



Seasonal Water logging Problem In A Mega City: A Study of Kolkata, India

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Received 17 March, 2016; Accepted 05 April, 2016 © The author(s) 2015. Published with open access at www.questjournals.org

ABSTRACT:- Water logging is become a severe problem in Kolkata metropolitan region with the increase of the high-rise buildings, which made the land congested and disrupted also. The sewerage and drainage system of the Kolkata is disrupting day by day due to unscientific land use system in the city. Mainly in the central portion of this metropolitan city's decreases the amount of open surface and there has created submergence due to ongoing high rises. So in this area badly affected in water logging situation after small downpour. Not only central part of K.M.C, Water logging is a persistent problem in different area of the Kolkata. This creates terrible situation in the metropolitan areas. This work is trying to identify the locational extent of the city with its affected area by water logged condition and to find out the main causes and result that led it to be a hazard. It analyse and picture out the main waterlogged zone, characters of canal and channel which helping to pass out the storm water flow from different part of the city, the drainage flow character and behaviour, ward wise waterlogged area with its varying depth, roads which are affected due to water logging, the traffic situation and the number of people affected by the water. So, it also analysed the proposed plan like setup new pumping station, development of sewerage system etc. which help to the people to get rid of that devastating situation hampering the socioeconomic situation of that metropolitan city.

Keywords:- Sewerage system; pumping station; water borne disease; KMC

I. INTRODUCTION

Kolkata is the metropolitan city located in the southern part of the lower Gangetic plain along the bank of river Hooghly. The physical configuration of the city is the longitudinal extent of settlements on the levee of river Hooghly. On the Western side it is river Hooghly and in the East it is Salt Lake. Western side is built up with the younger levee, lies almost near the moribund delta. But with the increase of the high-rise buildings the sentiment becomes suppressed and the land has been disrupted. The sewerage and drainage network for Adi Kolkata made by the British were for a lesser population and the canals were adjoined with this system. But by the increase of unscientific land use the system gradually collapsed. This older system failed to keep the parity between the drainage systems in various parts of the city. Water logging therefore became a persistent problem in different areas of the Kolkata Municipal Corporation. 'Waterlogging' is a severe problem faced by the city of Kolkata. It disrupts the general flow between these areas. It creates many problems in different sectors. This study and the selection of its severe problems consists some aims and objectives that are; Identify the locational extent of the city with its affected area by water logged condition and To find out the main causes and result that led it to be a hazard.. Water logging problem has become a severe problem in many of the metropolitan city. So on the special adherence to the waterlogging situation in the metropolitan cities on the world, there are so many examples and case studies has been done like in Bangladesh, the Teknaf urban area under Cox's Bazar district are affected by internal rain fed flood, this project also provide some recommendation to get rid of this stations (Anisha. N.F et al., 2014). Another case study has been made in Dhaka, the capital of Bangladesh have also faced the problem of water logging due to poor urban drainage problem which impact on the population by environmentally (water pollution, Water borne diseases etc) and socially (disruption of traffic, disruption of normal life, etc). they give also recommendation like to free the drainage system from any obstruction or blocking, set up institution for effective operation, etc. (Alom M. M et al., 2014). In India a case study has been drawn over four metropolitan cities like Kolkata, Chennai, Delhi and Mumbai, about the urban flooding from the period of 1988 to 2007. They have identified the reasons and showed how the people are impacted in this situation and provide some recommendation (Singh G.P., et al, 2013). The water logging fell impact on the

diseases which are caused by *Mycosphaerella* infection in field peas was measured in 2 experiments in the glasshouse. It leads to greater reduction in plant growth (McDonald G.K et al., 1996). There are currently almost 2 million hectares of salt affected land in south west western Australia and significantly larger area with high water table considered “at risk” of salinization sometimes in the future. The main road of the Australia commissioned a review of the current situation with regard to salinity and waterlogging impacts on their road network (Foley G, et al., 1999-11). Recently heavy rain caused traffic snarls in new delhi and metro city faced worst situation in this reason. The municipal corporation recorded 35 causes of waterlogging (The India Express, August 10, 2015, 10.50 am). Heavy rain in Mumbai’s dadar region has resulted in massive waterlogging causing numerous problems to the commuters. And it was reported that government does not take any action against it. (Mumbai , ANI , August 21 , 2014 11.57 am). In Mumbai during heavy rainfall the Lovegrove and Cleveland Bunder storm water pumping station which failed to deliver as promised (The India Express, Tnushree Venkartraman June 20 , 2015 , 10.50 am). Recently GIS data integration of groundwater and remote sensing image and groundwater modelling are utilized to access water logging problem and manage drainage deficiency along Wadi EL Tumilate basin in north Eastern Nile Delta of Egypt (Kaiser M. Fet al., 2013). The slum area are effected badly by waterlogging situation and the project try to identify the causes and location of the repetitive waterlogging in Thane city and it was proposed the recommendation of environmental management plan (MMR Environmental Improvement society).

