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Discussion Paper Series

Water Security in Peri-Urban South Asia
Adapting to Climate Change & Urbanization

ADAPTING TO PERI-URBAN WATER INSECURITY INDUCED BY URBANIZATION AND CLIMATE CHANGE

Rajesh Sada, Ashutosh Shukla and Anushiya Shrestha

This paper describes the implication of growing urbanization in combination with climatic variabilities on water security and adaptation strategies of the people in peri-urban landscape of Kathmandu valley. Through multiple series of focus group discussions and key informant's interviews, the study found that the entire households at Lubhu depend on public stand posts with water supplied for few hours a day. The hydro-meteorological data analysis showed the increasing trend of temperature but clear pattern in precipitation was not found. However, people perceived the changes in both precipitation and temperature and impacts on their livelihood. People have envisioned development of filtration system to treat water from another source, however for now,they have been fetching water from spring sources in neighbouring VDCs and dug wells during the days with no water supply in stand posts. Farmers have been adapting to water scarcity for cultivating agricultural crops by switching to less water demanding crops, leaving their lands fallow and even by deviating towards off-farm activities to be more resilient to increasing water scarcity. The concern for sustainable water management is growing among the community however, strong dedication and unity among the communities is essential to ensure the water security in the village.

Water Security in Peri-Urban South Asia

Adapting to Climate Change & Urbanization

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

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Adapting to Peri-urban Water Insecurity Induced by Urbanization and Climate Change

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1. INTRODUCTION

Urbanization is a continued phenomenon all over the world. In Nepal, the processes of rapid urbanization initiated during the 1980s and accelerated in the following two decades. The population of the country increased from 18.5 million in 1991 to 26.6 million in 2011 (CBS, 2012) whereas the urban population increased from 0.4 million to 4.5 million between the period 1971 to 2011 (CBS, 2012).

Kathmandu valley has been the most urbanized area of Nepal. The rapid growth in the population of the valley has brought dramatic changes in the land use pattern in Kathmandu valley. The built-up area in the valley expanded from 3,330 ha in 1955 to 16,472 ha in 2000 (Pradhan and Parera, 2005). The process of urbanization and subsequent expansion of the built-up area to the peripheral rural landscape and the resulting land use and land cover changes has been spontaneous without much government intervention, forming an area of mixed rural and urban livelihood called 'peri-urban'. These peri-urban areas have the characteristics of being inadequately integrated with the social and institutional characteristics of the city, as well as infrastructural facilities. This continued process of unplanned urbanization has created several physical, social, and environmental problems and created immense pressure on land and water services in the peri-urban landscape of the valley which has further been accentuated by climatic variability.

Lubhu Village Development Committee (VDC) is a peri-urban village of historical significance in Kathmandu valley, situated around 10 km south-east of Kathmandu. Prior to 1980s, main sources of water for Lubhu were rivers, springs, dug wells, stone spouts and ponds, The community water supply services started in 1981. However, Lubhu has no system of private water connection till date and thus all households at Lubhu depend on public stand posts. The consistent increase in population and changing life style with increasing urbanization has increased the water demand in the area, making it a real challenge for the people of Lubhu in a resource constrained scenario. It is in the backdrop of such realities that this paper tries to explore the implication of growing urbanization in combination with climatic variability in water security and adaptation strategies of the people in Lubhu, a peri-urban area of Kathmandu valley.

1.METHODOLOGY

1.1. Study Area

The study was carried out in Lubhu Village Development Committee (VDC), one of the peri-urban areas of Kathmandu Valley. It is a 700 years old traditional Newar settlement located at south-eastern part of Kathmandu Valley and lies at 850 21' 45″ to 850 23' 15″ East and 27° 37' to 270 39' North (VDC, 2008). Its area is approximately 4.76 square kilometers and the population size is 10,585, distributed across 1,871 households. The location map of the study area is given in figure 1.

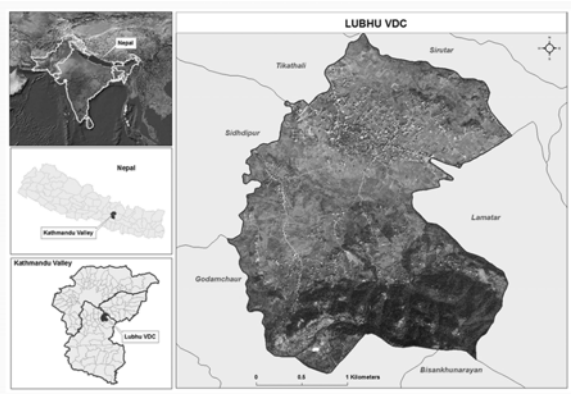

Figure 1: Map of Study Area

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2.2 Research Approach

The study involved series of focus group discussions with local people belonging to different age groups and occupations to understand water management practices at the household and community levels and to capture the perception of the local people on climate change and its implications on water resources and in turn agriculture. The information collected was validated through discussions with key informants that included the local leaders, key functionaries of water users committees, personnel in the development organizations and relevant government agencies. Similarly, key informant's interviews were conducted to understand the institutional role and strategies employed to reduce the water stresses in the area.

