is grown during the monsoon (rainy) season and is also lower yielding, whereas boro is irrigated and high yielding rice production grown during the dry winter season (January through June). Due to its comparatively higher yield potential (3.4 tons ha-1)

compared to aus (1.6 tons ha-1) and aman (2.0 tons ha-1), boro rice production has expanded in the last two decades in the Unions. Paddy cultivation in complemented by leguminous species (lentil lens culinaris), lathyrus (lathyrus sativus), and mungbean (vigna radiate) in non-irrigated areas during the dry season. However, the extent of dry season cropping is limited mainly due to lack of irrigation water and soil salinity.

Villages of Jalma and Attra Gilatala have established groundwater market. People share one-fourth of their crops in exchange of water. Households buy water hour wise (100 taka per hour) to irrigate their lands from vendors present in Jalma, Jamira and Attra Gilatala union. Some also share 380-450 Kg (38-.45 metric ton) rice from one bigha (33 decimal) in exchange of watering to their lands. Heavy concentration of jute, cement and salt manufacturing factories in Phultala sadar and Attra Gilatola union plays a significant role in shaping the occupational structure of the selected villages.

Following section provides a detail account of the villages-

a. Periurban nature of the villages

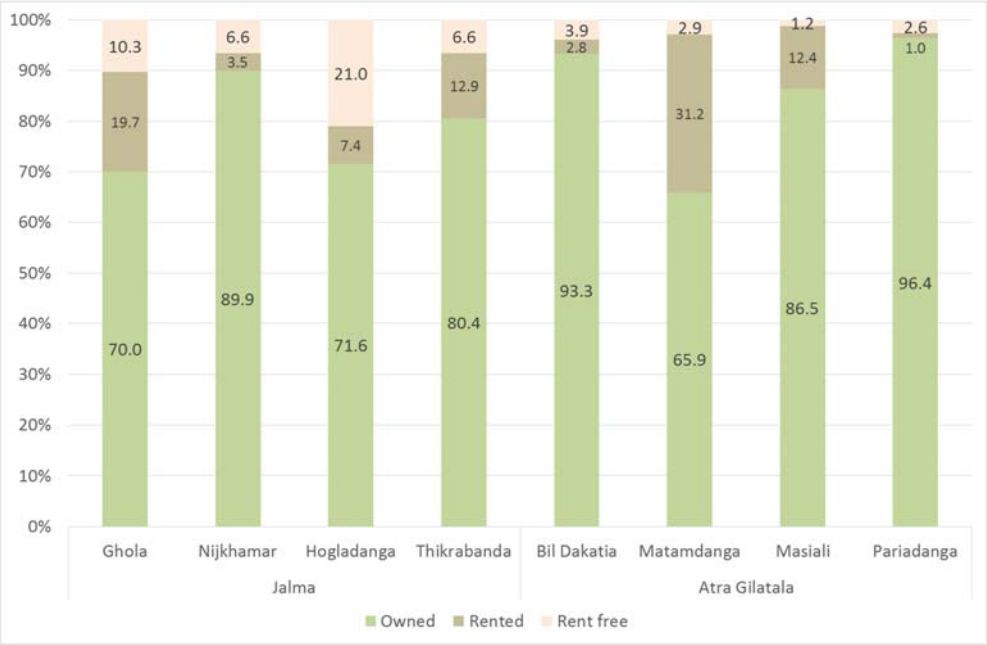
Periurbanisation processes reflected through construction of gas transmissions lines, communication network (highways and railways), public and commercial establishments have played a crucial role in shaping the growth trajectory of the selected villages in periurban Khulna.

Diversified livelihood choices have made Matomdanga, Nijkhamar, Hogladanga, Ghola and Thikrabandh more promising for large number of distressed migrants from the coastal areas of Paikgacha, Koyra, Symnagor. Seasonal migration is also common in almost all the villages during boro farming (figure 9).

Figures 10, 11 and 12 show electricity connection, type of houses and status of toilets in the villages in 2011. All the villages of Atra Gilatala have 70-90 percentage of electrified households while Hogladanga of Jalma has least electricity coverage. If we look into the type of houses and toilet facilities available Matamdanga has largest share of pucca houses with sanitary facilities. While Hogladanga has large number of kuccha and semi pucca houses. However as far as toilet facilities are concerned apart from Thikrabanda, BillDakatia and Pariadanga all other villages have water sealed sanitary structures. Periurbanisation process, measured in terms of household amenities shows varying growth across villages. Such changes in the household's

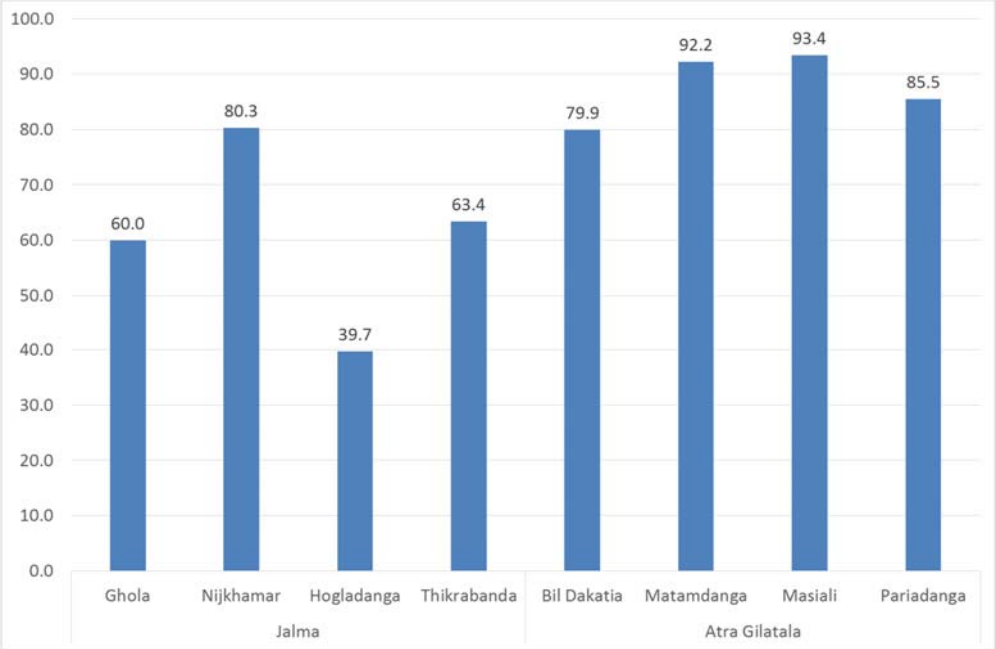
physical asset can be further explained through the economic activities, education level and status of women in the villages.