II. STUDY AREA

Kolkata is a metropolitan city, located in India on the bank of river Hooghly. Kolkata (Fig.1) from $88^{\circ}30'00''E$ to $88^{\circ}19'00''E$ and from $22^{\circ}33'00''N$ to $22^{\circ}33'00''N$ longitude and latitudinal ,altitude – from sea level, it is 6.9 meters (20 ft.), and the area of whole Kolkata is 1480 sq. km. within the corporation area. The word Kolkata ‘Kolkata’ derives from the word ‘kolikata’ the name of one of three villages that predated the arrival of the British, where the city eventually was to be established, the other two important village were Sutanuti and Gobindapur. Kolkata is located on the bank of river Hooghly as it was very important and very quenchable for the British .The port facility in before days were used by them greatly used by them , flourished their trading as they cultivated many crops efficiently and send them into their own kingdom. Kolkata is located on the bank of river Hooghly as it was very quenchable for the British. The port facility in before days were used by them greatly flourished their trading as they cultivated many crops efficiently and send them into their own kingdom. As they were very much interested with its aerial facility they have built up some sewerage and drainage system to way out the flows of waters and were maintained manually but as the population began to increase the system of British Kolkata to maintain the parity. As the slope is from west to east they also built the pumping station mainly in the eastern part of the city to pump out excess water. ‘Geography’ it’s a significant features of an area with its emphasis to physical structure. As Kolkata is located on the bank of river Hooghly the western part of this city is constructed with younger slit that one part of moribund delta are quite higher than the eastern side. The eastern part of Kolkata, where situated the circular canal and marshy salt lake area. In the year of 1960 , when it was invented by job Charnock there were three villages ,where Gobindapur was based one fishing activity and Kalikata was the main trading centre .Thus we can interpret the persistent land were marshy a and located on the bank of river Hoogly. Thus a denser clay layer created on the surface which does not allow water to penetrate inside it which causes the waterlogging problem. The soil on which the Kolkata is built is formed by the alluvial deposits of the Gang etic delta and has alternate layers of sand and clay. Often during early summer, dusty falls followed by spells of thunder storm and heavy rains lash the city, bringing relief from the humid heat. This thunder storm are convective in nature and locally known as Kalbaishaki (Nor westers), containing the average humidity 78%. Now a day, a concrete setup, of the city gradually decreases the amount of open surface and an up going high-rise causes the submergence of the central portion .That we can say the geographical set-up of this metropolitan area greatly influenced to occur the hazardous condition between the cities. Any physical attributes of a region affect the socio economic structure. I.e. life style, status of living, occupation, land use etc. As Kolkata metropolitan city is highly facilitated with some of physical and cultural well grown set-up. In ancient time under British rule kalikata was used as port and is the principle centre East India while the port of Kolkata is India’s oldest operating port as well as its major riverine port. As of 2011 year, 4.5 million residents; the urban agglomeration which comprises the city and its suburbs was home to approximately 14.1 million making the third most populous metropolitan area in India. In 1901 it had a population of 847796 million in its street core area and was the second most populated city in Asia and as well as British Kolkata. It is now the capital city of West Bengal state of India .As a growing metropolitan city in developing country Kolkata confronts substantial urban pollution traffic congestion, poverty, overpopulation and other logistic and other socio economic problems. The city is under residential division and served by civic amenities like rail, water, road, building, etc. this is supervised by Kolkata Municipal Corporation. They take care of its area, which is divided into its boroughs, and each borough contains 141 wards. 7-100 is the core city and the area is known as ‘Core Area’ but the rest of the areas were added recently and have come to be known

as 'Added Area' to the KMC. Maximum temperature rise during the summer months of May-June up to 24-42°C and the minimum temperature falls during winter months of December-January up to 8-26°C on an average. The climate is humid varying from 35-65 during the summer and exceedingly is pleasant during winter. From June to September, the average rainfall of Kolkata is 158 cm.

