Water Security in Peri-Urban South Asia

Adapting to Climate Change & Urbanization

WATER SECURITY IN PERI-URBAN SOUTH ASIA ADAPTING TO CLIMATE CHANGE AND URBANIZATION

Scoping Study Report: Khulna

Dr. M. Shah Alam Khan
Mr. Uthpal Kumar

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Working primarily on water security issues in Peri-Urban South Asia, across India, Bangladesh and Nepal, the project's main concerns are the rapidly changing peri-urban landscapes due to urbanisation and implications for water security in specific locations in the larger context of climate change. As an action research project, working across four locations in South Asia, it will serve as a basis for capacity-building at the grass roots level to address concerns of the poor, marginalised and other vulnerable communities to water security and seek to understand the dynamics of adaptation in the specific locations, for action and policy agenda at the regional level. It will build their capacities to cope with climate change induced water in-security.

The project is being coordinated by SaciWATERs, Hyderabad, India and executed in association with Bangladesh University of Engineering and Technology (BUET), Dhaka in Bangladesh and Nepal Engineering College (nec), Kathmandu in Nepal. This project is supported by Canada's International Development Research Centre (IDRC).

A scoping study was carried out for a period of six months from August 2010 – January 2011. It was an exploratory phase that investigated the key peri-urban and climate-change related issues in the research sites. The process of changing peri-urban landscape and its impact on water security and vulnerability was probed by literature review, field visits, discussions with various stakeholders, and use of other qualitative techniques. Specific sites were identified in Kathmandu (Nepal), Gurgaon, Hyderabad (India), and Khulna (Bangladesh) where the research would be carried out.

Four scoping study reports consolidate the outcome of this study. This is the Bangladesh Scoping Study Report.

Khulna, Bangladesh Project

Institute of Water and Flood Management (IWFM),
Bangladesh University of Engineering and Technology (BUET)

Dr. M. Shah Alam Khan, Professor, Project Leader, e-mail: msalamkhan@iwfm.buet.ac.bd
Dr. Rezaur Rahman, Professor
Dr. M. Shahjahan Mondal, Associate Professor
Mr. Uthpal Kumar, Research Fellow

Associate Partners

Institute of Livelihood Studies (ILS): Dr. Hamidul Huq, Leader
Environmental Science Discipline, Khulna University: Dr. Dilip Kumar Datta, Leader

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For more information, please visit: www.saciwaters.org/periurban

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IDRC International Development Research Centre
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ADB	Asian Development Bank
BWDB	Bangladesh Water Development Board
BUET	Bangladesh University of Engineering and Technology
DoF	Department of fisheries
DPHE	Department of Public Health Engineering
GoB	Government of Bangladesh
GPS	Global Positioning System
ILS	Institute of Livelihood Studies
IWFM	Institute of Water and Flood Management
IWM	Institute of Water Modelling
KCC	Khulna City Corporation
KDA	Khulna Development Authority
KU	Khulna University
LGED	Local Government Engineering Department
MLD	Million liters per day
MSL	Mean Sea Level
RA	Research Assistant
RF	Research Fellow
RI	Research Intern
WASA	Water Supply and Sewerage Authority
WQM	Water Quality Monitoring

1. INTRODUCTION

Peri-urban communities suffer from water insecurity caused by urbanization and climate change impacts. To overcome the vulnerabilities, communities tend to adapt through various means and strategies. Urbanization sustains mainly by acquisition and conversion of agricultural land and water bodies in the peri-urban areas. Consequently, this process adversely affects the water availability, access and quality in the peri-urban areas leading to stresses on the life and livelihood of the community. The effects of the changing peri-urban landscape would be further degraded by climate change impacts including sea level rise and salinity intrusion. Therefore the peri-urban communities in a coastal setting would increasingly become vulnerable to uncertainty in water supply, diminishing access, growing water conflicts and erosion of social capital.

Access to safe water supply and sanitation is a major challenge in many urban and peri-urban areas of Bangladesh due to rapid and unregulated urbanization. Khulna is the third largest metropolitan city of Bangladesh located on the banks of the river Rupsha and Bhairab with a population of 1.4 million (in 2007) (Figure 1). Khulna suffers from acute water scarcity due to unplanned urbanization together with increased salinity in both surface and groundwater. Arsenic contamination in groundwater has also been a major problem of the urban and peri-urban communities. Besides, Khulna suffers from recurring water logging and drainage congestion problems. This situation would be further exacerbated by increased rainfall and sea level rise due to climate change. At present the Khulna City Corporation (KCC) area generates about 240-280 tons of solid waste daily, which is dumped in unplanned landfills and low-lying areas around the city (WARPO, 2005), causing another severe problem in the peri-urban areas. Wastewater generated in the city is diverted out of the city through a number of open drains and canals. Since urban wastewater is diverted to peri-urban areas and surrounding rivers, the flood water becomes heavily polluted with the urban waste and wastewater.

The peri-urban communities of Khulna are embodied with diverse livelihood opportunities based on agriculture and aquaculture. These livelihood options are often exhausted by unplanned urbanization.