Figure 9 - Percentage distribution of households by housing tenancy, 2011



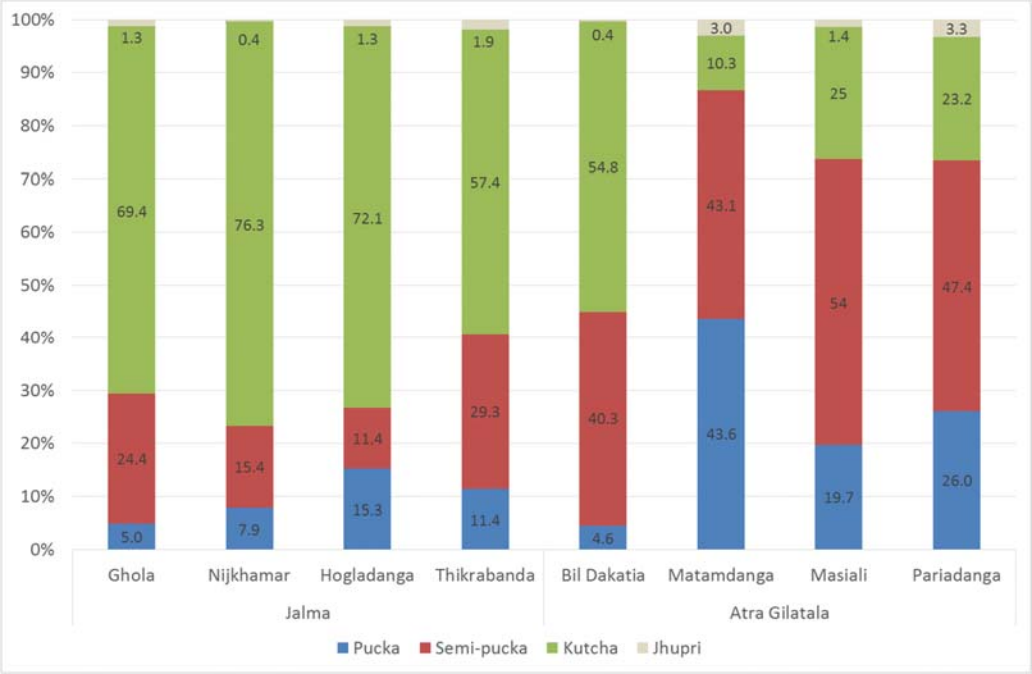
Source: Population census of Bangladesh.

Figure 10 - Percentage of households with electricity connection, 2011



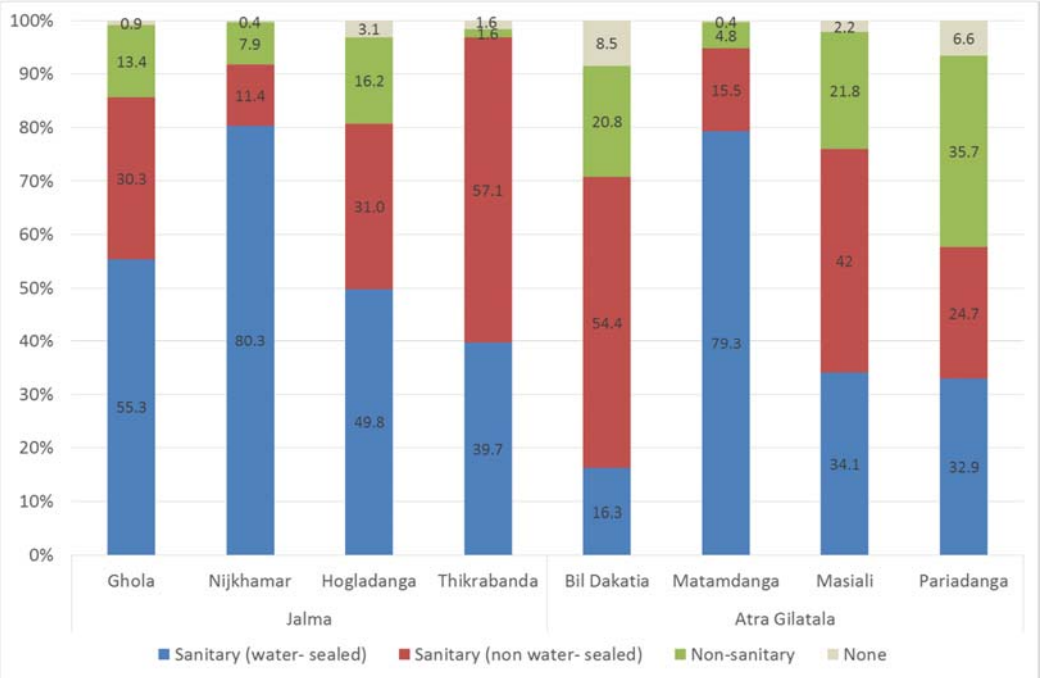
Source: Population census of Bangladesh.

