

Water Security in Peri-Urban Khulna: Adapting to Climate Change and Urbanization

**Uthpal Kumar, M. Shah Alam Khan, Rezaur Rahman, M. Shahjahan Mondal,
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Khulna is the third largest metropolitan city of Bangladesh with a population of 1.4 million (BBS,2007) with the Rupsha and Bhairab - the two major tidal rivers flowing on the east of the city. Due to unplanned and unregulated urbanization, urban and peri-urban residents have been facing acute water scarcity. Future projections indicate that it would be further affected by salinity intrusion and sea level rise due to climate change processes. This paper is based on the scoping study which was conducted to assess how urban and peri-urban residents of Khulna city have been suffering from problems related to water access and water insecurity due to urbanization and climate change impact. For this purpose, a number of public consultation meetings and key informant interviews were carried out during August to December, 2010. In this paper water related vulnerabilities of various livelihood groups in the peri-urban interface is discussed. The conflicts in water use between urban and peri-urban residents are also explored. Degradation of river water quality resulting from urban activities such as wastewater discharge and dumping of solid waste, and the vulnerabilities due to climate change are also addressed. Finally, the paper discusses issues for further research in the area.

This is one of a series of Discussion Papers from the Peri Urban Project of SaciWATERS.

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Water Security in Peri-Urban Khulna: Adapting to Climate Change and Urbanization¹

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Abstract

Khulna is the third largest metropolitan city of Bangladesh with a population of 1.4 million (BBS,2007) with the Rupsha and Bhairab - the two major tidal rivers flowing on the east of the city. Due to unplanned and unregulated urbanization, urban and peri-urban residents have been facing acute water scarcity. Future projections indicate that it would be further affected by salinity intrusion and sea level rise due to climate change processes. This paper is based on the scoping study which was conducted to assess how urban and peri-urban residents of Khulna city have been suffering from problems related to water access and water insecurity due to urbanization and climate change impact. For this purpose, a number of public consultation meetings and key informant interviews were carried out during August to December, 2010. In this paper water related vulnerabilities of various livelihood groups in the peri-urban interface is discussed. The conflicts in water use between urban and peri-urban residents are also explored. Degradation of river water quality resulting from urban activities such as wastewater discharge and dumping of solid waste, and the vulnerabilities due to climate change are also addressed. Finally, the paper discusses issues for further research in the area.

1. Introduction

Coastal peri-urban communities suffer from water insecurity caused by urbanization and climate change impacts. In the peri-urban areas of Khulna, water availability and access to the communities are adversely affected by rapid urbanization and industrialization, leading to competition and conflict over water. This is compounded by climate change induced sea level rise and salinity intrusion in the surface and ground water sources (ADB, 2010). Projected climate scenarios indicate that frequency and severity of cyclone and storm surges would increase, which will add to the vulnerabilities of the coastal communities. Sea level rise will aggravate the drainage congestion, water logging and flooding problems that are already severe in the urban and peri-urban areas of Khulna (ADB, 2010). The overall goal of this research is to analyze the dynamics of the physical and social systems to understand in a participatory way the vulnerabilities and insecurities, and to build multi-stakeholder platforms as a means for better adaptation to the changing situation. 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 scoping study conducted during the first six months of the project period focused mainly on identification of the vulnerable communities, and setting objectives and boundaries of the future research and action. This research article has been divided into four major sections. In the first section water security issues, aim and objectives of the research work have been described. Section 2 describes in detail, the study area. In Section 3 and Section 4, the methodological framework and major findings of the scoping study have been presented.

2. Study Area

Khulna is the third largest metropolitan city of Bangladesh (with an area of 46 km²). Once it was known as an industrial city with a large sea port at Mongla. Geographically, Khulna city is located on the natural level as 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. Figure 1 shows the map of Khulna. Historically, Khulna was a market town and it 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 per cent) due to rural-urban migration. Literacy rate is relatively high compared to other major cities in Bangladesh and gross population density is very high, about 18,000 per km². 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). Technically, Khulna 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.

3. Methodology

The scoping study relied on both primary and secondary information. Primary data was collected through reconnaissance survey, direct observation, stakeholder and community consultations and key informant interviews. Secondary data was collected from different sources including published and unpublished literature, different databases, newspapers and the World Wide Web. Secondary information, preliminary stakeholder discussions and field visits led to selection of 12 preliminary study sites for detailed baseline study. At this stage, an inventory of the peri-urban characteristics, vulnerabilities and major concerns were discussed in field visits by the 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, focused group discussions (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 was synthesized through group meetings of the research team.

