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A Study on Causes of Waterlogging in Southwestern Suburban Area of Kolkata, India

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Abstract

The riverine city of Kolkata with its characteristic physical set up is a classic example of human-induced influence on the entire hydro-geophysical characteristics of the region leading to geomorphic hazards like waterlogging. This has a profound subsequent implication on social and economic facets of the inhabitants. The severity of the waterlogging problem in the southwest part of Kolkata Municipal Corporation is highlighted in the present discussion where almost every individual tend to distort the micro-relief and natural slope of the area in the absence of any master plan.

Keywords: *riverine, hydro-geophysical, geomorphic hazard, waterlogging.*

Introduction:

In an urban system the forms of land instead of landforms play considerable role to affect the day to day activities of urban population. Sometimes the very form of land with its micro-relief variations, if not properly planned, implemented and maintained, pose serious threats to the citizens. And over period of time an anthropocene micro relief has been developed leading to distortion of natural slope. Human-induced influence on the hydro-geophysical characteristics of an urban region like Kolkata often leads to several geomorphic hazards like waterlogging. It has a profound subsequent implication on social and economic aspects of the inhabitants of the area paralyzing the daily chores of life in the rainy season.

Study Area:

Borough XIV of Behala, the study area (fig. no. 1 to 3) located at southwest corner of the metropolis is termed as added area of Kolkata as the area comes under the administrative jurisdiction of Kolkata Municipal Corporation since 1984. Apart from the haphazard residential growth and indiscriminate filling of natural water bodies, inadequate or complete absence of sewerage and drainage facilities

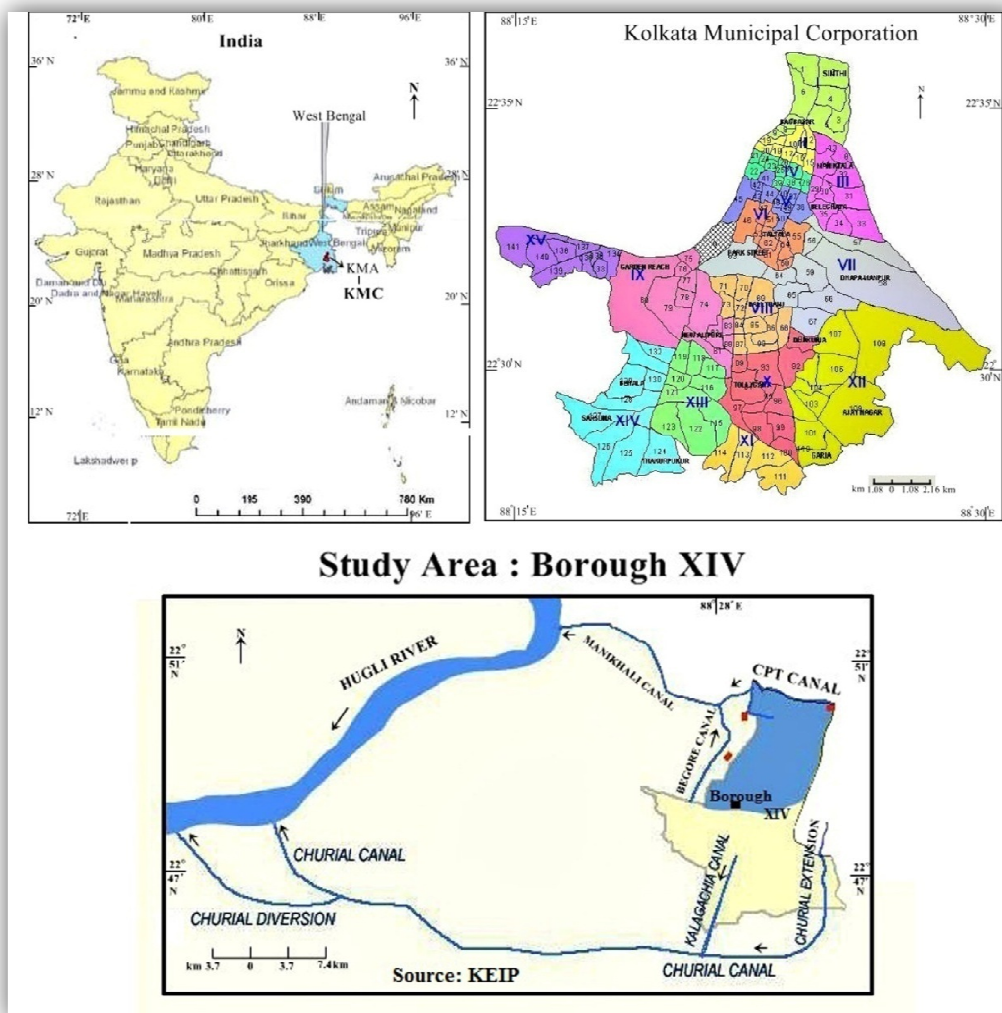
coupled with unplanned annual road maintenance lead to water logging as a perennial problem during the monsoon months.