Figure 11 - Percentage distribution of households by type of housing structure, 2011



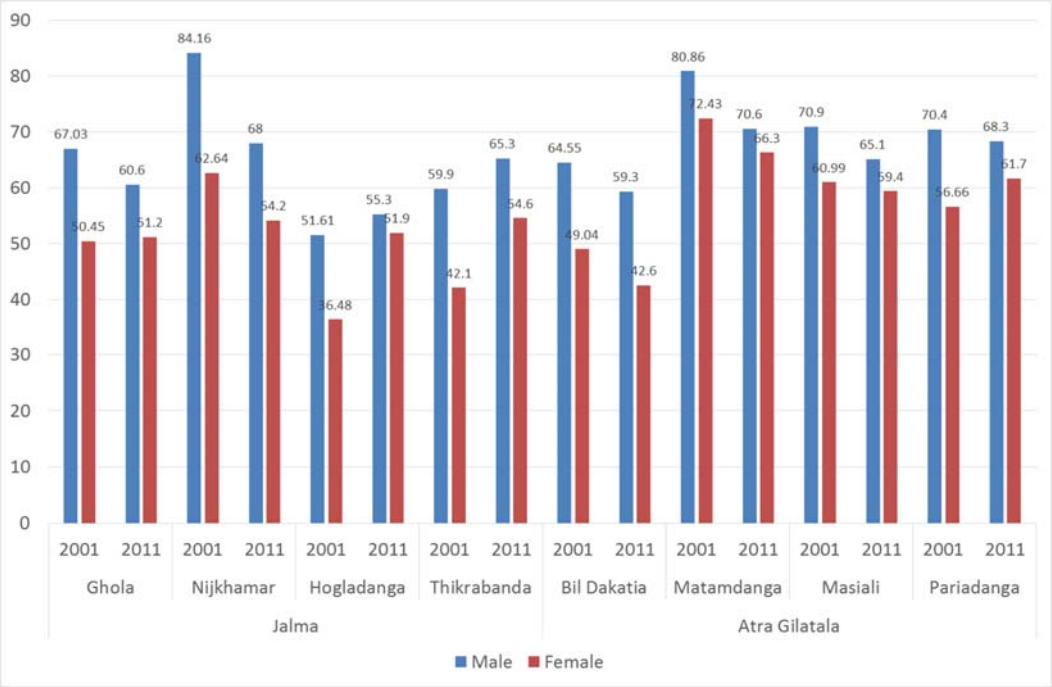
Source: Population census of Bangladesh.

Figure 12 - Percentage distribution of households by type of toilet facility, 2011



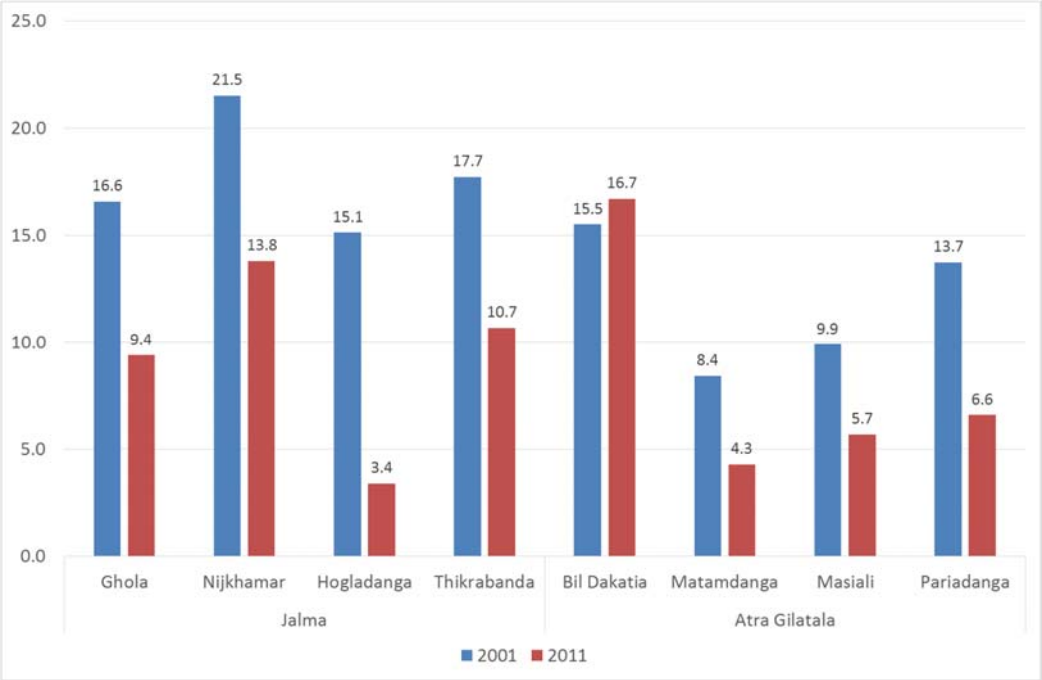
Source: Population census of Bangladesh.

Figure 13 - Change in male and female literacy (percentage), from 2001 to 2011



Source: Population census of Bangladesh.