The hydro-meteorological data were collected from seven stations within Kathmandu Valley to understand the climatic trend. The stations Tribhuvan International Airport (TIA) and Panipokhari are situated within urban core of Kathmandu City. Khumaltar lies in the newly built urban area of Patan (Lalitpur). The stations Godawari, Changunarayan and Sankhu are situated the furthest away from the urban center. Lubhu being a part of Kathmandu valley, the climatic trend in these stations have been used to interpret the long term climatic trend in Lubhu. An overview of these field sites can be found in table 1.

Table 1: Summary of Hydro-Meteorological Records Used in Analysis

Index No.	Station	Location (Deg. Min.)		Altitude (m) abovemsl
		Latitude	Longitude	
1029	Khumaltar	$27^0 40'$	$85^0 20'$	1350
1030	TIA	$27^0 42'$	$85^0 22'$	1337
1022	Godawari	$27^0 35'$	$85^0 24'$	1400
1039	Panipokhari	$27^0 44'$	$85^0 20'$	1335
1059	Changunarayan	$27^0 42'$	$85^0 25'$	1543
1035	Sankhu	$27^0 45'$	$85^0 29'$	1449
1076	Naikap	$27^0 41'$	$85^0 15'$	1520

3. RESULTS AND DISCUSSION

3.1. Trend of Urbanization

Kathmandu valley has been facing rapid land use and land cover change. It has witnessed dramatic changes in the land use pattern over the last few decades which have been largely due to the rapid growth in the urban population and development of settlements, infrastructure and services. This rapid urban expansion has been engulfing agricultural land in the surrounding villages and Lubhu is not an exception. The total population of Lubhu was 3741 in 1971 A.D. , increased to 7481 in 1991 and 10374 in 2011 with 2365 households (CBS, 2012) with an average annual growth rate of 3.63 percent (figure 2). This population growth rate at Lubhu is three and half times higher than the growth rate of rural population in Nepal i.e., 1.03 percent and almost two times higher than the national annual average growth rate of 1.35 percent. Surprisingly, it is even higher than the growth rate of urban population of the country i.e.; 3.38 percent which clearly shows the rapid growth of population in Lubhu. Land pooling project was implemented in Lubhu from 1993 to 1996 which increased the selling away of the cultivable land resulting in increasing number of households reaching to 2365 households in 2011 from 1439 in 2001.

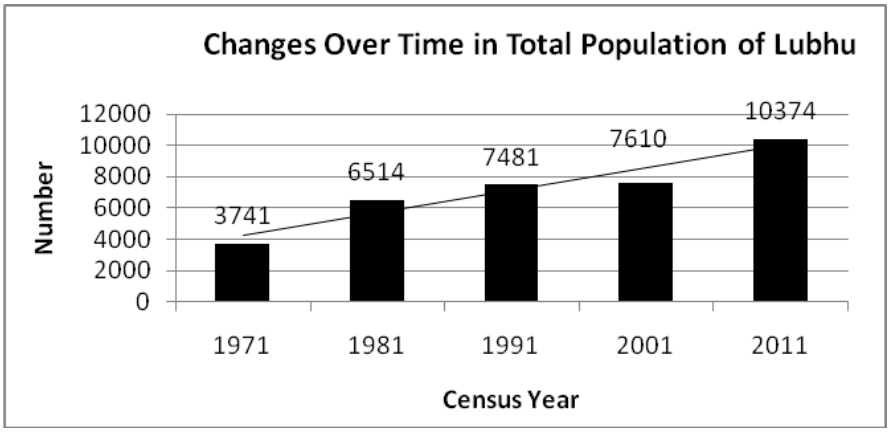

Figure 2: Increasing Population Trend in Lubhu

3.2 Climatic Variations in Kathmandu Valley

The hydro-meteorological data analysis of Kathmandu Valley showed that there was a decrease in the number of days with temperature < 0°C and increase in the number of hot days (> 30°C) (figure 3). The figure clearly shows the strong downward pattern in Khumaltar and TIA. The weakest signal was in Godawari. This is striking; TIA and Khumaltar are two stations situated in urban area, whereas Godawari is the station furthest away from the urban core. This gave the idea that there might be an urban heat island effect. This urban heat island effect is more pronounced in minimum temperature (Mitchell, 1961) and might therefore very well be visible in the number of < 0°C days. The figure also shows that the number of hot days had increased in all four stations. This signal is particularly strong for TIA, with a yearly increase of 1.52 hot days. It is also striking that in the case of Godawari, the station furthest away from the urban core, shows the smallest change.