It is worthy to note that Borough XIV bears now nearly 10.22% and 14.31% of the total area and total water logged area of Kolkata Municipal Corporation respectively.

Geologically, the area is of Quaternary age formed out of deposits of alluvial sediments of the river Ganga and its tributaries. Lithologically, the alluvial fill consists of clay with low porosity, silt, fine to coarse sand mixed with fine pebbles. The climate is humid and tropical. The Churial and Manikhali canal network on a very low gradient of less than 2cm per km drain the surface water to the Hugli River in the west.

Objective:

The objective of this study is to determine the major causes behind waterlogging in the area.





Previous works:

As waterlogging is one of the major problems of land degradation in India, the Ministry of Water Resources, Government of India shows a special interest in it. It is constantly assessed by National Agricultural Commission in the rural areas as well as Ministry of Urban Development in the urban areas. The report by Central Ground Water Board, Ministry of Water Resources, Government of India on Ground Water Scenario in major cities of India is very relevant in this regard. At the local level governments (KMC Report-Initial Environmental Examination Report on Sewerage and Drainage Project) and various research wings (KEIP) from government or non-government sectors conducted survey and research work to mitigate the problem paralyzing our daily chores of life. But the southwestern part of the city of Kolkata is not studied intensively in the light of the most intrinsic problem of waterlogging, which has a significant impact on the socio-economic environment of the area as well as the city on the whole. Some of the relevant books, papers and research works on overall aspects of Kolkata water logging are mentioned below:

Dasgupta, Biplab (1991) and others in their edited volume 'Calcutta's Urban Future', took into account the spatio-temporal evolution of Kolkata, settlement pattern and form of this city, water supply, transport modes as well as the drainage network.

Bandopadhyay. Sudhindra (1992) in his book 'Behala Janapader Itihas' vividly portrayed the growth of settlement at Behalawhich was previously a cluster of scattered villages.

Urban Water Research School, Chalmers University of Technology, Gothenburg, Sweden (2004) in their report on '[Sustainable Urban Water Management in International Mega-Cities](#) Experiences from Study Trips to Cairo, Kolkata and Tokyo' studied sustainable urban water systems in a mega-city context to assess sustainable development including waterlogging issues.

Basu, S.R., Ray, A.(2005) in their paper on Changing scenario of waterlogged areas in Kolkata City examined the shifting patterns of waterlogged areas in Kolkata city vis-à-vis internal migration of population.

Bhattacharya, Mohit (2009) in his paper 'Urban Floods: Case Study of Kolkata' attempted to examine the causes behind urban flooding in the city.

Dey, S (2009) in her paper 'Urban Floods in Kolkata, Case Study: Churial-Monikhali Basin' proposed strategies to mitigate the effect of floods in the city of Kolkata. The study analyses the phenomena and characteristics of flooding in Kolkata by studying the past trends and observe changes in the spatial extent of the areas inundated during floods as well as the duration of water logging. The critical

features of the flood prone areas and the causative factors have been analyzed to suggest measures to mitigate urban floods.