Peri-urban communities of Khulna are also vulnerable to frequent natural disasters which are likely to be further aggravated by the projected impact of climate change. Experiences from the recent cyclones (SIDR and AILA)[1] and frequent droughts clearly indicate that the peri-urban communities of Khulna are vulnerable since the resilience of these communities is poor. It is also likely that climate change induced disasters will reshape the dynamics of the

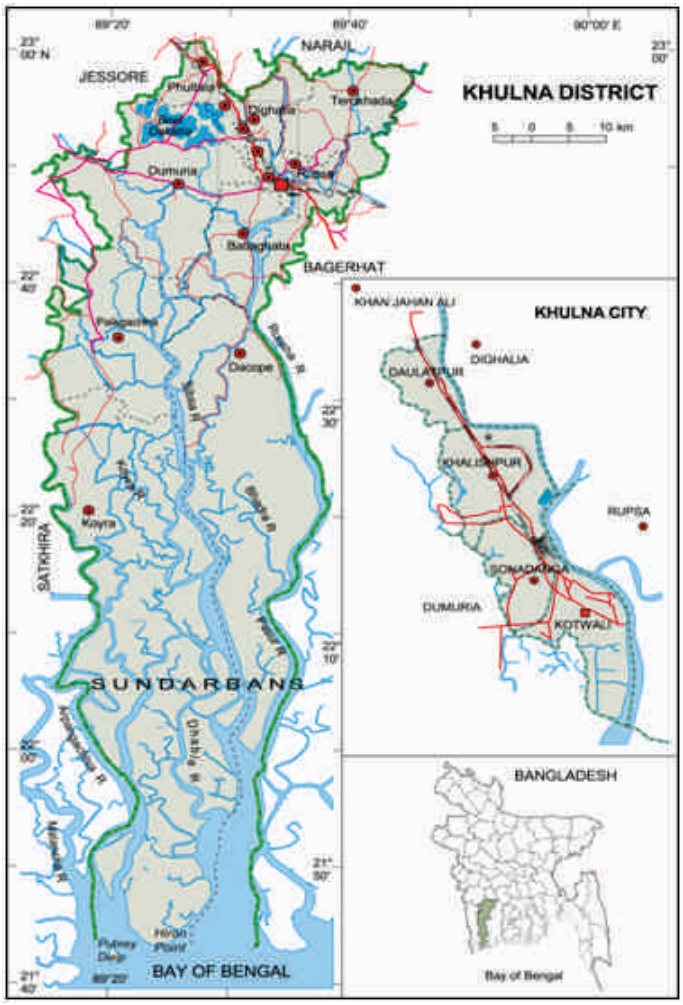

Figure 1: Location map of Khulna.

[1]SIDR: also known as the Super Cyclonic Storm Sidr. It was the strongest (Category-5 on the Saffir-Simpson Scale) cyclone formed in the central Bay of Bengal and quickly strengthened to reach a peak 1-minute sustained wind of 260 km/h. The storm eventually made landfall in Bangladesh on November 15, 2007. The storm caused massive destruction of life and properties and immediate toll death of about 3,447 people in the coastal region. AILA: was a Category-1 cyclone and hit the southwestern coastal region of Bangladesh on 25 May 2009. The cyclone formed on 23 May and dissipated on 25 May 2009 in the southwest coast of Bangladesh. About 2.3 million people were affected in greater Khulna, Satkhira and Bagerhat districts, and caused immediate death of about 325 people and massive infrastructure damages.

resource base over which the poor households will have no control. This will make them even more vulnerable because of the lack of resilience to cope with such problem (ICZMP, 2002). This is a serious concern and source of conflict over water resources in the area.

This research will attempt to analyze the dynamics of the system and to build multi-stakeholder platforms for better adaptation to urbanization and climate change impacts. This aims at understanding in a participatory way with the peri-urban communities the implications of urbanization for their water insecurity considering the overall context of climate change. This action research also aims at working with the communities in assessing and monitoring their vulnerabilities, and determining strategies and implementing them to overcome their water insecurity. Since these vulnerabilities entail various dimensions of the social and physical systems, the study also adopts an interdisciplinary approach. As a first step in this process, the present scoping study focuses mainly on identification of the vulnerable communities, setting objectives and boundaries of the future research and action in developing a framework for vulnerability assessment and monitoring in peri-urban locations of Khulna, Bangladesh.

2. DESCRIPTION OF RESEARCH PROBLEM

Urbanization and climate change processes are causing water insecurity in the peri-urban areas of Khulna city. Salinity in surface water and groundwater in and around the city is likely to increase due to sea level rise. This will stress water availability in the urban areas and, in turn, the peri-urban areas. Sea level rise along with rapid urbanization will also aggravate the existing flooding, water logging and drainage congestion situations in the area. Urbanization is diminishing the open water bodies and threatening the subsistence use of water bodies (washing, bathing, livestock rearing, etc.) in the peri-urban areas. The degree of vulnerability varies among different stakeholders and peri-urban residents adapt to these situations through alternative means and mechanisms. In this process a combined action by the community and public agencies is essential.

Networking and capacity development of the vulnerable communities will empower the communities and will help them reduce their vulnerabilities. With this conceptual understanding and background, the following research questions were formulated for the study:

1. What are the contexts and dynamics of urbanization process in Khulna, and what are the roles of different actors in this process?

2. What are the impacts of urbanization on peri-urban areas? What are the linkages among urban, peri-urban and rural areas? What are the consequent changes in livelihood and social dynamics?

3. What are the history and current status of :

(a) water availability in terms of source, quantity, quality, access, affordability and capacity (technical and institutional)?

(b) urban wastewater discharge and solid waste management that in turn affect the peri-urban areas?

(c) flooding, drainage congestion and water logging?

4. What are the impacts of climate change? What are the physical vulnerabilities?

5. What are the vulnerabilities of the communities to water insecurity stressors? What are the impacts on different capitals – social, institutional, etc.?

6. What are the strategies of the communities to reduce the vulnerabilities? How would the communities implement these strategies?

3. METHODOLOGY OF THE SCOPING STUDY

The scoping study relied on both primary and secondary information. Primary data were collected through reconnaissance survey, direct observation, stakeholder consultation, community consultation and key informant interview. Secondary data were collected from different sources including published and unpublished literature, different databases, news paper and the internet. Secondary information, preliminary stakeholder discussions and inception field visits led to selection of 12 preliminary study sites for detailed baseline study.

[9]This SEZ was expected to be the largest in India and promised to provide 500,000 jobs. The main developer in this project- Reliance Industries Ltd. (RIL) - would hold 90 percent of the shares of the project. (Gurgaon Workers News – Newsletter 2, April 2007)

At this stage, an inventory of the peri-urban characteristics, vulnerabilities and major issues was also completed through 3 two-day long field visits by the entire research team. Urbanization and climate change impacts were considered with a particular focus on heterogeneity of land use, mixed institutional arrangement and livelihood linkages between urban and peri-urban areas.