Figure 14 - Trend of gender gap in literacy (percentage), from 2001 to 2011

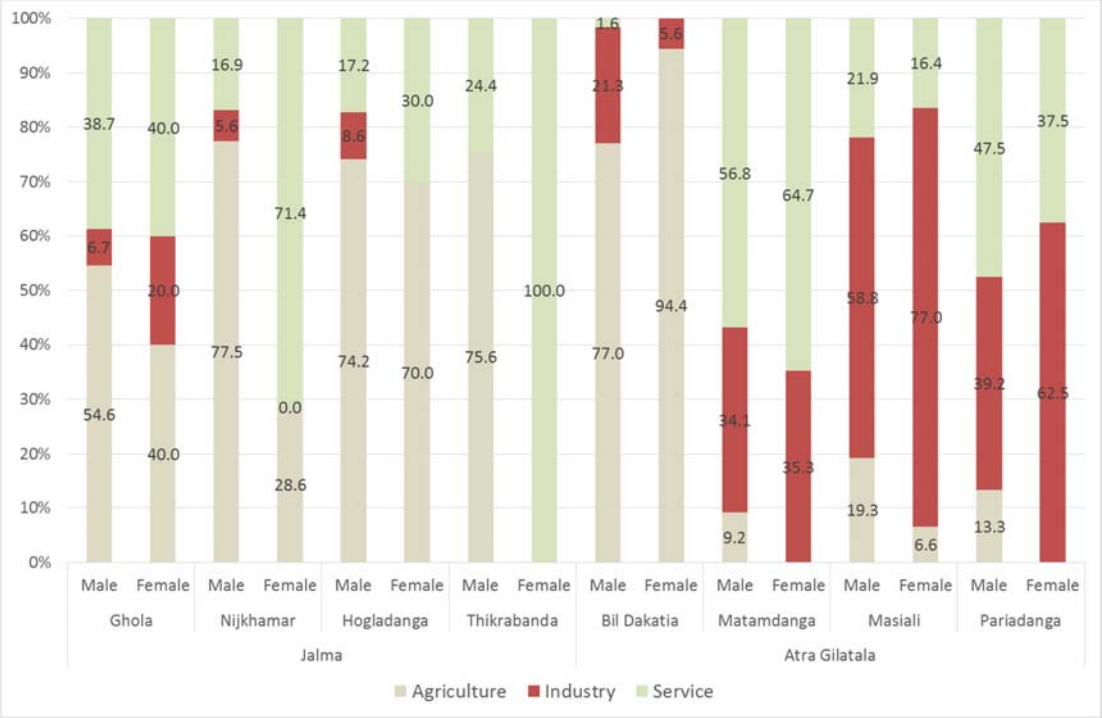


Source: Population census of Bangladesh.

Figures 13 and 14 depict the literacy level and gender gap across villages. Women literacy is considered to be an important indicator of periurbanity. Change in literacy level between 2001 and 2011 shows a positive trend in all the villages. Gender gap in terms of literacy has reduced over last 10 years with village like Bil Dakatia showing a negative gap, in the sense that women literacy rate has out number male. Among all the villages Hogladanga has least growth in female literacy with largest gap. Such a trend has its implication on women's economic and social status as explained by occupational pattern and sex ratio.

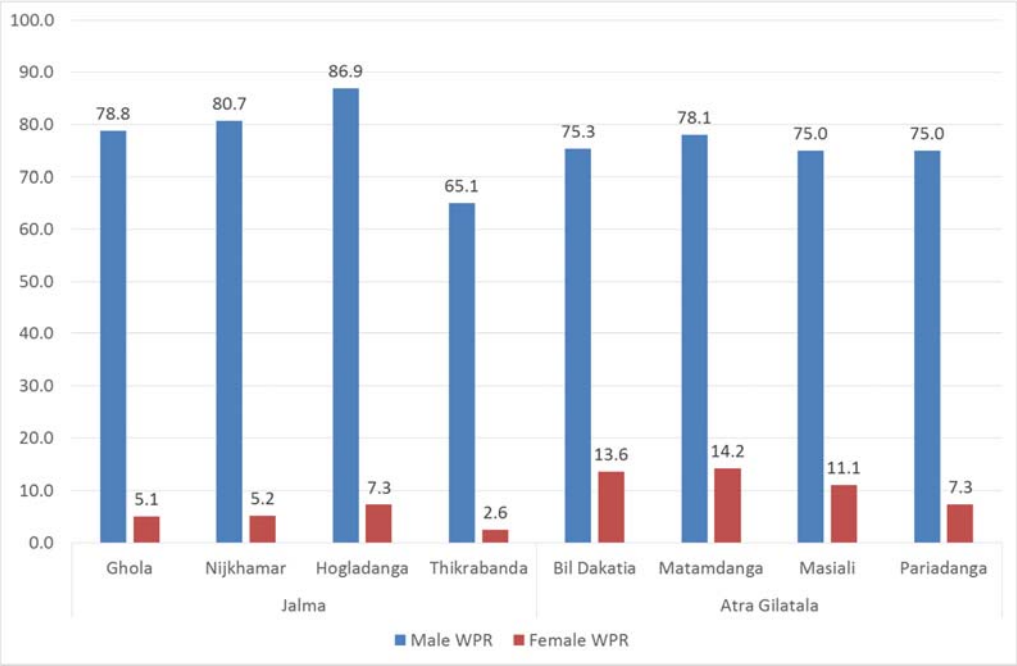
Hogladanga has largest number of women agricultural worker, while Matamdanga, Pariadanga and Masiali has large share of women in service sector. Lack of data on women cultivators, household and hired women laborers has restricted our analysis. However a strong correlation can be seen across women literacy rate, work participation and sex ratio explaining the situation in selected cases. Lower women literacy rate in Hogladanga can be explained with low work participation in general, largely restricted to agricultural domain as unpaid household labourer. While decrease in sex ratio with increase in literacy is a probable indication of early marriages and low socio-economic status of the women in Hogladanga (figures 16 and 17).