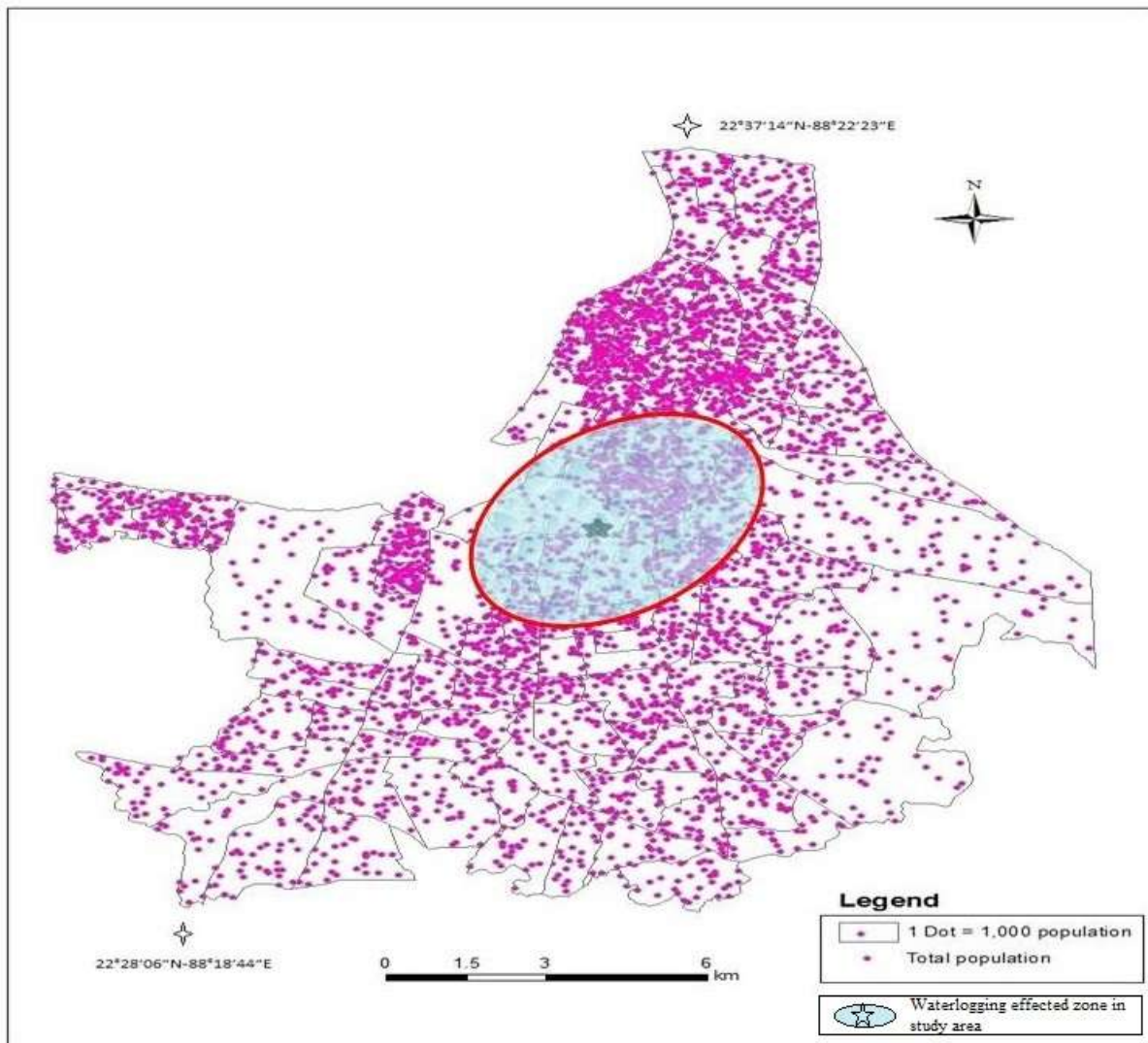


Fig:1 Scenario of population pressure in Kolkata,2011 and the location of study area where seasonally waterlogging maximum observed.

III. METHODOLOGY

This work mainly based on several collections of data. Two main types of data collection are primary and secondary. Primary data collected from field like Primary survey, household survey and market survey of borough 5 under KMC has been made on total 30 families/shop owners. Secondary data sources of drainage network and with its canal system and the identification of waterlogging prone area by the KMC. Engineers provided their recent maps and frameworks of recent Kolkata and also provided some historical maps. The Lalbazar Traffic Control Board has given some elementary document of traffic during the waterlogged period. The previous research reviews provide the clear idea of this type of work. Some statistical method has applied to analyse the project, like scatter diagram with regression analysis and time series analysis. Conceptual mapping (like choropleth, isopleth) has been drawn for showing population density, road density, depth of water level, during waterlogging period. Some diagram like pi-chart, proportional circle, bar diagram, ternary diagram, square diagram, flow diagram, etc. have been made for showing the impact of waterlogging on diseases, the waterlogged area, waterlogged affected road, the flow of water through the canal and also the year wise rainfall variation. The work is completed through the application Google Earth and some software like Arc GIS10.2.2.