The preliminary peri-urban study sites were visited to understand the growth pattern of Khulna city as well as to identify the major problems and issues related to water access and security of the peri-urban communities in those areas. Furthermore, field explorations were also aimed at understanding the urbanization and climate change impacts on water access, availability of water resources in the peri-urban area and long-term water security of the local communities and their current adaptation strategies. During these visits, FGDs, transect walks, social mapping, consultations and interviews were carried out with the local community, key informants and community leaders to determine the specific problems and issues of water stress and vulnerability. During the scoping study five stakeholder meetings were arranged to discuss the present status of water related vulnerabilities of the peri-urban communities. Information gathered from primary and secondary sources were synthesized through group meetings of the research team. The following is a summary of activities performed during this scoping study:

- Preliminary identification of stakeholders and vulnerable communities,
- Consultation with stakeholders and communities,
- Selection of preliminary sites for baseline study,
- Community consultation and direct observation, and
- Selection of study sites for further study.

4. REVIEW OF LITERATURE

Literature review for the scoping study focused on five areas:
(I) Characteristics of and social dynamics of peri-urban areas,
(ii) Information on the study area,
(iii) Impacts of climate change and urbanization,
(iv) Gender dimension of vulnerability to water stress and climate change, and
(v) Indicator and framework for vulnerability assessment.

The literature review process will continue through the project duration as outlined in the research design. A summary of the literature compiled to date is given below.

4.1 Characteristics and social dynamics of the peri-urban areas

The nature and characteristic of a peri-urban area varies largely with geographical location and socio-economic development. Although the term peri-urban is frequently used in many literature and policy documents, the definitions of peri-urban area are largely situational and case-specific (FAO, 1999). Peri-urban area is closely linked with an urban setting and livelihood of these people is largely affected by the urban activities. FAO provided a basis for a unified understanding of a peri-urban setting. However, the following statement shows the basic characteristics of a peri-urban area, which is given by the Organization for Economic Co-operation and Development (OECD) in its report on peri-urban agriculture (OECD, 1979).

The term "peri-urban area" cannot be easily defined or delimited through unambiguous criteria. It is a name given to the grey area which is neither entirely urban nor purely rural in the traditional sense; it is at most the partly urbanized rural area. Whatever definition may be given to it, it cannot eliminate some degree of arbitrariness."

Houston (2004) defines peri-urban areas on the basis of population density, employment in non-agricultural industry and population mobility. In the developing world, a large number of uncounted population live in the peri-urban areas. These areas have the characteristics of being inadequately integrated into the city with regard to social and institutional issues as well as infrastructure services including water supply and sanitation systems (Tornqvist, 2007).

Therefore, peri-urban interfaces are often neglected or forgotten, and consist of informal or illegal settlements with inadequate infrastructure and other community services (Paterson et al., 2006). Peri-urbanization, as a consequence of urbanization, is a dynamic urbanizing process that leads to subdivision, fragmentation and conversion of former rural lands (Buxton and Choy, ----). It involves very high levels of informal growth and often results in a transitional zone comprising of both urban and rural functions. Thus the resulting peri-urban landscape comprises a heterogeneous land use pattern that exhibit a high degree of heterogeneity, continual change and conflicting values and interests.

4.2 Information on the study area

Khulna is the third largest metropolitan city of Bangladesh (46 sq. km.). Once it was known as an industrial city with a large sea port at Mongla. Geographically, Khulna city is located on a natural levee of the Rupsha and Bhairab rivers and characterized by Ganges tidal floodplains with low relief, criss-crossed by rivers and water channels, and surrounded by tidal marshes and swamps. Historically, Khulna was a market town and the seat of regional administration. During the early days, tobacco and sugarcane were traded here and it had a trading link with Kolkata. Khulna was declared a municipality in 1884. It was linked with the regional railway network in 1985. Industrialization started in Khulna in the 1960s (Murtaza, 2001). Demographic characteristics indicate that population growth in Khulna is rapid (3.8%) due to rural-urban migration. Literacy rate is relatively high compared to other major cities in Bangladesh. Gross population density is very high, about 18,000 per sq. km. A large proportion of the local people are engaged in informal sector activities (Murtaza, 2001).

The land surface slope of Khulna is westward whereas the regional slope is southward. The average land surface elevation of Khulna is about 3.32 m from the Mean Sea Level (MSL) (Adhikari et al., 2006). The area comprises of mostly flat land with the natural ground slope in two different directions: one from northwest to southwest, parallel to the general flow direction of the Bhairab river (upper reach) and Rupsha river (middle to lower reach); and another from northeast to southwest, which allows the sea water intrusion into the aquifer system of Khulna. The Khulna City Corporation (KCC) area lies on the Late Holocene-Recent alluvium of the Ganges deltaic plain in the north and Ganges estuarine plain in the south (Adhikari et al., 2006). Tectonically, the area lies within the Faridpur Trough of the foredeep part of the Bengal Basin (Alam, 1990). The trough is filled with Tertiary and Quaternary sand and clay rich sediments with few coarse sand beds. Lithologically, the area is composed of coarse to very fine sand, silt and silty clay to a depth of 300 m with peat soil and calcareous as well as non-calcareous soil at the top. The surface lithology of the area is of deltaic deposits which are composed of tidal deltaic deposits, deltaic silt deposits, and mangrove swamp deposits (Alam, 1990).