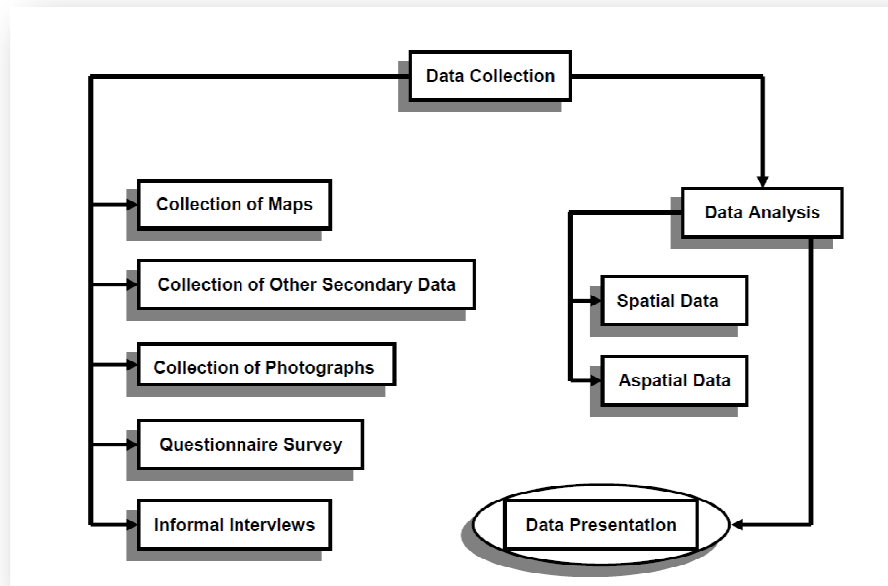
Maitra, A.K. (2010) in his paper ‘Climate Change on Coastal Metropolis: Case Study of Kolkata’ discussed the effect of urban flooding in Kolkata which the city experiences every monsoon. Through a detailed study on vulnerability aspect of the flood affected areas the article, focused on mitigation measures.

Roy, Mohit (2013) in his book ‘Kolikatar Pukur Katha’ studies the importance of urban water bodies in maintaining ecological balance of a city like Kolkata especially in its added areas.

Adhikary, Pabitra (2014) in his book ‘Brihattara Behala Janapader Itibritta’ established the fact that Behala is a settlement of historical importance with a true riverine impact.

Methods:

The methods applied in this study primarily include the identification of the study area and analysis of data and information collected from appropriate authorities as well as these obtained from community perception survey. The methodological approaches of the study are as follows:



Discussion and Result:

The study of consecutive periods of waterlogged areas in the city of Kolkata shows that there is a gradual shifting of waterlogged areas from north and central part of Kolkata to south, south eastern and south-western parts of the city (Basu and Roy,2005). This is to a large extent due to internal



migration of population from north to south, south-eastern and south-western parts (study area). It is found that population concentration in the southwest fringe areas with respect to total population of the city has been increasing manifold (from 7.6% in 1971 to 24.1% in 2011). The southern part of the area is largely still unsewered.

Interestingly, despite poor drainage facilities, this fringe area did not suffer from acute waterlogging even during the colonial period as the natural configuration and drainage was not distorted by human interference.

Acute drainage congestion, unplanned growth has reduced the cross-section of the existing canals which act as the drainage channel of the area. Heavy siltation and continued disposal of industrial and municipal waste have rendered the water quality of these canals unfit for any use.

Major Determining Factors of Waterlogging

The lesser growth of urbanization in the southwestern part of the city (around Behala) geared up substantially after 1980 to make room for huge influx of internal migration from the city proper. With the widening of Diamond Harbour Road as well as construction of other road connectors, the accessibility of these areas has improved to a great extent. This has generated a spurt of private land transaction and development activity in these areas. As a result, indiscriminate encroachment on green areas, wetland and water bodies are taking place. Wetlands made way for new neighbourhoods which are flood prone and drainage proved to be difficult, expensive and ineffective in the rainy season.