IV. RESULTS

4.1.1. Main waterlogged zone:

Kolkata is still working to build up its relief pattern. As situated on the bank of river Hooghly, Kolkata and its surroundings areas are under the younger levee zone. The western part of the Kolkata is not affected by the severe water logging problem as it is reach in higher zone. Mainly Garden Reach (Borough 15) but the central and North Kolkata (sealdah and the adjoining zone like collage street M.G road, Thanthania Kalibari, Bidhansarani etc.) Southern Portion (Jadavpur, Southern Avenue, and part of Behala etc.) are facing a problem of waterlogged. Some part of Shyambazar and the East Kolkata West Land (at Dhapa - Mathpukur) also facing the problem due to waterlogged. Mainly this severe situation occurs basically in the rainy season and due to water logged. There are some causes which act as the helping factor, encouraging the critical situation of waterlogging. The reasons are; Kolkata since 1960 act as a port facility for the British But the physical and cultural flourishment attracts the population settle down within it. Accessibility is most important to grow up a town bigger. As population increases the road network also build up greatly. The road density become higher, but it was not properly planned. Material used rigidly, even the elevation of land was not properly studied so that, the unplanned road network make hindrances to pass out the water from logging situation. A narrow path mainly in central Kolkata and in the part of Behala also causes the same situation. As the commercial activities has grown up very fast so it is getting essential to build up offices and with pressure of population the complex grown up in the recent decades. The suppress that the clay layer and cause the depression in its outer surface. So that it can be seen the pressure is higher in the central Kolkata and the part of southern Kolkata. As central Kolkata lies in the palm of this levees so it faces a great problem as the part of southern Kolkata also facing this problem including Behala. As a part of developing country Kolkata facing a rapid growth of population and it causes the higher population density in its core area. In added area with its civic amenities also have a higher density of population. The wastes from the domestic households From the industries became higher that can collapse the canals way out and the drain out channels, which does not allow water to pass away that can cause waterlogging and with the increment the of population density the unplanned land use also cause the situation of waterlogging. From the former discussion it can be concluded that the varying features both including physical and human behavioural (throw out elsewhere non bio degradable wasted like plastics and polymers) causes the stagnancy of water which are not possible to pass away that they from the cases of water logging.

4.1.2. Character of canals and channels:

Kolkata is connected with some of canals and channels which help to pass out the storm water flow from different parts of the city. The main canals are Bagjola and Kestopure that serves the area of borough 1, 2 and 3 and other eastern important canals are town Head cut and chowbagha canal which serves mainly the north eastern part of the city Kolkata. They remove their water in Kulti River. Another important canal system are shown in the western side of the city which removes its water in Hooghly. Manikhali canal with its important distributaries serves the western portion and churial canal are there which flows it's westward and remove in the Hooghly. But the very recent eras due to extreme urbanization and up growing density of population with their domestic and industrial wastes also pass through small drains and channels and they finally remove on the canal and the big sized solids like construction debris. Industrial waste and solid wastes causes the congestion in its flow and that also causes the frequent waterlogging problem with its flooded condition. Theoretical concept to self-cleaning is also being practically incapable.

4.1.3. Drainage Flow Behaviour:

Sewerage and the drainage network system converse the entire city structure. Canals serve the different part of the city and they are named as its corresponding basin system. Mainly the north-eastern part of this flow it's water toward eastern part of this country flow it's water towards Eastern side's canal and they mainly flow eastward by chowbagha canal and finally fall into kulti river. But in the south western part of Kolkata corporation area serves by its western pattern as they remove on the river Hooghly flow eastward direction but only in the extreme north and Garden Reach area directly flows its water to river Hooghly without help of any canal as they named "Hooghly system".

4.1.4. Ward Wise Water Waterlogged Area with Its Varying Depth:

Topography moreover relief pattern vary in different part of this city. It is mainly made of clay which does not allow the water to penetrate. That is way highly intensive rainfall logged within an area due to low land , having marshy land, prevailing clay layer that make the hindrance for percolating more over the canals are also getting blocked by waste disposal by the increase of population and its associated factors.

The entire region has facing same problem. Central part of Kolkata having a "soup plate" shape suffering from a severe water logging as traffic flows of vehicles get slow down and the movements are need to be diverted in many ways meanwhile Behala region also accompanied with this problem even a narrow paths in

this region suffering from stagnancy of water above ankle deep for a few days having a little breeze also. The situation affects the general flow of vehicles and commuters many ways. Various depth of water that differs from place to place but as the connotation shows the densely distributed area suffering more problems from this seasonal hazard. According to the primary survey it is also summarized that the level of satisfaction is very low in this region as they facing a great problem to go to school, offices and other designation. This is also because the extra fare of vehicles in the highly water logging prone regions.