4.3 Impacts of climate change and urbanization

Approximately one-fourth of the country's population live in the coastal region of which three-fourths are poor livelihood groups (Mohal et al., ----; Chowdhury, ----). In the coastal region, water plays a vital role in the economic and social development. However, people of this region are vulnerable to water related natural hazards as well as climate change impacts. Sea level rise is a growing threat to the coastal region while Khulna is one of the 15 most vulnerable cities of the world (The Daily Star, 2009). Future climate projections indicate that the increasing rate of sea level rise caused by global warming would lead to permanent inundation, drainage congestion, salinity intrusion and frequent storm surge inundation in the southwestern coastal region including Khulna. It is estimated that about 11% more land will be permanently inundated over the next century in the coastal region of Bangladesh. As a result, the Sundarbans (a Ramsar site) will be lost due to high salinity and permanent inundation by 2100 (Mohal, et al., ----).

Salequzzaman et al. (----) reported that climate induced natural disasters such as devastating cyclones and tidal surges, floods, treacherous river erosion, excessive rainfall and overwhelming salinity intrusion have been

occurring more frequently in the southwest coastal regions of Bangladesh. Climatic disasters adversely affect peoples' livelihood in Khulna and these disasters have increased the vulnerability of the local communities living in the area. Climatic disasters also inundate coastal lands with high saline water which reduce soil fertility and crop production. As a consequence most of the low-income people are now facing food insecurity and potable water crisis.

In the urban and peri-urban areas, polluted water increases the threat of different water borne diseases. Thus adequate infrastructure and improvement of socio-economic capacity are needed to face these challenges with support from the government or non-government agencies (Salequzzaman et al., ----). In the peri-urban Khulna disposal of solid waste into the nearby drains or low land areas, discharge of waste water into open roadside drains, the concentration of hanging latrines in lower income settlements areas, annual flooding, noise, and domestication of cattle and poultry are major environmental problems faced by local communities (Murtaza, 2001). Ahmed (2010) reported that due to the hopeless environmental condition people lost their livelihood options and consequently out-migrated to either urban areas or to the fringe areas, or peri-urban areas. He indicated that the urban centers of Khulna have been the prime Desakota destination for the people in Khulna region who have lost their livelihoods due to failure of adequate ecosystem services. Salinity ingress in groundwater also threat people in Khulna and its peripheral area (CCC, 2009). In Khulna, groundwater is slightly alkaline and largely varies in chemical composition. The physico-chemical characteristics show that groundwater is of brackish nature due to seawater intrusion and hydrogeochemical processes (Bahar and Reza, 2010).

4.4 Gender dimension of vulnerability due to water stress and climate change

Livelihood opportunities and vulnerabilities in the coastal areas are largely determined by water resources. Rapid expansion of the population growth, depletion of the surface and ground water resources, frequent floods and droughts, degradation of water quality and climate change have created an added stress on the communities living in urban and peri-urban areas of Khulna. In Bangladesh, women and girls are primarily responsible for household water security while men are responsible for managing water for irrigation, livestock and industries (Fisher, 2006; Khosla and Pearl, 2003).

A recent report indicates that women and children in Bangladesh are 14 times more likely to die than men during disasters (IUCN/WEDO, 2007). It has been also observed that sometimes women face an array of physical, psychological and social problems (Faisal and Kabir, 2005; CCC, 2009; Ahmed, 2010). Sometimes young girls are deprived from educational opportunity as they have to spend more time for water collection instead of schooling activities (Moore and McLean, ----; WEDO, 2003). By walking a long distance to fetch water, women and girls have to expose themselves to harassment or sexual assault, especially during disaster period (Bartlett, 2008). In urban areas, water collection is an emerging issue where women and girls may spend many hours for intermittent water supplies (WEDO, 2003). In many areas water collection also depends on income or social class, location of water source, time of the day, and religious or cultural factors, etc.

Life of a women living in the coastal belt is burdened with hardship for household water collection. Salinity, water logging and frequently occurring natural disaster due to climate change have been making this scenario more difficult and complex. Approximately 25 million people in 43 districts of Bangladesh have been using water with arsenic concentration more than 0.05 mg/L (Fazal et al., 2001). Arsenic contamination of the groundwater has made the coastal communities more vulnerable. It has been observed that women in Khulna continued to use water from arsenic contaminated tube wells since no alternative sources are available to them (Faisal and Kabir, 2005). People avoid even social interaction with arsenic affected people as they think it is an infectious disease. Sometimes young men and women in arsenic affected areas face difficulties in getting married. In many cases, husbands divorce their wives, often under social pressure, if they have visible symptoms of arsenicosis (Faisal and Kabir, 2005).

In the southwest coast including the Khulna area, women are more vulnerable to the impacts of climate change since they are often not allowed to participate in the public activities and discussions, and therefore are less likely to receive critical information for emergency preparedness. Women have very limited access to information and training which restrict their capacity of adapting to climate change impacts. Besides, most climate change policies and programs are not gender sensitive (Leduc and Shrestha, 2008). In many cases, socio-economic factors also hinder women's adaptation capacities and increase their vulnerability.

Salinity intrusion due to climate change is a major hydrogeophysical as well as social problem in Khulna. During the dry period, drinking water scarcity becomes an acute problem which forces women and girls to hard work for collecting fresh water. Research shows that gender inequalities can also be exacerbated in the aftermath of disasters. The household workload may increase substantially, forcing many girls to drop out of school to help with household chores (Davis et al., 2005). Women and girls also suffer from various gynecological problems due to hard work for water collection. High rates of premature birth and abortion are reported in the area (CCC, 2009), and climate change stress is likely to increase this in future.

It is recognized that climate change will increase scarcity of natural resources such as water and conflict over resources (Hemmati, 2005). Impacts of climate change will be felt more acutely by those with the least adaptive capacity: poor countries and the poor in developing countries (Lambrou and Piana, 2006). Women are often less able to adapt to climate change as they are less empowered. In the context of climate change, gender analysis promotes an understanding of the ways that men and women are differently impacted by climate-related hazards. Thus, for better adaptation to climate change, gender responsive research is required to address the vulnerability, coping capacity and mechanisms of different social groups. This is also necessary for policy makers in the negotiating process (CCC, 2009). Mitchell et al. (2007) found that the children's voices in household, community and national decision-making relating to climate change are also necessary, particularly in the disaster risk reduction process. A recent participatory research project by ActionAid and IDS clearly shows that women in the rural communities in the Ganga river basin in Bangladesh, India and Nepal are adapting their practices in order to secure their livelihoods in the face of changes in the frequency, intensity and duration of floods (Mitchell et al., 2007).