Figure 15 - Sectoral distribution of workers (+7 age and not attending education), 2011



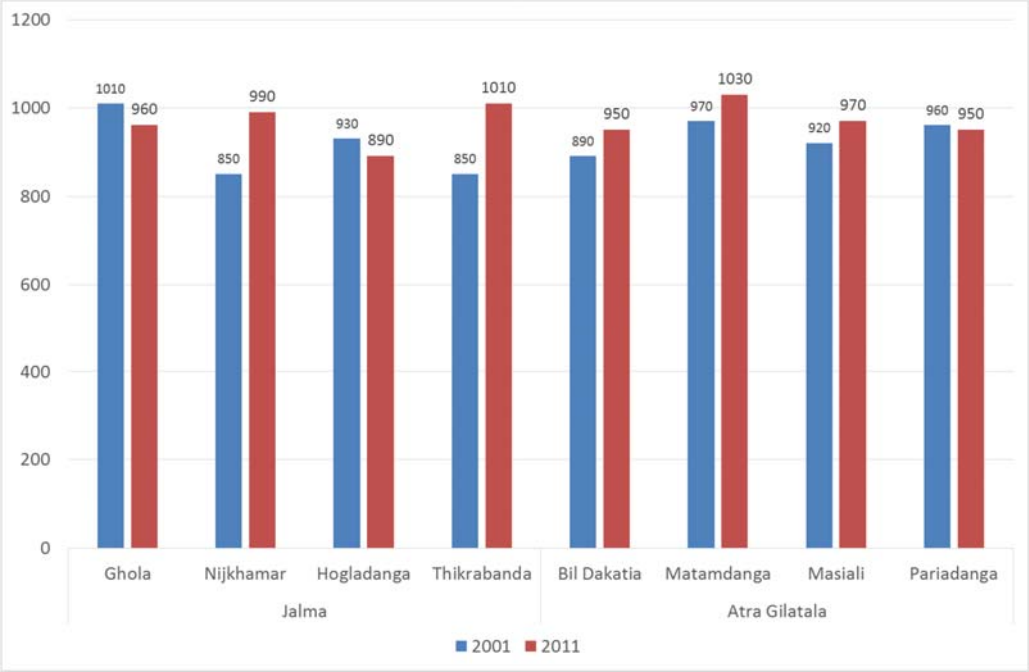
Source: Population census of Bangladesh.

Figure 16 - Worker population ratio (+7 age and not attending education) in study villages (percentage), 2011



Source: Population census of Bangladesh.

Figure 17 - Change in sex ratio (females per thousand males, +7 age), from 2001 to 2011



Source: Population census of Bangladesh.

Above discussion surfaced some of the critical dynamics of periurban processes. Urban expansion has different connotation to the life and livelihood of the periurban community. Household power dynamics, aspirations, governance and institutions determine its ability to create economic and social assets. Not all the periurban areas are able to make strategic responses to the periurban processes. Weak regulatory mechanisms and governance structure has led to haphazard industrialisation and commercial activities in Matamdanga, Pariadanga and Masialli. Lack of coordination between KDA and KCC is reflected in delayed implementation of master plans, illegal construction of apartnments and commercial buildings in the peripherial areas. It is therefore crucial to see who wins and who losses out in this context. Based on afore said discussion Hogladanda from Jalma union and Matamdanga from Atara Gilatala union have been selected.

b. Importance of groundwater as a major resource for local stakeholders

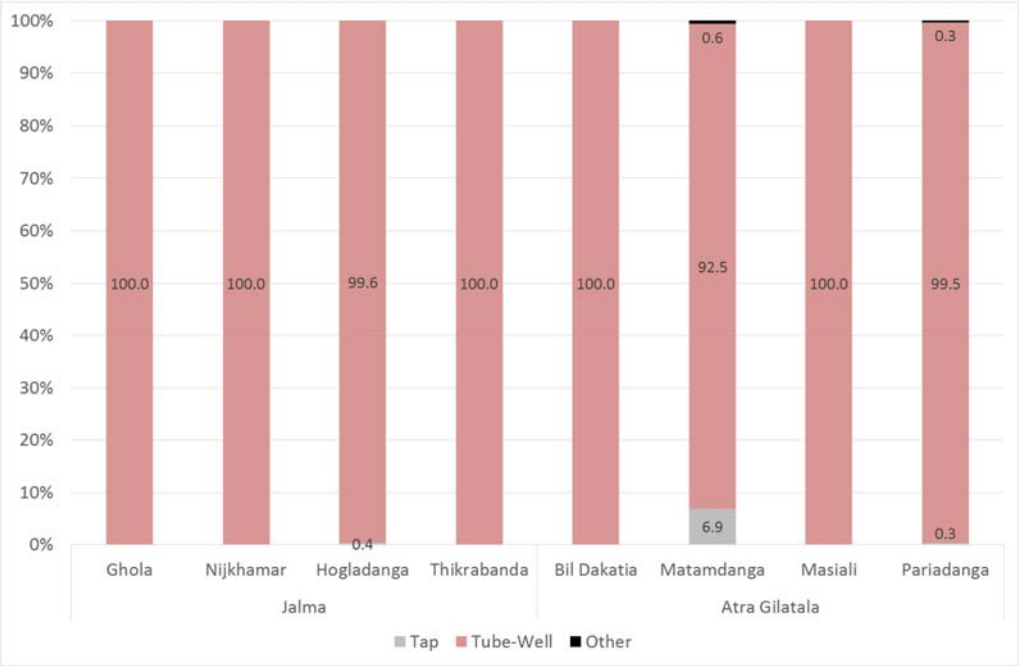
Groundwater forms the main source of irrigation and domestic needs in all the selected villages. . Irrigation is affected due to fallen groundwater level and erratic rainfall. FGDs with farmers and women groups revealed that in Holgadanga, Nijkhamar, Thikrabandh, Ghola and Matamdanga cultivators use boring (Irrigation scheme by Tubewell normally 3-4 inch diameter) to cultivate boro paddy and seasonal crops. Shallow borings are essentially privately owned in all the villages. However collectively owned tube wells can be seen in Hogladanga and Matamdanga. Although Bangladesh Agriculture Development Corporation (BADC) has provided deep wells for irrigation in Matamdanga its access is politically guided.