4.1.5. Areal Distribution of Pumping Stations with Its Capacity:

As Kolkata is made by alluvium the clay layer beneath its surface does not allow much rain water to penetrate that is why water because stagnant in this area. To remove the water by pump force several pumping station has been made up throughout the city. Maximum stations have been set up in the north eastern part of the city. The central Kolkata having more powerful pumping station, Palmers Bridge P.S. The Dhapa lock pumping station in the eastern by pass serves this associated area. But the Southern western part has no capable station to flow out the waters. Jodhpur Park pumping stations has served by any capable pumps. Through some equipment are used such as Diesel pump, suction machine. After 2008 new pumping stations have been made to cure up the problems by this, Ultadanga storm pumping station has been made to flow out the storm water along with the area of slip road. This was made within 12 month by the cost of 3, 40, 07, 6, and 19. In the year of 2009 decision has been made to build up the pumping station at Gokhale road to flow the storm water and the Marcus Square storm water drainage pumping station which would work within a very short time. Beside the pumping stations some lifting pumping station (like Maniktala) has been made to lift up the water and flow with its canals and sewerage line but now a days the sewerage network also facing problems due to siltation and by the depression movement of the landmass.

4.2. Sewerage System in Kolkata and its recent views:

- 1) The underground sewerage network of the city of Kolkata is pretty old of over. 100 years laying of most of the old city sewers was started in 1870 and was continued up to 1935. Subsequently till date some addition and alteration was made.
- 2) The city of Kolkata is bounded by the River Hooghly on the west and Dhapa area on the east crossing Eastern Metropolitan Bye-pass. The city is topographically sloping towards east and thus the major trunk sewers were laid from west end as summit and sloping towards outfall end on the east.
- 3) The entire sewage water (dry weather flow) from the city is being discharged to the east side outfall i.e. Town Head Cut Channel, Suburban Head cut Channel, Eastern Channel etc. Which are finally discharging to the Kullu Gang, after long travel 40 (Forty) km. from the city eastern boundary. In this process of long travel, sewage load is being gradually reduced due to natural aeration process and parallel voluminous psych. Ultra by the adjoining wet land owners and fishermen. In this way waste gets purified to the reasonable extent.
- 4) Since lying of sewer one 100 years back – no sewage water (dry weather flow) is being discharged directly to the river Hooghly and at its tributaries like Tollynullah, Beliaghata circular canal and new cut Kestopur canal. Only storm water during rainy season is being discharged to the Hooghly River and these channel through controlled operation by block gates which are located on the eastern banks of river Hooghly for discharging storm water.

The sewerage system of Kolkata is one of the oldest in India (140 years ago the system was constructed in British era). In Kolkata 55 percent of the area is covered by the sewerage system and part of the remaining portion is covered by the “septic Tank” system. In some places the existing storm water drains are used to carry sewage as well. The system has adequate conveyance capacity during weather flow but do not have enough capacity to handle storm flow. The city has a total of 1390 km of sewers, of which 1207 km is pipe sewer and 180 km is brick sewer (as per the record of KMC/KMWSA in 1992 around 88 km of the sewer line is made up of bricks and are entry sewers, with 42 inch diameter (Biidl, 2006). Kolkata being a mega city has only 60 percent of its area under the underground sewerage system. In addition to this, nearly 10 percent of total area under KMC is not yet covered by “drainage system”. But now a days the system by the British have failed to keep the balance between it. Thus they are made by their supervision and were man brick sewer but now observes are siltation takes place in this man entry sewers, water level cannot go down through this sewerage lone as the slope of the canal broke down, the sewerage are not now maintained by entering human beings, brick wall from previous get eroded and make the debris of heavy wastes in flow of water within this network. These are main features of Kolkata sewerage system which KMC as well as KMDA should look after.

4.3. Proposed Pumping Station:

Some of the problems due to waterlogging in this city can be removed by set up of modernized pumping station in the frequently flooded areas. As the core city (ward no: 7-100) serves by some of pumping station with machinery and tools used, they also used by its modernized capacity with technological improvement. If they will set up in the added area could remove the storm water, it is more over successfully done by the improvement of underground drainage system, which works is in progress both by improvement and modernization of existing pumping stations and built up new station needed areas. From the previous analysis is can be calculated that the water logging conditions, mainly caused due to retreat the capacity of underground drainage network are suffering from severe problems. And old pumping stations interlinking with sewerage network are not sufficient to pump out the water as they should come make immediate supervision by K.M.C, K.E.I.P and other state or central governmental organization. Inadequate physical and cultural phenomenon presents within a region causes the disturbances in human life then it is consider as 'HAZARDS. Rainfall is common climatic characteristics which happen in every year during monsoon period i.e. from the month of June to September and the rest of the years receives little or heavy rainfall according to their local phenomena. British constructed network that flow out the water that when intensity will 6mm/hours. But the climatic changes and population increases those network became suppressed, not maintaining their slope and that will favour for the aforesaid hazards. In rainy season the total amount receives more or less 1500-2000mm (approx.), that will not possible to pass away presence of hindrances and that affect the human life causing stagnancy of water which causes the spread of water borne diseases and diseases and disruption of communication system.