In Bangladesh, former water policies and plans at all levels tend to ignore women's needs and contributions. However, such gender disparities have been recognized in the recent years. For example, the Interim Poverty Reduction Strategy Paper (IPRSP) clearly states that 'Empowering women is crucial both for its intrinsic value as a development goal and as an instrument for bringing about greater women's empowerment.' Similar provisions have also been found in the Guidelines for Participatory Water Management (GPWM) published by the Ministry of Water Resources.

4.5 Indicator and framework for vulnerability assessment

Vulnerability is a function of three defining factors: exposure, sensitivity, and adaptive capacity. These three factors must be considered in an integrated way to assess the vulnerability of a specific community or group in a given location and time period. Vulnerability has been defined in various ways depending on the contexts and objectives (see Blaikie et al., 1994; Buckle et al., 2001; Nicholls et al., 1999; Oksuz, 2003). Different types of vulnerability, and their criteria and indicators can be found in Brooks et al. (2005), Bea (2005), Moss et al. (2001), and World Economic Forum (2002).

Vulnerability assessment requires a framework that selects criteria and indicators to characterize the vulnerability of the coupled human-environment system. Hamouda (2006) describes different categories of indicators required for vulnerability assessment.Ebert and Kerle (2008) describe physical proxies identified for the original social vulnerability indicators. Indicators are commonly used to monitor trends at regional and national scales, which should not be confounded with a method

that seeks to inform stakeholders of a place-base specific reaction in response to climate change impacts (Nkem et al, 2007). An understanding of the existing local knowledge base of indigenous adaptation strategies within a community, as part of the evaluation of adaptive capacity, is also required to assess the vulnerability. Stakeholder interests play important roles in vulnerability assessment. This facilitates the decision-making process of specific stakeholders about their options for adapting to stresses within their local resource base. Vulnerability is highly dependent on context and scale, and care should be given to describe its clear derivation and meaning (Downing and Patwardhan, 2005) and to address the uncertainties in vulnerability assessment (Patt et al., 2005).

The formal methods of vulnerability assessment have been proposed by many scholars (Ionescu et al., 2005; Metzger and Schroter, 2006) but are very preliminary. Vulnerability Assessment Frameworks (VAF) should be rigorous to integrate the social and biophysical dimensions of vulnerability (Klein and Nicholls, 1999; Polsky et al., 2003; Turner et al., 2003). The methods and framework of vulnerability assessment should also address the determinants of adaptive capacity (Turner et al., 2003; O'Brien and Vogel, 2006) in order to examine the potential responses of a system (natural or human) to climate variability and change. Many studies attempt to do this in the context of human development index to understand the underlying causes of vulnerability and to further strengthen adaptive capacities (World Bank, 2006). In some quantitative approaches, the indicators such as national economic capacity, human resources, and environmental capacities have been used. However, some other studies include indicators that can provide information related to the conditions, processes and structures that promote or constrain adaptive capacity (Eriksen et al., 2005).

Vulnerability assessment offers a framework for policy measures that focus on social aspects, including poverty reduction, diversification of livelihoods, protection of common property resources and strengthening of collective action (O'Brien et al., 2004). Such measures enhance the ability to respond to stressors and secure livelihoods under present conditions. It also reduces vulnerability of future climate change impacts. Other methods applied in regional vulnerability studies include stakeholder consultation and survey (Eakin et al., 2006), and multi-criteria model (Wehbe et al., 2006). The traditional knowledge of local communities represents an important aspect for climate change impact, vulnerability and adaptation (CCIAV) assessment (Huntington and Fox, 2005). Empirical knowledge from past experience in dealing with climate related natural disasters such as droughts and floods (Osman-Elasha et al., 2006), health crises (Wandiga et al., 2006), as well as long term trends in mean conditions (Huntington and Fox, 2005), is particularly helpful in understanding the coping strategies and adaptive capacity of indigenous and local communities.

5. MAJOR OUTCOME OF THE SCOPING STUDY

Selection of study sites was one of the major activities of the scoping study. Several locations in and around Khulna city were visited to identify the study sites. The primary criteria for site selection were heterogeneity in land use, mixed institutional arrangement, diversity in livelihood options including dependence on urban resources, urban-peri-urban hydrological linkages, urban-peri-urban water use nexus, and vulnerability to water stress. A list of the visited sites is given in Table 1.

Name of the site	Primary Water Use	No. of Vulnerable Households (Approximate)
Alutala 10-vent sluice gate	Domestic, agricultural and fisheries (capture and culture)	400
South Labonchara (near two sluice gates)	Domestic, agricultural and fisheries (capture and culture)	300
South Labonchara (Matha Bhanga Village)	Domestic, agricultural and industrial	350

Name of the site	Primary Water Use	No. of Vulnerable Households (Approximate)
Mohammodia Para	Domestic, agricultural and industrial	50
North Labonchara (near Rupsha bridge)	Domestic and industrial	600
Mohmmad Nagar (Zero-point)	Domestic, agricultural and industrial	120
Gollamary bridge	Domestic and industrial	50
Boyra (near Boyra residential area)	Domestic, agricultural and industrial	110
Chhoto Boyra (Shashan Ghat)	Domestic and agricultural	350
Nirala (beside Nirala residential area)	Domestic and agricultural	100
Dowlatpur	Domestic and agricultural	80
Khalishpur industrial zone	Domestic and agricultural	150
Rupsha ferry ghat	Domestic, industrial and water transport	120

Table 1: Sites visited during preliminary site selection.