Conjunctive use of surface and groundwater can be seen in '*gher system*' traditionally practiced in Hogladanga. Gher forms an important livelihood strategy for small and marginal farmers where field channels are dug out around the agricultural parcel. These dug out channels are used as water storage structures in rainy season to cultivate freshwater prawns. Several groundwater intensive non-farm activities like poultry, fishing are extensively practiced in Bill Dakatia and Matamdanga. In Hogladanga seasonal groundwater scarcity has affected both agricultural and shrimp farming. In lean period irrigators are required to pump from deeper aquifers or borrow from tube well owners for the cost of 50 BDT. In Hogladanga, Nijkhamar, Bil dakatia and Thirkabanda lack of irrigation facilities have reduces the cropping intensity from 3 crops of rice per year to only 1 crop with shrimp/ fish culture during Amon. Groundwater irrigation is access through market in Matamdanga where tube well owners

becoming water vendors selling water to local irrigators at rate of 3000-4000 BDT/season/ 0.5ha for unlimited use.

Figure 18 shows distribution of drinking water sources across villages. Interestingly, apart from Matamdanga all other villages have tubewell as their only source. The tubewells are largely owned and managed by KWASA and union parishads. Frequent reporting of high level salinity and arsenic been registered by the households in all the villages. Number of agencies including BWDB, DoE, DPHE and BADC with WARPO acting as the central planning and coordinating body for national policies on water quality in the country. State functionaries of each of these departments and ministries have overlapping jurisdictions. For instance DoE currently only monitoring surface water quality despite industrial, agricultural and urban sewage threats to groundwater quality. DPHE undertakes groundwater monitoring only at time of tube well installation while BADC produces GW quality reports 1-2 years as well as groundwater zoning/ availability monitoring. WARPO currently developing guidelines for BWA 2013 but expressed difficulty in coordinating groundwater data from different ministries. Lack of coordination often hinders effective management of these asset particularly in the transitional areas.

Figure 18 – Percentage distribution of households by type of drinking water facility, 2011



Source: Population census of Bangladesh.

c. <u>Tensions</u> (recent, actual or imminent conflicts) over groundwater resources (quantity and/or quality)

Masiali, Dakatia, Pariadanga and Matumdanga protested against massive extraction and transfer of groundwater from Atara Gilatala union to the Khulna City. The violent protest, agitation, negotiation happened with regard to KWASA's ambitious 'Phultala Water Supply Project' of supplying water from Phultala upazila to the city corporation area. KWASA attempts to bridge the demand gap (53 percent currently) for KCC residents through installation of 20 groundwater pumping stations in Phultala was met with widespread community opposition and court petitions. Phultala Paani Andolan Committee together with Bangladesh Environmental Lawyers Association BELA have organised a formal community led opposition campaign in 2005 against KWASA (then KCC) pumping project leading to its halt in 2010.

Table 7: Village wise use of groundwater in Jalma Union, Khulna

Village	Drinking	Irrigation	Other usage	Issues
Holgadanga	Deep tube wells are the main drinking water sources. Khals and shallow tube wells are used for domestic purposes.	Both surface and ground water based irrigation.	Cooperative usage of boring for paddy cultivation.	Most of the agricultural lands are cultivated by Tenant farmers or leaseholders. Only 1-2 % lands are cultivated by owners.
	Shallow tubewells contain chloride (upto 200 ft) and iron while salinity reduces after 450 ft .	Shallow tubewells based boro cultivation is extensive. The water is extracted at 300-400 ft.		High incidence of rural in-migration from coastal areas due to climate disaster.
		Fresh water aquaculture and composite farming (paddy and fish) are practiced.		Politics and conflicts between farming and fishing community with the operation of sluice gate.
		Strong presence of groundwater market. Water is sold per hour or per bigha basis.		Strong political influence in tenancy and sharecropping.
		People share one-fourth of their crops in exchange of water. Some also buy water hour wise (100 taka per hour) to irrigate their lands from vendors present in that area.		Cropping cycle has reduced
				Real estate boom.
				Diversified livelihoods (mason, auto driver, dairy and poultry farming).
				Access to groundwater is politically determined.
				Landfill site causing pollution and hygiene problems.
Nijkhamar	Deep tube wells are the main source of drinking water. Shallow tube wells are used for domestic purposes.	Khals forms the main source of irrigation. Shallow tube well irrigation are restricted due to high salinity. No water market present.	Surface water forms major source for domestic use. Industries are having private bore wells.	Salinity and arsenic in shallow water.
				Rich farmer installs "Boring" for their personal usage. Boring must be 3 inches otherwise water pressure falls in winters.
				Incidence of agriculture is much less agricultural lands are being converted into housing plots and also some are used as business centre (poultry).
Thikrabandh	Deep tube wells are the main source of drinking water. Shallow tube wells are used for domestic purposes.	Surface water is the main source of irrigation while groundwater irrigation is slowing emerging.	Groundwater usage is mainly restricted to drinking and boro cultivation.	No apparent issues of water conflicts can be seen. However the village has relatively high crime rate and reported cases of drug addiction.
				NGOs are quite active here.
Ghola	Water is drinkable after 450 ft and shallow water contains iron and salinity.	Groundwater based irrigation. Strong presence of groundwater market.	Industries are less in number.	Seasonal in-migration during boro cultivation.
			Real estate boom are also not quite visible.	