Both the maximum and minimum of the Tmax as well as Tmin of the year had increased, which may imply that the warmest day of the year had become even warmer, and also the coldest day of the year. It also showed a distinctly increasing trend in temperature with an average increase of 0.05˚C/year in daily maximum temperature and 0.04˚C/year in daily minimum temperature. Baidya et al., (2008) shows comparable results for stations all over Nepal: an increase in warm nights and warm days and a decrease in cold nights and cold days. Similarly, a study made by Practical Action Nepal Office (2009), based on the observed meteorological data for the period 1976- 2005, shows increasing trend in the maximum temperature (0.05°C/year) and the minimum temperature (0.03°C/year).

Analysis of precipitation data from four weather stations namely Khulmatar, Tia, Godawari and Panipokhari showed that there was no clear visible increase in the number and length of dry spells, the number of rainy days and the daily intensity index. There was much spatial variation. An increase of events with > 50 mm of precipitation was found for most stations. There were no significant increasing or decreasing trends in total precipitation. A study by Practical Action also revealed that no significant trend in the precipitation was found. A time-series analysis of the effect of climate variables during 1978-2008 by Joshi et al., (2011) also found trend of precipitation is neither increasing nor decreasing significantly during the period.

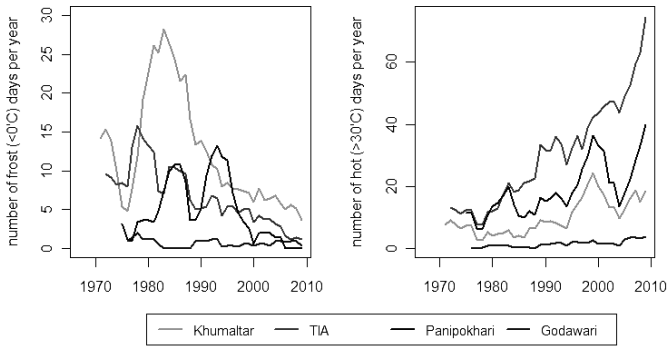

Figure 3: Temperature Trend in Kathmandu

Besides scientific analysis of the hydro-meteorological data, the perception of the local people on climate change was also studied which showed that daily temperatures were on the rise while rainfall was perceived to be declining. Further, the community perceived that the rainfall was erratic and thus, no longer dependable as far as water for agriculture was concerned.

3.3 Implications of Combined Effect of Urbanization and Climate Change

3.3.1 Impacts on traditional water infrastructures

People in Lubhu were traditionally dependent on water from dug wells, stone spouts, water tanks, ponds and river to meet their domestic and irrigation needs. These traditional water infrastructures were also closely linked to their culture and religious rituals. Many of these traditional water systems have however vanished over time due to urbanization and rampant construction of other physical structures. Prior to 1980s, nine ponds existed in the VDC which were used for the purpose of irrigation, personal hygiene and also for groundwater recharge, but by the year 2000, most of them had disappeared or reduced in size at the cost of construction of the public infrastructures. Similarly, traditional stone spouts have also deteriorated. At present, there are five stone spouts- Sankhadevi Dhara, Amrit Dhara, Bhagbati Lachi Dhara, Gaphal Dhara and Jharu Dhara. But most of these spouts are either completely dry or only partially in use.

3.3.2 Impacts on water supply systems

The Chapakharka community started managing the drinking water supply system of Lubhu since 1981.

tapping a source from neighbouring Bishankhu Narayan VDC. This system has been supplying water through 67 public stand posts with each stand post designated for approximately 30 households around it. According to the local people, the system supplied water twice on a daily basis, few hours in the mornings and the evenings in the initial phase. Lubhu being located close to expanding areas of the sub-metropolitan city, the number of people to be served by the existing water supply system has increased while the supply from the source has been adversely affected and limited especially due to the combined effects of climatic change and urbanization. Currently, water is supplied only once a day and that too, it is irregular and is only supplied for a few hours in the morning. This makes it imperative for women to spend most of their time during the morning hours at the public stand posts, just to fetch a single bucket of water. Mothers of school going children suffer the most because of the disproportionate volume of water collected against the number of hours invested in this process. Over a decade, five other community managed water supply systems have been in operation. However with massive increase in population, there has been no substantial improvement in the water availability for the inhabitants in Lubhu.