During the scoping study, investigations were carried out at each of these sites to determine whether these would be suitable for further detailed study, and to understand the water-related issues and vulnerabilities. During this process information from secondary stakeholders were also considered and synthesized. The following sections summarize the major outcome of the scoping study based on field exploration, community and stakeholder consultation, literature review, and direct observation.

5.1 Major water uses

Primary water uses in the peri-urban areas of Khulna are domestic use (drinking, washing, bathing), agricultural use and industrial use. The water bodies are also used for subsistence fisheries and capture fisheries by the poor. Most people collect water from nearby community tube wells. In most cases community tube wells are situated at a central location of the villages and people, mostly women and girls, collect water 5-10 times daily. About 200-300 families depend on a single tube well. As a result, water for washing and bathing are rarely collected from the community tube wells. Farmers use irrigation water from the nearby rivers, ponds and khals (canals) for their agriculture. Groundwater based irrigation is not in practice since the groundwater is highly saline. In the peri-urban areas of Khulna, people commonly find employment in jute, brick, fish processing, lime, fish feed and poultry industries. All industries, except brick industries, use groundwater. Brick industries are mostly situated beside the river, and river water is used in the processing. Thus, industries consume a large amount of freshwater (groundwater) resources. Future urban expansion and industrial growth are likely to increase the overall water demand in the study area.

5.2 User conflict

Water conflict among different users is more complex in peri-urban Khulna than in other parts of the country. The nature and dynamics of these complexities mainly depend on social, economic and political factors. An analysis of the complexities indicates that there are mainly four types of conflict in the area:

- Conflict between agriculture and fisheries
- Conflict between urban and peri-urban users
- Conflict between urban and urban users
- Conflict between peri-urban and peri-urban users

Agriculture occupies a predominant land use in the peri-urban areas of Khulna. The Mayur river plays an important role in providing irrigation water for peri-urban agriculture. However, farmers at the downstream sites claim that they suffer because of unfair gate operation of the Alutala sluice constructed at the confluence with the Rupsha river to control salinity intrusion into the Mayur river. The Mayur river system is the only major freshwater source in the area for irrigation, and thousands of farmers on both side of the river depend on this river. The Mayur river used have natural tidal flow and was an important river for agriculture, subsistence fisheries, navigation and domestic water use. The river lost this importance after construction of the Alutala sluice gate. Now the river is a stagnant water body used by the local power elites for culture fisheries. The Alutala gate is operated to serve the culture fisheries, not agriculture. Local farmers at Chhoto Boyra also suffer from unexpected flooding of their paddy fields.

A FARMER'S VIEW

Md. Harun-or-Rashid, Age: 50, Occupation: Farmer, Locality: Chhoto Boyra

Mr. Harun-or-Rahsid is a local farmer at Chhoto Boyra. Mr. Rashid cultivates rice and vegetables in his own lands. As prices of rice and vegetables have increased significantly, he likes to produce two crops for his own consumption and selling. Mr. Rashid has been facing severe problems in growing the crops due to the mismanagement of the Alutala sluice gate. He said that BWDB operates Alutala sluice gate as per instructions from the local elites and politicians. He added that Alutala sluice gate has been constructed to make the Mayur river a closed water body so that local elites and politicians can do business of culture fisheries in the river. He claims that farmers who are dependent on the Mayur's water for agriculture are suffering from drying up of their lands due to water shortage in the dry season. On the other hand, most of the agriculture lands become flooded during the wet or monsoon period due to the mismanagement of the Alutala gate.

NGO and civil society representatives believe that Bangladesh Water Development Board (BWDB), Local Government Engineering Department (LGED), Department of Fisheries (DoF), KCC and other public agencies are involved in encroachment of the rivers and water bodies. They also believe that Khulna Water Supply and Sewerage Authority (WASA) is trying to withdraw water from Fultala (a peri-urban area of KCC) without any environmental impact assessment. This may lead to a big social conflict between urban and peri-urban residents since local communities have been protesting this plan. It may be possible to solve the present water crisis of Khulna city by using the Mayur river as a water reservoir.

5.3 Water access and security

Groundwater is the only potential source for freshwater supply in the urban areas of Khulna. WASA estimates indicate that the present water demand in KCC area is about 240 MLD on an average. However, with the present infrastructure WASA is capable of providing only 35 MLD through the water supply network. The water sources include 10,000 private tube wells providing an additional supply of 60 MLD. The present water supply network of WASA covers only about 30% of the total city population. In the peri-urban areas, community tube wells are used for drinking water collection. Besides, surface water from nearby ponds and Khals are used for washing, bathing and other domestic uses. Field survey results show that peri-urban residents have limited access to safe drinking water. About 200-300 households depend on a single water source. Sometimes people, mostly women and children, have to walk a long distance (1-5 km) to fetch drinking water.

At present the entire water supply system in the KCC area is groundwater based with deep tube wells having depths greater than 1000 ft. A large number of privately owned tube wells are also present in and around the city. As a result, the groundwater table declines significantly during the dry period. Consequently the wells provide limited or no water during the dry period. To prevent this, WASA is not giving out further permission for installation of deep tube wells in the KCC area. Among other efforts to resolve the water crisis, KCC has been trying to transport water from the peri-urban areas. This may hamper future water access and security of the peri-urban people and their traditional livelihood and resources.

5.4 Water related vulnerabilities

The major water related problems in the study area include scarcity of drinking water, water pollution from urban solid waste and wastewaters, salinity ingress in surface and ground water, arsenic and excessive iron in groundwater, and flooding and water logging. NGO and civil society representatives indicate that continued water crisis is prevalent all over the KCC area. At present there are no water management initiatives outside the KCC area. The people of Khulna city are already getting used to consume polluted water. Freshwater sources have been polluted over the years due to rapid industrialization and unplanned urbanization. The major surface water bodies including khals are now water logged or extinct due to encroachment. No research has been conducted so far to resolve the crisis in the urban and peri-urban areas.