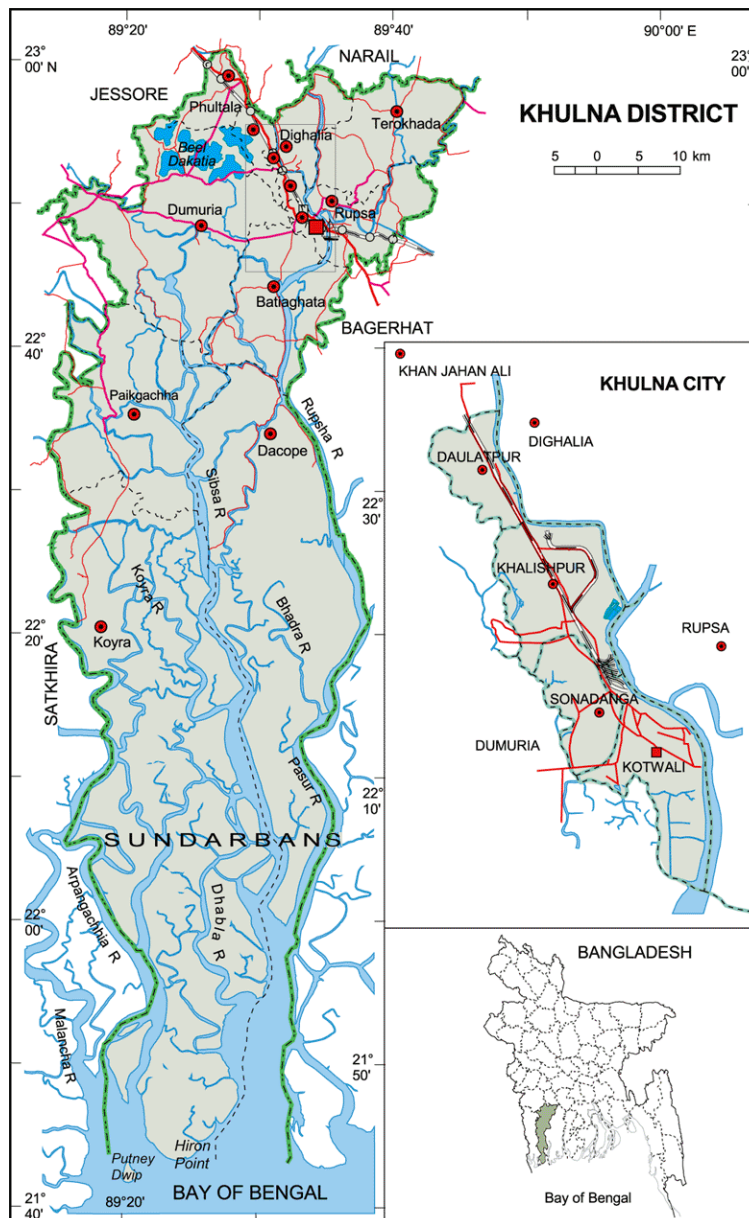


Figure 1: Location map of Khulna (Source: Banglapedia)

4. Major Findings 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 arrangements, 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. 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.

4.1 Water uses

Primary water uses in the peri-urban areas of Khulna are domestic (drinking, washing, bathing), agricultural and industrial use. The water bodies are also used for subsistence fisheries by the poor. Most people collect water for domestic use 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 is 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 these 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 (both surface water and groundwater) resources. Future urban expansion and industrial growth are likely to increase the overall water demand in the study area.

4.2 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 conflicts between:

- agriculture and fisheries,
- urban and peri-urban users,
- urban and urban users, and
- 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 has 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 10-vent regulator including a city protection dam by the Bangladesh Water Development Board (BWDB) in the year 1982-1983. 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 claimed by the local farmers at Chhoto Boyra. NGO and civil society representatives believe that the KCC (Khulna City Corporation) 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 since local communities have been protesting this plan. However, it may be possible to solve water crisis of Khulna city by using the Mayur river as a water reservoir.

4.3 Water access and security

Groundwater is the only potential source for freshwater supply in the urban areas of Khulna. Water Supply and Sewerage Authority (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 per cent 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 result shows

that peri-urban residents have limited access to safe drinking water. 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 (March-May), 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.

4.4 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, 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 used to consuming 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 and waste dumping of KCC. However, no research has been conducted so far to resolve the crisis in the urban and peri-urban areas.

People of South Labonchara face severe problems 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. 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. During community consultation meeting, most of the respondents said that they face acute problems of acidity, kidney diseases, diarrhoea, fever and water-borne diseases. People also use canal water for washing and bathing purposes. At the lower reaches, farmers also use canal water for irrigation in the dry season.

Chhoto Boyra is surrounded by Boro Boyra in the north, Gollamary and Khulna 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.

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



Figure 4: Solid waste accumulation at sewer outfall on the Mayur River, Chhoto Boyra (Shashan Ghat).



Figure 5: Solid waste accumulation inside the Mayur River at Gollamary Bridge site affected normal river flow.