Similarly, the negative impacts have been visible in the irrigation systems as well. There are seven community-based irrigation canals in the VDC. Dovan Khola Rajkulo (state-sponsored irrigation system) has been virtually degenerated after being damaged by the flood in 1996. Ultimately, this historical canal was covered up for the expansion of road network passing through Lubhu. Furthermore, local residents have been releasing the household sewerage into the underground canal. The irrigation systems in Lubhu lack maintenance and have been further destroyed due to plotting for construction of residential and other infrastructure planning in the area. While Dovan Rajkulo has become defunct, the other smaller irrigation systems in Lubhu have been increasingly dependent on rainfall due to decreased water supply at the source itself. With reducing capacity of irrigation systems, agriculture in major parts of Lubhu is now only being rain-fed. The local communities have been in communication with concerned authorities to negotiate for the maintenance of these canals but the outcomes have not yet been very fruitful.

Godawari River flowing along the administrative border of Lubhu is also facing serious problem of pollution. Household sewage along with effluents from the increasing number of textile factories is being discharged into this river resulting in further decline in the river flow and therefore water availability. Moreover, upstream water extraction and irregularity in rainfall pattern has just accentuated the problem manifold.

3.3.3 Impacts on spring sources

In Nepal Chaur area of Lubhu, there were two natural spring sources prior to 2000. Among these, Karange ko Padhero was tapped for Ban dhara water supply scheme. As a result of the changing rainfall patterns and large scale deforestation for the construction of road and new residences around the spring sources, the water availability in both the springs have progressively declined. The untapped spring vanished by 2000 while the yield of those being tapped, has declined significantly. As per the observation of the local people at Lubhu, there has been decline in the yield of spring sources in the neighbouring VDC and thus the existing water management practices were less reliable to meet their increasing water needs.

3.3.4 Impacts on agriculture

The local people in Lubhu perceived that rainfall was declining and was no longer dependable. The combined effect of urbanization and climatic variability in Lubhu has increased crop damage due to increased pest attacks. As a result of increasing water scarcity, the incidence of pest attacks is increasing. The farmers also reported on the emergence of new pest in crops and felt that it is an impact of increasing temperature along with the disturbance in natural pest predator system as a result of soil degradation resulted from unbalanced use of chemical fertilizers and pesticides. Consequently, the cost of production has been increasing while crop production is declining. As per the recent estimation made by local government, only eight percent of the total households in the village have been able to sustain the family for whole year solely from agricultural productivity whereas forty eight percent have agricultural production sufficient only for three months or even less. This has been a major cause of growing deviation from agriculture to non-agricultural occupation.

3.4. Adaptive Strategies

The adaptive practices varied with the nature of the stresses faced by the people at the local level, emerging from climate change and urbanization and were found encompassing a spectrum of alternatives in the use and management of water at the domestic level and for agricultural purposes. Following is a summary of the adaptive practices of people in Lubhu.

3.4.1 Community initiatives in water management

There are six different community managed water supply schemes in Lubhu which have been supplying water to all the people through public stand posts. Chapakharka water supply scheme is the foremost among all. Dovan Drinking Water Supply System was initiated in 1998 with water diverted from Dovan River

with the aim of reducing the pressure on Chapakharka water supply system. This has been considered as the most reliable water source for Lubhu. However, the poor quality of water from this source is compelling the residents in Lubhu to depend upon the earlier water supply system for drinking. Local people spearheaded by Lubhu Water Resource Committee have defined two phases of achieving water security in Lubhu; in improving the capacity at Dovan River by constructing a reservoir, (250,000 litres of total volume) and installation of a filtration system to treat the collected water. The committee has envisoned to shift from public stand posts to household based piped water supply as an ultimate water management plan for Lubhu. Similarly, the other water supply schemes have also been exploring the alternative water source and technical and financial support to improve their water service.

3.4.2 Household's water hoarding: Security for increased future demand

The female members, especially those who do not have private water taps or water source at the household level, spend a larger part of their time during the entire day in fetching and managing water for their daily needs. The schedule for fetching water in the morning and evening often coincides with other household activities, like getting children ready to go to the school. Given the unpredictability in water supply, on the days of good supply, women collect as much water as they can, so that there is a provision of an additional water reserve during lean times. This additional water stored at the household helps meeting extra water needs during the festivals and also for the days of scarce supply. For instance, for a local festival celebrated in April/May, water is collected and stored during the winter months when household water demand is less, which clearly reveals the nature of insecurity, where water is stored, not for a day but for months in advance.