Figure 2: Stakeholder consultation with local NGOs and civil society groups. Participants described the water shortage and water related vulnerabilities in the peri-urban areas of Khulna.

People of Mohammad Nagar and Tetul Tala are dependent on the Mayur river for freshwater supply. They are suffering from polluted water caused by the KCC wastewater discharge and solid waste dumping. Thus, water-borne diseases are now commonplace in these areas. In the peri-urban areas of KCC, access of the poor to safe water is very limited if not absent. The unplanned city protection embankment has destroyed the surface water bodies (khals). A KCC master plan has already been drafted without consultation with local communities or secondary stakeholders, which may amplify further conflict and vulnerability of different water user groups.

Local communities strongly believe that rapid urbanization is the main reason for encroachment of the existing rivers and water bodies.

Figure 3: Consultation meeting with Khulna University faculty. Participants described the major issues and water related vulnerabilities in and around Khulna city.

People of South Labonchara face severe problem since only two hand tube wells serve the whole community. Although water from one tube well is potable, water from the other tube well is not useable because of very high levels of iron and salinity. Although the locality is situated within the city corporation boundary and people pay taxes as per the KCC regulation, they do not receive any service (electricity, water supply, etc.) from the KCC. Healthcare facilities and schooling opportunity for the children are also inadequate at this site. Women of this area collect water approximately 8 times daily (by jar/kolosh/bottle) from a distant location. Two jars are used for drinking purposes and the rest are used for domestic purposes. Most of the people in the community face problems of acidity, kidney diseases, diarrhoea, fever and water-borne diseases. People also use canal water for washing and bathing purposes. At the lower reach farmers also use canal water for irrigation in the dry season.

Chhoto Boyra is surrounded by Boro Boyra in the north, Gallamary and Khluna University in the south, Khalishpur in the east and Andirghat cemetery in the west. The whole area has both urban and rural features although it is situated within the KCC boundary. Local farmers suffer because of mismanagement and controlled operation of Alutala sluice gate.

Figure 4: Social mapping by community people at South Labonchara.

Figure 5: Baseline study with local community at Chhoto Boyra.

There are 22 drainage canals in the KCC area which directly discharge wastewater into the Mayur river. Besides, clinical wastes and wastewater are also directly discharged into the Mayur river system. Farmers of this area are seriously affected by unexpected flooding of their croplands. Often their crops are damaged in the field just before harvest because of suddenly opening the sluice gate at Alutala without prior notice. There have been several attempts by the local farmers for negotiations regarding a fair operation of the gates, all of which were unsuccessful. Excessive rainfall also causes distress to the community. During heavy rainfall people mostly suffer from inundation of their homestead, submergence of toilets, skin diseases (for a minimum of 3 months), transportation problem, and water-borne diseases including dengue, diarrhea and typhoid.

Figure 6: Solid waste accumulation at sewer outfall on the Mayur river, Chhoto Boyra (Shashan Ghat).

Figure 7: Solid waste accumulation inside the Mayur river.

Information gathered from literature and secondary data indicate that Khulna is likely to be affected by more severe natural disasters in future due to climate change. Community consultations indicate that during any disaster event drinking water crisis is one of the major concerns in the peri-urban areas.

There is a sense of expectation and hope among the NGOs and civil society that the present study would be pro-people and this research would work as a catalyst to motivate people for safe use of water resources in a sustainable manner. Community resilience and migration due to climate change should be also studies under this research. Southwest coastal economy is based on water

resources. The economic slowdown in the Southwest region has been mainly caused by mismanagement of water resources, which is clearly visible in the polder and embankment areas.

5.5 Institutional arrangement

There are apparent conflicts of interest among Khulna Development Authority (KDA), KCC, Department of Public Health Engineering (DPHE) and other water-sector agencies. KDA has developed Nirala residential area without any long term plan for stormwater management. Consequently, this area becomes water logged after a single rainfall event. KDA has recently handed over the Nirala residential area to KCC. The drainage system of KCC has been developed without considering the natural topography.

During the scoping study, meetings with KDA, KCC and Khulna WASA were conducted to assess the institutional arrangement for water management, their responsibilities and future plan in Khulna city. KDA has developed a draft 20-year Master Plan including a 5-year Detail Area Plan (DAP), which are to be finalized soon. A long term solution is being sought to provide water security in the region and to face the challenges of climate change. According to the KDA chairman, the peri-urban people of Khulna are not affected by urbanization as proper compensation for land loss is ensured in the process. Compensation is provided based on the governmental rules and regulations in the form of land or cash.

Figure 8: Consultation meeting with KDA.

KDA chairman also indicated that urbanization is relatively slow in Khulna due to collapse of the major industries (jute, pulp, paper and match industries) in the region.

Figure 9: Consultation meeting with KCC.

A fully functional institutional arrangement for management of water resources, solid waste and wastewater is absent in Khulna. Presently KCC is responsible for solid waste and wastewater management in the city area. In future WASA will be responsible to manage water and wastewater in the city area. The KCC authority indicated that already a $25 million project is proposed by the ADB to develop a 'linier park' beside the Mayur river. This project also aims at re-excavation, lining and flow management of the river. In the first phase (2011-2016) of the project, lining and re-excavation will be completed and in the second phase (until 2021) flow management and other arrangements will be developed.

Figure 10: Consultation meeting with Khulna WASA.

In the peri-urban areas, water management institutions are not found in any form. Local people said that neither KCC nor the local government authority take the responsibility to ensure the basic community needs. A functional participatory institutional framework for water management may improve water security of the peri-urban communities.

Based on the above discussion, and the criteria set for study site selection, five sites have been finally selected for further study. Important characteristics and major issues of these sites are summarized in Table 2. Further studies including detailed baseline survey, vulnerability assessment, action input, and participatory monitoring and evaluation will be conducted at these sites.