4.4. Water Logged and percentage of affected Population:

As human beings are major sufferers for having this problem. The zone of waterlogged is identified as highly to moderately populated area. The zone of central Kolkata in northern part and towards the part of south-west including Behala, Jadavpur, Griaahat, and in central portion including sealdah, Amharst street, Bow bazar, suryasen street, park street, park circus connector and its associated area are suffering from this problem as the population density also calculated very high. We can interpret population density is very in borough 8. And mainly higher dense population has been found in mainly borough 2 and 4. On the other hand the moderately population density has been shown on borough 7, 6, 9, 10 and lastly the very low population have been found in mainly 11,12, 13, 14 and there is a relationship between population density and waterlogged area. From this relation we can get the socio-economic condition of that waterlogged affected area. Here showing the positive and negative relation between percentage of waterlogged area and population density. Negative relation have been found in north east and southern part of that map, where populations are not badly affected by waterlogged area and infrastructure was very developed. On the other hand the positive relation have been found in mainly the central, south western and some regions of south eastern part of Kolkata, where population are badly affected by the waterlogging problem. It happens for poor infrastructure, though the south-western part have well-developed infrastructure. Positively related area of waterlogged where population have faced lots of problem during that period. Basically the co-relation has been made between the population density and the waterlogged affected area in this map (Fig.2). We can interpret the relationship among them by regression analysis and scatter diagram. Mainly it is perfectly positive in nature. The water is logged mainly the high concentric area of population (The central, the north Kolkata, Amharststreet, Thanthania, etc.) So the severe problem of waterlogged situation occurs and populations are badly affected during waterlogging period in those affected regions.

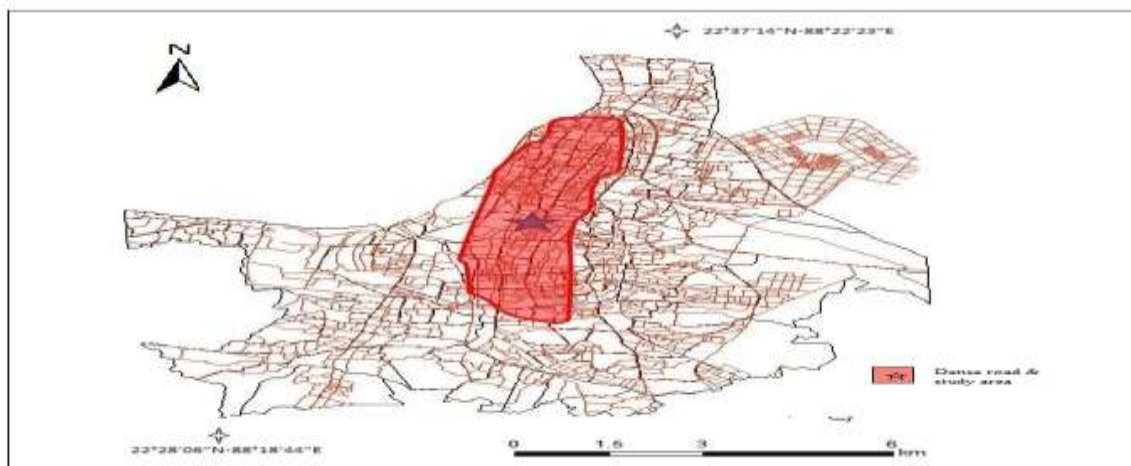


Fig: 2 Maximum road density zone where seasonal water logging is maximum

4.5. Waterlogged and Road Density:

Unplanned road construction decayed the physical setup of the city Kolkata. The core city (specially north and central Kolkata) having a great pressure population and high road density which already causes the depression. Heavy pressure of small and giant size vehicles found in the waterlogged area in different part of roads causes the traffic congestion. The roads are closely dense at borough 6 and 4. The moderately dense road network found in mainly borough 13, 10, 8, and 3. The low road network is found in the north western, south western and south eastern part of Kolkata. The traffic system is badly affected at the time of waterlogging situation. As Lalbazar said, C.R Avenue is the most vulnerable zone facing the problems due to highly waterlogging. From the control panel it is said that many diversions should be made by this time for removing the excessive pressure of vehicles. Basically here we find that the relations of them are negative. When the waterlogged situation increases during the monsoon period the roads are become highly affected and as a result of it the traffic situation become hamper and the population have been affected, as well as socioeconomic setup adversely affected. We can find that in the north, central, and south-western part of Kolkata are under the major waterlogged area. On the other hand south eastern part and north western part of Kolkata are under the minor waterlogged area. The major waterlogged area ate under borough 4, 5, 6, 11, 13, 14, and minor waterlogged area are reach in mainly borough 3, 7, 8, 15, and along their roads (Fig.3).