The filling up of backswamp in a haphazard way leads to frequent waterlogging in the area paralyzing the daily chores of life in the rainy season. As the land was low, individual developers filled the land without caring to maintain the general slope of land, which was very necessary for easy draining of accumulated rain or waste water. Thus over period on the imperceptible slope of the delta, an anthropocene micro relief developed due to such reckless alteration of land use leading to distortion of natural slope.

The study area now has become a perpetual area of waterlogging and the reasons of this ever-increasing problem are numerous. Apart from internal migration problem, only the major ones are examined below:

1. **Ground Configuration and Drainage System:** The study area has a very low gradient of less than 2cm per km. with a slope towards west. It is worth mentioning here that the study area (Borough XIV) drains towards the Hugli River in contrast to the general ground profile of the city, which slopes away from the river towards the east.



The areas experiencing frequent waterlogging during the monsoon months are mainly confined to the lowest part of the study area, i.e. land below 3.5 m contour. The situation aggravates because of intense and periodic monsoon rain coupled with onset of a number of tropical cyclones. As a result huge quantity of water flows beyond the capacity of old drainage systems of the area creating flooding in the area.

The near flat terrain of the area makes drainage under gravitation difficult, for which waste water is pumped to the neighbouring canal system by pumping stations, which are also mostly not working efficiently. Over the past decades there has been an increase in water logged areas, especially in Behala area comprising the Churial and Monikhali basin. Increasing built up areas, high siltation and eutrophication compounded the drainage problem of the city.

In the absence of planned drainage facility, the local residents have built their own household-based small drainage outlets themselves without any knowledge of or concern to the actual land condition. Hence a messy drainage network has been evolved through decades of neglect and fulfilment of trivial interest in which most of the drains; including some high drains (built by the authority) also have become totally obsequent to the local topography, land use, population distribution and rate of waste water disposal.

From the analysis of six boreholes drilling up to a depth of 20m within the study area, it is found that the lithology of the area is dominated by clayey layers with a compact plastic texture. This lithological characteristic make the soil impervious and the surface water cannot enter underground easily.

2. **Changing Pattern of Landuse:** In the selected study area, drastic changes in landuse resulting in distortion of micro-relief have been found to occur within a span of 30 years (1980-2010). With the rapid pace of urbanization due to huge influx of people to the study area, situated in the southwest corner of Kolkata, roads and other paved areas replaced the unpaved areas, natural depressions, open spaces and arable lands. In many cases, natural drainage canals and open water bodies were filled up for development works.

As a result when rain falls on the land - mostly covered by impervious surface (roads, built up areas and pavements) - the natural infiltration of rainwater into the ground is prevented. Often the remaining open ground cannot accept water as rapidly as it did in its natural state, because during the course of civic constructions topsoil was either removed, compacted or mixed with low-permeability subsoil. Hence, direct runoff can increase to more than 80 percent of the rainfall volume.

3. **Unplanned built up areas and Shortage of Road Spaces:** The haphazard residential growth of the area reflects administrative lacuna and absence of any master plan in proper perspective. Every



individual develops his own premises without considering the natural gradient, which in turn distorts the micro-relief. High-density of population as well as shortage of land causes intense densification of human habitat in the existing built up areas.

The shortage of road spaces in the area acts as a constraint to natural drainage of rain water. The narrow, congested and encroached road networks are not fit for laying proper sewerage system. The narrow roads, streets and lanes almost gag the study area.

Apart from this, sporadic road maintenance works continue to raise the road level to such an extent that the raised road benches act as low embankments causing huge accumulation of rain water at their edges where sewerage and drainage facilities are either inadequate or absent. The unskilled and unplanned road maintenance is an absolute violation of the ratio between the sanctioned plinth level of the already constructed houses and the connecting road level in front of the houses. This practice of indiscriminate raising of road level often surpasses the plinth level of the houses making life miserable in rainy season.

4. Disappearing wetlands, ponds and canals:

Unplanned built up area with encroachment on canals and waterbodies pose a serious threat to the ecosystem of the area. Shrinkage of wetlands (confirmed from NATMO report, 2006) aggravates the problem of water logging. As a result, the nature and intensity of waterlogging scenario changes with time.