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. South-west coastal economy is based on water resources. The economic slowdown in the south-west region has been mainly caused by mismanagement of water resources, which is clearly visible in the polder and embankment areas.

4.5 Institutional arrangement

There are apparent conflicts of interest among Khulna Development Authority (KDA), Khulna City Corporation (KCC), Department of Public Health Engineering (DPHE) and other water-sector agencies. KDA has developed Nirala residential area without any long term plan for storm water management. Consequently, this area is 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 report of 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, either in land or cash. KDA chairman had also affirmed that urbanization is relatively slow in Khulna due to collapse of the major industries (jute, pulp, paper and match industries) in the region.

A fully functional institutional arrangement for management of water resources, especially 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 for managing water and wastewater in the city area. The KCC authority indicated that a \$25 million project has already been proposed by the ADB to develop a 'linear 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. In the peri-urban study areas, water management institutions are absent. Local people say that neither KCC nor the local government authorities have taken the responsibility to ensure provisioning of 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-1. Further studies including detailed baseline survey, vulnerability assessment, action input, and participatory monitoring and evaluation will be conducted at these sites.

Table 1: Sites selected for further study.

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 labour, 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)	Situated beside the RupshaBhairab 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).

Name of Site	Socio-economic Characteristics	Issues/Problems Identified
South Labonchara (Matha Bhanga Village)	Situated between Alutala and two sluice gates of South Labonchara. Around 500 households are located on the river bank (RupshaBhairab). 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)	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. Absence of community participation and institutional framework for water management.
Chhoto Boyra (Shashan Ghat)	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.

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5. Summary and Conclusion

A scoping study was conducted to understand the issues and the existing vulnerabilities and to make a preliminary selection of study sites. Twelve sites were initially selected through community and secondary stakeholder consultations with the communities. Based on issues identified by the local people and secondary stakeholders, and information gathered from literature, the following criteria were used for selecting study sites for further research:

- 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.

Based on the above, five sites have been selected for further research, action input and participatory monitoring.

The following are the major issues that were identified during the scoping study.

5.1 Water Scarcity

The entire water supply in Khulna city is groundwater based. But this supply serves only one third of the population in the KCC area. Thus, an acute gap in supply still exists in the urban and peri-urban areas of Khulna, which suffer acute crisis.

5.2 Water use conflict

In peri-urban Khulna water use conflict among different users is very complex. The nature and dynamics of these complexities mainly depend on socio-economic and political factors. Now, KCC has been trying to import water from different peri-urban areas of the city, which may hamper access to local water sources for the peri-urban communities and their traditional right on local resources. This may ultimately lead to a social

conflict. There are conflict of interests already existing among KDA, KCC, DPHE, WASA and other water-sector agencies in Khulna. A feasible institutional arrangement may improve water security and access of the peri-urban communities in the overall context of climate change and urbanization.

5.3 Water uses, pollution and health issues

The predominant uses of water in peri-urban Khulna are domestic which includes drinking, washing, bathing, agricultural and industrial. The problem of surface and ground water salinity has triggered water insecurity in the area. Besides, fresh water sources are being polluted in the city and its adjacent areas due to rapid development and unplanned urban growth. About 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. Sometimes, young girls are deprived from educational opportunities since they have to spend more time for water collection instead of attending to their studies. People in the peri-urban communities also face health problems including diarrhoea, fever and water-borne diseases.

5.4 Climate change issue

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 salinity intrusion and drainage problems in the adjacent areas.

6. Further study and way forward

During the course of the scoping study, an activity plan was prepared for the entire 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 reducing the vulnerability of the community.

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Water Security in Peri Urban South Asia: Adapting to Climate Change and Urbanization

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.

www.saciwaters.org/periurban

Coordinating Institution:

The project is being coordinated by **SaciWATERS**, Hyderabad, India. SaciWATERS focuses on transforming water resources knowledge systems, key ideas being an interdisciplinary approach to understanding water resources issues, from a pro-poor, human development perspective, with an emphasis on exchange, interaction and collaboration at South Asia level.

Partner Institutions:

Bangladesh University of Engineering and Technology (BUET) is the oldest and leading university in Bangladesh in the area of technology. IWFM is a premier institute for the advancement of knowledge and development of human resources in water and flood management.

Nepal Engineering College (NEC) was established in 1994, as a non-profit organization under private sector initiative, to function as center for advanced learning in engineering and allied sciences. It has been offering the Interdisciplinary Water Resources Management (IWRM) Program since the beginning July, 2007 under the support of Crossing Boundaries (CB) Project funded by Government of the Netherlands.

Project Support:

This project is supported by Canada's **International Development Research Centre (IDRC)**. IDRC is one of the world's leading institutions in the generation and application of new knowledge to meet the challenges of international development. For nearly 40 years, IDRC has worked in close collaboration with researchers from the developing world in their search for the means to build healthier, more equitable, and more prosperous societies.

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