Source: Compiled from the field reports prepared by JJS, Khulna, Bangladesh.

Table 8 - Comparative assessments of issues across villages in Atra-Gilatola Union

Village	Drinking	Irrigation	Other usage	Issues
Pariadanga	Deep tubewells for drinking purpose	Surface water based irrigation	No other significant usage of groundwater except for drinking purpose	Water logging
Matumdanga	Deep tubewells for drinking purpose	Groundwater dependent irrigation	Extensive usage of groundwater by cantonment board and industries	Conflicts, quarrels, oral disagreements across farmers sharing groundwater through water markets
		Presence of strong groundwater markets		Crisis of safe drinking water, collection points are inadequate and situated far from the village
		Three cropping season (ravi, aman and boro)		Increase cost of investment on shallow submersible bore wells, increase in labour cost
		More cultivators and less sharecroppers or tenancy farmers		Water logging due to construction of highway road that blocks the drainage system in the area
				Canal is blocked by siltation and land encroachment
				Polluted water from BSCIC industrial area runs through the village
				Inadequate sanitation system
				Decrease of agricultural land due to rapid urbanisation and construction of new houses by the migrants people
				High rate of land acquisition by the government
				Poor opportunity for women employment
Masiali	Deep tubewells for drinking purpose	Farmers use deep tubewells water buying them 100 taka per hour. Some also share 380-450 Kg (.38-.45 metric ton) rice in exchange of watering to their lands.	Extensive use of water in Jute and cement industries	Rapid industrialisation scored up the land prices; High Crime Rate; Land acquisition
Dakatia	Deep tubewells for drinking purpose	Surface water dependence with fewer incidence of groundwater irrigation. Almost all family have a shallow engine and they use it to draw water from khals to cultivate their lands	Industrial development is low. Domestic uses are high	Heavily waterlogged

Source: Compiled from the field reports prepared by JJS, Khulna, Bangladesh

Frequent cases of petty fights have been reported with hiring of shallow machine during boro irrigation. High demand and rent (120-150 BDT per hour for shallow- machine) during peak irrigation season are barriers that restricts small farmer's access to groundwater. Longer hours of waiting in the queque beaks into arguments, quarral and fights across households in Matandanga, Hogladanga, Bil datatia and Nijkhamar. Many a times nasty fights turns into bloodshed where more politically and economically powerful households subjugates the poor and marginalised as reported in Masailie and Matamdanga.

Informal rules and regulations to collectively manage and access groundwater from the shallow tubewell often get beset with power politics. Latent tensions and frustrations have been reported by the poorer households who does not often get access to drinking and irrigation water from the tubewell installed by BRAC and other NGOs. Table 7 provides a comparative account of the groundwater use and issues of conflicts across villages in Jalma and Atara Jilatala unions respectively.

d. Willingness of key players to engage with Shifting Grounds researchers

JJS has a strong presence in these areas at large. Several consultations with the community members helped the mobilisers and researchers to win the confidence of the villagers. Two villages namely Matomdanga in Atara Gilatala and Hogladanga in Jalma union have been selected.

e. Ability of key players to engage (Existence of nucleus for self-organisation or platform, such as presence of NGO, CBO or village committee who has already identified the problem)

Most of these villages are aware of NGOs and alternative governance systems to manage resources. They are sensitive and conscious of their needs and seek support to mobilise their voice. In Matamdanga, Bildakatia and Mseili organisations like Brac, DMS, Jagoroni Chakro Foundation (JCF), TMSS, Muslim Aid, Bureau Bangladesh, CSS Microcredit, CSS Health, Merry Stopes etc. are activities.

f. Practical feasibility: accessibility of location, documentation, data

All the villages are close to the city with effective transportation.

g. Diversity in the full set of sites, befitting the more exploratory nature of our research efforts

In terms of diversity of issues Matamdanga stands out as an excellent where multiple uses of groundwater can be explored. Conflicts and contestations among the households involved in irrigation water trading have been reported in all the villages. However Hogladanga and Matamdanga has shown larder conflicts dynamics.

Table 9 – Summary table showing ground water dynamics across selected sites

Villages	Periurbanity													Importance of groundwater as a major resource for local stakeholders	Tensions over ground water resources	Willingness of key players to engage with Shifting Grounds researchers	Ability of key players to engage	Practical feasibility	Diversity
	NF	Mig	DC	FL	CA	Irr	ML	DCPR	HLV	PSC	LR	PS	TC						
Kolkata																			
Bodai	High	Medium	High	Low	High	High	High	High	High	Medium	High	Medium	High	High	Medium	High	High	High	High
Tihuria	Low	Medium	Medium	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High
Khulna																			
Hogladanga	Medium	Low	Low	Low	Medium	High	Low	High	High	Medium	Medium	Medium	High	High	Medium	High	High	High	High
Mantomdanga	Medium	Low	Medium	Low	Medium	High	Low	High	High	Medium	Medium	Medium	High	High	High	High	High	High	High