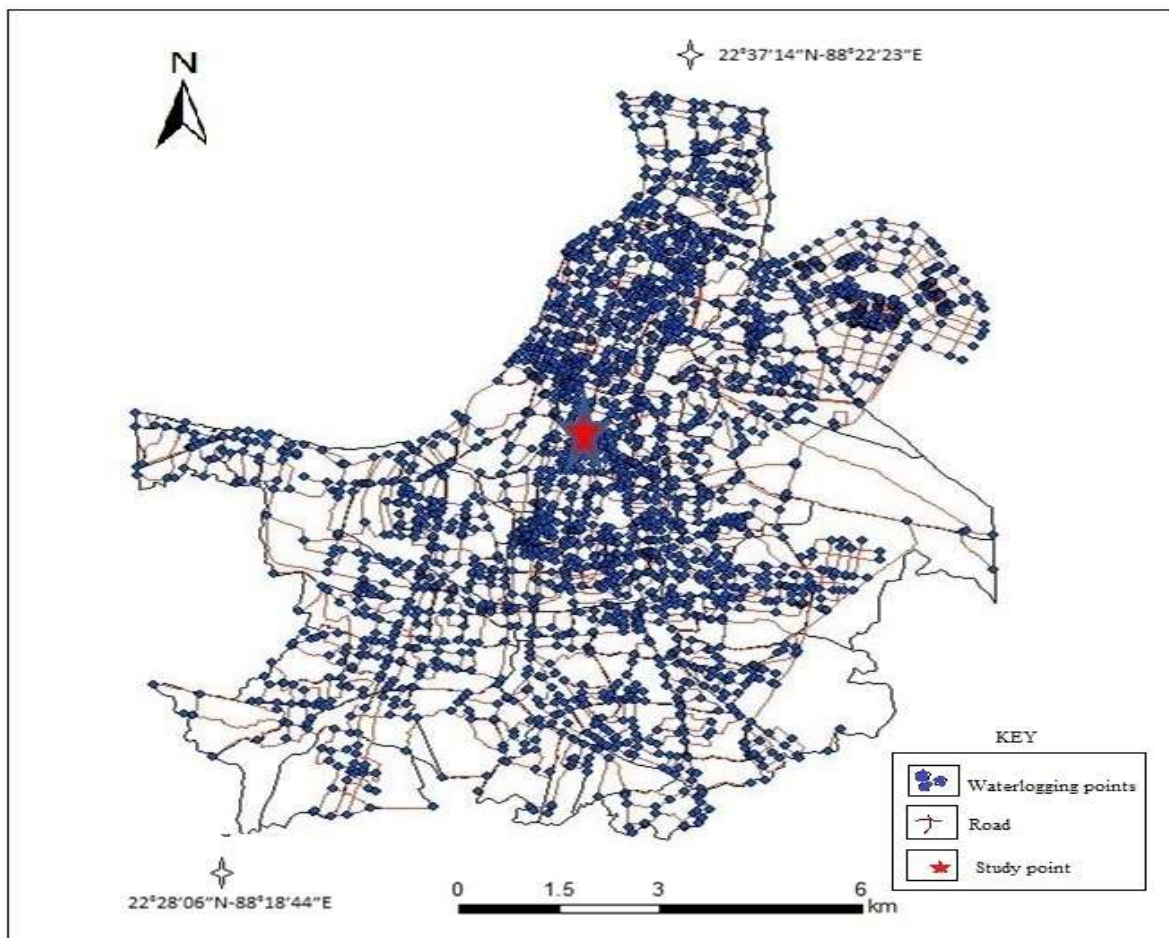


Fig : 3 Scenario of road nodal point in Kolkata where seasonal (time) water logging observed

4.5.1. Water logging situation in various depth along the road:

We can find that in the borough map of K.M.C, the various depth of water during water logging period. The water is logged like knee length (42cm), the Ankle length (8cm) and estimated a middle length that is (36cm). Now in the 6, 5, 4, 7 borough surrounding areas are highly depth waterlogged area(42cm) and as well as 10, 9, 7, 2, 4, 3 borough are the area where the water depth (Table 1 & 2) reach basically ankle length and low depth of water logged situation occur in the borough of 14, 13. The highly waterlogged depth area are the central Kolkata and also the surrounding area, on the other hand other area are relatively relatively low depth waterlogged during monsoon period. Firstly we assume that south to north and west to east network of road where the waterlogged situation is degradable condition. Those are mainly Karl Marx Sarani, Jnu road, leninsarani, BBD Bagh road, Apc road, khidripore road, and the Beliaghata road. Now from the graphical