3.4.3 Sequential queue for water fetching: dealing with scarce supply

Women groups in Lubhu have unanimously created an informal, but innovative system of fetching water through a queue, decided on a lottery drawn from amongst the women fetching water from a community tap. This is a consented arrangement among the female members and guarantees that everyone gets their due share of water from the tap and avoids a situation of 'might is right'. The lottery is drawn either on a regular basis, weekly basis, monthly or annual basis, but once decided is maintained and followed meticulously by everyone for the stated period. At some of the public taps, this system was found to be in practice for past 30 years or even more. The advantage of this arrangement has been a social guarantee of the turn for fetching water without disrupting other activities and avoiding conflict within the community. However, with the Dovan Water Supply scheme in place in recent times, water availability has improved considerably, therefore easing out the pressure on the public stand posts, and therefore the traditional practice of queue at many of the public stand posts.

3.4.4 Contingency plan: Collective ferrying of water and reliance on the market solutions

In the event of extreme scarcity of water, fetching water from spring sources in the neighboring VDCs and depending upon tanker supply are the alternatives left to the people. Ferrying water in containers loaded on the bicycle is a common sight at Lubhu. Often a number of households join and rent a vehicle to transport water in larger vessels. Since large quantity of water is transported in a single trip of the rented vehicle, this becomes an easy and cost effective mechanism.

Tanker water supply is another alternative for the households to deal with the scarcity in the dry season and in the event of disruption of water supply in Chapakhrka Water Supply Scheme during monsoon due to landslides in the area. Those who cannot buy water in bulk may buy water in small quantities from the tanker operators- the usual rate charged by tanker operators for small quantities of water is NPR. 5 per gagri of approximately 15 liters.

3.4.5 Capturing roof top runoff: Innovation of low cost options

Some households at Lubhu have started innovative practices of capturing roof top rainwater and storing the harvested water for uses in cleaning, washing and other sanitary uses. This is done by digging a pit in the homestead for storing water for uses apart from drinking and livestock watering. Some households have also developed roof top and underground water storage tanks to store enough water to meet the needs during periods of water scarcity. These households use electric pumps to lift water from dug wells or depend on tanker supply.

3.4.6 Changes in cropping practices and occupational diversification

The agricultural land in the area has been undergoing rapid transformation in recent times due to urbanization. There has been two important shifts in the area as a result of this transformation: i) shift from traditional grain farming to vegetable farming in smaller areas, which has been found economically more rewarding, and ii) people shifting to non-farm occupations. The area was traditionally known for rice and wheat production but the farmers in the area have stopped cultivating wheat due to high water requirement in growing the crop, lower economic returns and higher input cost and drudgery of crop cultivation. People in the area are shifting to other occupations, such as, weaving traditional textiles, jobs in the government,

private firms and industries and non-farm wage earning activities. A very important reason for shift in occupation has been the increasing scarcity of water for irrigation and the drudgery involved in farming. The usual practice at present is to maintain a small piece of land for cultivation of economically more rewarding crops, such as vegetables, and selling the additional land and shifting to non-farm occupations for additional income.

3.4.7 Changes in the practice of water use

On account of the hardship of fetching water, female members go to the river to wash clothes despite the poor quality of river water and male members take bath in the stone spouts and wells in neighbouring VDCs and rivers passing by Lubhu. Since Saturday is a public holiday in Nepal and household level activities take priority especially for service holders, women try to escape from these water demanding activities usually on Saturdays.

3.4.8 Shift of settlements from the upland to low land

The availability of water is always a constraint in the upland areas due to unavailability of dependable spring and groundwater source and also topographic limitations in developing piped water supply system. In order to avoid this difficulty, there is increasing preference and tendency among the people to shift the location of their houses from the upland to lowland. This shift in the settlement pattern was noted in Ward No. 8 of Lubhu where people have shifted the location of their house form upland to low land areas for better access to water from stand-posts, which were earlier too far.

4.CONCLUSIONS

The increasing water demand due to increasing urbanization and declining water sources due to the compounded effect of urbanization and changing climatic trends have resulted in further increase in the water stress in Lubhu. Considering the rapid urbanization trend and increasing variability in climate, the concern for sustainable water management is growing among the local community. However, strong dedication and unity among the communities is likely to be critical to ensure water security in the village and improvement in their adaptive capacities.

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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

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.

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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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