High | Medium | Low

Source: compiled from field notes of JJS and The Researcher. *Note:* ***NF***- Higher percentage of non-farm families (Rigg 2006); ***Mig***- Higher percentage of migrant population (Narain 2009); ***DC***-High incidence of daily commuting to the nearby industries and towns for employment, education etc. (Narain 2009); ***FL***-Feminisation of labour force (Ranjan & Narain 2012); ***CA***-Prevalence of high value commercial agriculture and allied activities e.g. horticulture, aquaculture, floriculture (Narain 2010); ***Irr***-Larger area under irrigation; ***ML***-Mixed land use pattern (Narain 2010); ***DCPR***-Degradation of forest lands (Narain, Banerjee, and Anand 2014) AND Disappearance of surface water bodies (Ramachandraiah, Westen and Prasad 2008); ***HLV***-High valuation of building and land (Periurbanisation in Europe, Plural, 2010); ***PS***-Political hotspots; ***PSC***-Change in the behavioural pattern of population, breaking of the traditional networks, creation of new associations (formal and informal); ***LR***-Larger expenditure in education, particularly girls education (Narain, Banerjee, and Anand 2014); ***PS***- 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); ***TC***-Connected with the nearby cities by means of transport corridor (Narain, Banerjee, and Anand 2014).

Annexure

A 1: Key person interviews

Khulna

- Engr. MD. Kamaluddin Ahmed, Deputy Managing Director (Engg), Khulna Water Supply & Sewerage Authority
- Engr. Sk. Abdul Mannan, Executive Engineer, DPHE, Khulna
- Md. Tanvir Ahmed, Asst. Town Planner, Khulna Development Authority
- Abdul Gafur Molla, Chairman, 01 no Jalma Union Parishad, Batiaghata
- Shandipon Kumar Roy, Teacher, Phultola Reunion Model School & College & Secretariat Member, Phultola Pani Andolon Committee, Phultola, Khulna
- Md. Shah Nawaz Talukder, Designation: Chief Revenue Collector,, Khulna City Corporation

Kolkata Friday, 4 December 2015

Name of the Village : Tihuria
Name of the block : Sonarpur
Name of the District : South 24 pargana
Main Occupation : Farmer and waste water aquaculture
Place : playground of South Para
FGD Participants : Pinky Mondol, Madhumita Halder, Ranu Mondol, Arunima Haldar, RekhaHaldar, Archana Khan, Dipa Haldar, Geeta Dey, Madhabi Mondol

Name of the Village : Tihuria
Name of the block : Sonarpur
Name of the District : South 24 pargana
Main Occupation : Farmer and waste water aquaculture
Place : in front of the deep tube well No 1 Saheberabad
FGD Participants : Prbhas Mondal, Partha sarathi banerjee, Binoy mjumdar, Dipa Haldar, Geeta Dey, Madhabi Mondol

A2: Group Discussions

Khulna

Name of the Village : Shantinagar
Time 04.00 pm
Name of the Upazilla : Batiaghata
Name of the District : Khulna
Date 20 June 2013
Main Occupation : Farmer
Place : House of Setara Begum
FGD Participants : Md. Yeasir Ali , Ashraf Ali Howlader, Miraj Shikder, Anowar Hossain, Md. Hanif, Md. Lokman, Md. Obaidul, Oli Sarder, Md. Liakat Hossain, Monir Faraiji, Saukat Baiati

Name of the Village : Shantinagar
Date 20 June 2013
Name of the Upazilla : Batiaghata
Name of the District : Khulna
Main Occupation : Farmer
FGD Participants : Josna Begum, Setara begum, Piara Begum , Beauty Begum, Taslima,Tohfa Begum, Zakia Begum, Selina Begum, Rumana Begum, Selina Begum, Monira Begum, Ayesha Begum, Moyna Begum

Name of the Village : Mashiali
Time 04.00 pm
Name of the Union : Atra
Date 22 June 2013
Name of the Upazilla : Phultola
Name of the District : Khulna
Main Occupation : Farmer
Place : House of Sarifa Begum
FGD Participants : Zahangir Hossain, Kamrul Islam, Md. Ismail Sheikh, Md. Lokman Hossain, Md. Harun-Or-Rashid, Md. Piar Ali Shiekh, Habibur Rahman Sheikh

Name of the Village : Moshiali
Time 05.30 pm
Name of Union : Atra
Date 22 June 2013
Name of the Upazilla : Phultola
Name of the District : Khulna
Main Occupation : Farmer
FGD Participants : Chompa Begum, Rabeya Begum, Rina Begum, Johora Begum, Komola Begum, Jahanara Begum, Halima Begum , Rina Begum, Sharifa Begum, Hosneara Begum, Sumaya Khatun

Shifting Grounds: Institutional transformation, enhancing knowledge and capacity to manage groundwater security in peri-urban Ganges delta systems

The project aims to build knowledge and capacity among local actors to support a transformation process in peri-urban delta communities in Bangladesh and India for a pro-poor, sustainable and equitable management of groundwater resources across caste/class and gender. This will be based on an improved understanding of the dynamic interplay between local livelihoods, the groundwater resource base, formal and informal institutions and links with nearby urban centres in Khulna and Kolkata. These two cities provide a good basis for an institutional comparison, being part of the same Ganges delta system, yet located in different countries.

Funded by the Netherlands Organisation for Scientific Research (NWO), the Shifting Grounds project is executed by a group of academicians, researchers and civil society organisations. Delft University of Technology (TU Delft) leads the consortium and SaciWATERs is the regional coordinator for the project. Other project partners are Jagrata Juba Shangha (JJS), The Researcher, Bangladesh University of Engineering and Technology (BUET) and Both ENDS.

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