analysis, in Jnu road and LeninSarani are high depth of waterlogged affected area. On the other hand, other roads are under the moderately or low level waterlogged depth during this situation. The trend of the depth of waterlogged graph, started to increase firstly and then reach highest peak and after that it started to decrease and lastly it reach in same height. We take into 8 major roads which are mainly DH road, Alipore road, MJ road, DG sarani, BT road, KC road, AJC road, CR Avenue. The highest depth of water situation has to create in the MJ road, the DH road and the DG saraniand relatively small depth of waterlogged situation create at that time of waterlogging situation. So the trend line is mainly decreases at near Alipore road and Ajcbose road and again increases in near JNU road, CR road, highest reach at MJ road and again decreases near the KC road.And indirectly the traffic situations are adversely affected for these reasons. Area at the time of monsoon it happens due to situation of low laying area and poor sewerage system. So the major problem of waterlogged situation has been faced in that region and populations are badly affected. Now here we find that we find that a broad relation between them, is positive which means the area have faced depth of waterlogged due to some poor sewerage and also low infrastructure of road network and absence of proper place to throw the solid waste. Maximum scatter reach in the upper portion of best fit curve. So, moreover that the relation between water level and waterlogged area is positive, that's why the waterlogged area affected by the depth of water level and as well as the population also have been affected by it. The high percentage of waterlogged area reaches in the central Kolkata. The moderately waterlogged affected area have been found in surrounding zone of northeast, southeast, and south-western part. On the other hand the low waterlogged region is found in the southern, south-western and the south eastern part. It can be notified that the percentage of waterlogging situation is varied in different area of K.M.C. The various depths have been shown by isopleth. The north central part as well as south-western part of Kolkata where the depth rise maximum and moderate depth of water lies in whole over the region specially in the eastern, the south eastern region during the waterlogging period.. The relation may be positive or may be negative. We find that negative relation in south east, north- northeast, south-southeast part of Kolkata, where mainly the areas are not affected by the high depth of waterlogging problem. Because these regions are basically high laying areas so water are not logged in that region. So there is no relation. But in the central, south-western part of Kolkata, where the positive relation occurs between the water level depth and waterlogged.

Table 1: Water depth during the waterlogging period

Kolkata bouragh no.	Water Depth during waterlogging period (in cm)	Total population	Kolkata bouragh no.	Water Depth during waterlogging period (in cm)	Total population
I	36	323903	IX	36	370667
II	8	284516	X	42	406286
III	8	315419	XI	36	197584
IV	8	248212	XII	42	225213
V	42	275572	XIII	42	248799
VI	42	290308	XIV	36	253349
VII	42	264158	XV	36	117507
VIII	36	286509			

Source: KMC Report, 2013

Table 2: Amount of water flow during waterlogging period

Station	Amount of water in waterlogging time(cusec)
Palmer's bridge pumping station	48216
Ballygange	37237
Mominpur	5239
Dhapalok	20390
Ultadanga	25410
Gholkhale	5309
Marcus Square	10125
Topsia	2034
Behala Flying club	8930
Maniktala Drainage	3527

Source: KMC Report, 2013

Table 2: Depth of water during waterlogging period in road wise

West to East		South to North	
Road Name	Depth of Waterlogged in cm	Road name	Depth Of Waterlogged in cm
Karl marxsarani	8	Dh road	35
khiddipore road	8	Alipore road	8
Jnu road	35	Ajcbose road	8
Lenin sarani	42	CR avenue	35
BBD Bagh road	8	MG road	35
APC road	8	DH sarani	42
Beliaghata road	8	BT road	35

Source: KMC Report, 2013

ACKNOWLEDGEMENTS

We are thankful Mrs Lila Mahto (Head of the department, Krishnagar Government College) for giving valuable suggestion. We are wishing to extend our thankful to BharatiHansda, Sharmistha Das andSumanAyaz for her support. We are very grateful to the K.M.C. and Borough 5 for giving information with data.

V. CONCLUSION

Water logging has become a major problem in this metro city Kolkata by which population are effected badly. The history of Kolkata's evolution is very interesting regard of both physical and cultural aspect. The physical setup like active clay layer, presence of marshy land, on the other hand the social setup like growing urbanisation and high rise, and no of non-biodegradable solid waste are responsible for this devastating situation. The overall studies have identified the main waterlogged zone , ward wise waterlogged situation and its varying depth , waterlogged road and traffic congestion and the people who have been suffered from waterborne diseases(mainly in the slum and the squatter people). K.M.C had provided recommendation for setting up new pumping station and maintaining the drainage and sewerage system. But all of are not materialised properly due to lack of K.M.C's interest and this worst situation are increase day by day and people are affected badly.

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