5. Silting of canals/outfall channels:

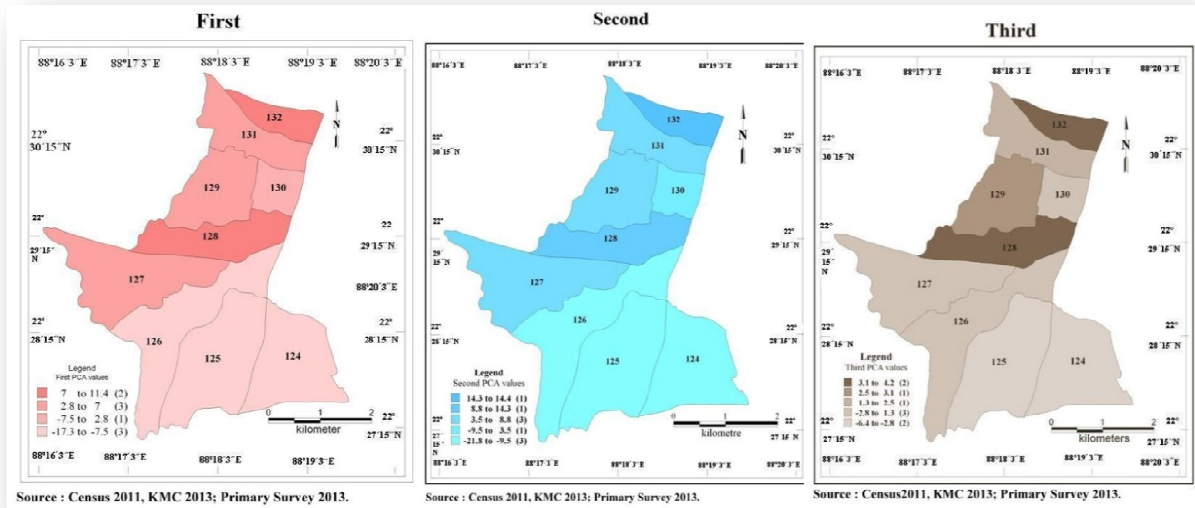
Heavy siltation and continued disposal of waste (in absence of proper waste management system) has reduced the depth of the canals; which in turn are incapable of draining the excess water during the monsoon months. This is due to their poor maintenance by the concerned authority and lack of people's consciousness.

A Z-score analysis of the efficiency of canals based on the information gathered from KMC Borough Office shows that the Begore canal (a part of Monikhali canal system) serving mainly the wards 127,128,129 and also part of ward 130 is the most efficient. But its present condition is miserable with encroachment, siltation and reduction in carrying capacity. The original drainage and canal system of the Behala area became ineffective because of the newly urbanized areas.

Principal Component Analysis have been done with eight parameters viz. population density, household density, waste generation, low level of land, intensity of water logging, duration of water logging, covered and uncovered sewerage system. The aim is to find out relationship between these parameters after the computation of factor loadings and eigen values are estimated for first, second and third principal components. Nearly 100% of the variation is explained here (*fig. 4 to 6*).

Principal Component Analysis (PCA)

Index of Water logging Determinants



| Factor loadings of First PCA | Factor loadings of Second PCA | Factor loadings of Third PCA |
|---|--|---|
| A significant positive correlation with population density, household density and waste generation. | A significant positive correlation with low level of land, intensity of water logging and duration of water logging. | A significant negative correlation between covered and uncovered sewerage system. |
| Fig. 4 | Fig. 5 | Fig. 6 |

Conclusion:

Waterlogging in the study area is the result of unplanned development. The efficient and holistic nature of urban management in future may be the only solution to get rid of this problem. For this, planning, design, operation and maintenance of urban drainage systems will be a challenge for all stakeholders. Planned urbanization proposes to arrest further unplanned extension of the area with an effort of retention of the general slope of the land. Preservation of the existing wetlands, open areas and agricultural spaces and urban greens to serve as ground water recharge points is extremely necessary. Water bodies are to be conserved as they can act as buffers for absorbing excess rainwater during heavy storm.



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