Name of Site	Socio-economic Characteristics	Issues/Problems Identified
Alutala 10-vent sluice gate	Alutala is about 10 km from Khulna city boundary. It is situated at Botiaghata thana of Khulna district. Agriculture and culture fisheries are two major activities at this location. People are mostly dependent on agricultural labor, and capture and culture fisheries.	• Acute drinking water scarcity. • Conflict between upstream and downstream (Mayur river) water users. • Vulnerability to climate change induced sea level rise. • Vulnerability to flooding and water logging. • Salinity intrusion in groundwater. • Absence of community participation in sluice gate operation and management.
South Labonchara (near two sluice gates) GPS Coordinates: N 22046.110' E 89034.	Situated beside the Rupsha-Bhairab river. About 250-300 households on the river bank are vulnerable to annual flooding, drinking water scarcity, river erosion and climate change impacts. Most people of this location are dependent on informal business in city and nearby agriculture and fish firms.	• Acute water scarcity for drinking, washing and sanitation. • Conflict between urban and peri-urban water users. • Vulnerability to climate change induced sea level rise. • Vulnerability to flooding and water logging. • Salinity, excessive iron and arsenic in groundwater. • Absence of community participation and institutional framework. • Lack of sluice gate management (gates are non-functional).
South Labonchara (Matha Bhanga Village)	Situated between Alutala and two sluice gates of South Labonchara. Around 500 households are located on the river bank (Rupsha-Bhairab). Most people at this location are day laborer in the nearby jute industries, and agriculture or fish firms.	• Very few tube wells for a large number of households (250-300). • Vulnerability to climate change induced sea level rise. • Salinity, excessive iron and arsenic in groundwater. • Absence of community participation and institutional framework for water management.
North Labonchara (near Rupsha bridge) GPS Coordinates: N 22046.694' E 89034.559'	People living in about 800-1000 households are engaged in informal business in the city area. Women of this locality are mostly engaged in making packets from waste paper and supplying to the city area.	• Very few tube wells for a large number of households (300-400). • Water logging due to urban wastewater discharge. • Vulnerability to climate change induced sea level rise. • Salinity, excessive iron and arsenic in groundwater.

Name of Site	Socio-economic Characteristics	Issues/Problems Identified
		• Absence of community participation and institutional framework for water management.
Chhoto Boyra (Shashan Ghat) GPS Coordinates: N 22049.521' E 89031.765'	This is an agriculture-dominated area near the KCC. Farmers are dependent on the Mayur river for agriculture. A significant number of people in this area are engaged in business in the city.	• Acute water scarcity for drinking, washing and bathing, and agricultural uses. • Conflict between urban and peri-urban water users. • Vulnerability to flooding and water logging, and solid waste dumping in the Mayur river. • Salinity, excess iron and arsenic contamination in groundwater. • Absence of community participation and institutional framework for water management.

Table 2: Sites selected for further study.

6. SUMMARY AND CONCLUSION

This scoping study was conducted to understand the issues and vulnerabilities in the study area and to make a preliminary selection of study sites. Twelve sites were primarily selected through community and secondary stakeholder consultations. Based on issues identified by the local people and secondary stakeholders, and information gathered from the literature, the following criteria were determined for selection of study sites for further study: heterogeneity in land use, mixed institutional arrangement, diversity in livelihood options including dependence on urban resources, urban-peri-urban hydrological linkages, urban-peri-urban water use nexus, and vulnerability to water stress. Thus five sites have been finally selected for further detailed study, action input and participatory monitoring.

The following are the major issues identified during the scoping study. These issues will be addressed in the next phases of the research.

• An acute water crisis exists in the urban and peri-urban areas of Khulna. Surface water and groundwater salinity is the main problem in the area.
• At present KCC water supply serves only one-third of the population in the KCC area. Fresh water sources are being polluted in the city and its adjacent areas due to rapid industrial development and unplanned urbanization.
• The major surface water bodies (including khals) in the city are now water logged or extinct due to encroachment and solid waste dumping.

- At present 100% of the water supply in Khulna city is groundwater based. KCC has been trying to import water from peri-urban areas of the city, which may hamper access of the peri-urban people to local water sources and their traditional right on local resources.
- The major water uses in peri-urban Khulna are domestic (drinking, washing, bathing), agricultural and industrial.
- Approximately 200-300 families depend on a single tube well in the peri-urban areas. Women and girls are mostly responsible for collecting water for domestic use. Often women face an array of physical, psychological and social problems during disaster period. Young girls are also deprived from educational opportunities since they have to spend more time for water collection instead of schooling.
- Most people in the peri-urban communities face health problems including diarrhoea, fever and water-borne diseases.
- In peri-urban Khulna water conflict among different water users are very complex. The nature and dynamics of these complexities mainly depend on social, economic and political factors.
- Local farmers suffer because of arbitrary operation of the Alutala sluice gate. However, the Mayur river can play an important role in providing irrigation water supply for peri-urban agriculture, if it is properly managed.

- Apparently, there are conflicts of interest among KDA, KCC, DPHE, WASA and other water-sector agencies. A feasible institutional arrangement may improve water security and access of the peri-urban communities in the overall context of climate change and urbanization.
- The Rupsha and Bhairab rivers are two major tidal rivers flowing beside the Khulna city. Future climate projections indicate that salinity in these rivers will increase due to sea level rise, aggravating the salinity intrusion and drainage problems in the adjacent areas.

During the course of this scoping study, an activity plan was prepared for the whole study. The activities mainly focus on a baseline survey to clearly understand the present condition and vulnerabilities, developing vulnerability indicators and methodologies in a participatory way to assess and monitor vulnerabilities, and determining inputs and mobilizing them for the community for vulnerability reduction.

In the next phase of the research a vulnerability assessment framework will be developed in a participatory way. During this process the main research questions will include: (i) what are the vulnerabilities? (ii) who are the vulnerable groups? (iii) what are the vulnerability indicators? and (iv) what will be the methodology of vulnerability assessment?

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