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Climate Change and Urban Flood in Kolkata: Vulnerability and Mitigation

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Abstract: The present investigation aims to assess the impacts of urban flooding and mitigation processes in Kolkata. Now a day this urban flood has become a challenge to urban planners because of its disastrous consequences. This paper highlights how that frequent flooding and waterlogging problem in metropolis, endangering public health and increasing the heavy economic losses. The author suggests that technical solutions are not sufficient to ensure safety and human security. A judicious combination of structural and non-structural responses, including institutional, economic, financial, and social efforts is essential. Coordination (horizontal and vertical) between various institutions and administrative bodies is equally important to optimize results.

Key Word: Urban Flood, Climate Change, Anthropogenic impact, Vulnerabilities, Proactive Approach

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I. APPROACH TO THE STUDY:

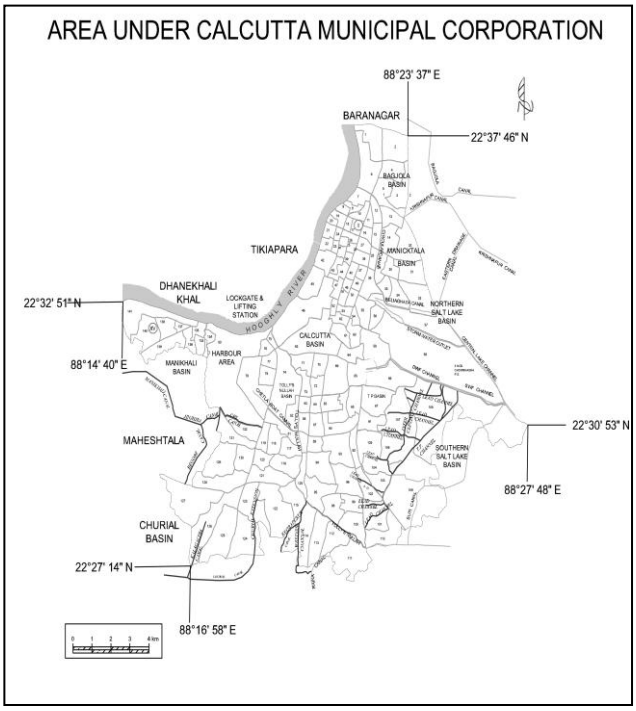
Climate change is a phenomenon being experienced by the mankind since its origin on the earth. The Planet earth is going through this phenomenon ever since its birth. It is also a driving force of evolution that life on earth has undergone over the last million of years. The industrialization that started from the late 17th century is believed to have accelerated the process of climate change by emissions of Greenhouse Gases (GHGs) to the atmosphere. The observed levels of GHGs have perhaps nearly crossed tolerance levels in the atmosphere so that the survival for many animal and human species is at stake, while developmental needs of human race are contributing to factors like deforestation, urbanization etc., that can hasten the process of climate change. The Inter-Governmental Panel on Climate Change (IPCC) and the World Meteorological Organization (WMO) defines climate change as 'a change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity'. The phenomenon of climate change and urban flood has in recent times engaged the attention planners, governments and the politicians worldwide since the emergence of the threat of climate change which has origins in anthropogenic activities

Flooding is becoming an increasing threat to many societies world-wide. Flooding in urban areas can be caused by Flash floods, or Coastal floods, or River floods, but there is also a specific flood type more appropriately to be called waterlogging which is called urban flooding. In India many of our large urban agglomerations such as Greater Mumbai, Delhi, Kolkata and other areas have used to live with flood as a matter of annual routine, and only recently National level discussions are going on to study the ground level reality and intervene in a planned manner in the flood situations in the large mega cities.

Potential climate changes influences the vulnerability of urban areas to regular seasonal flooding and the consequential social and economic damages in the affected areas. It has been the experience in most cities that, intensity of flooding has a certain relationship with `unplanned' growth of' the urban areas under situations of tremendous demographic pressure. Unplanned land use and other human activities influence the peak discharge of floods by modifying how rainwater is stored on and run off the land surface into streams and low lying areas.

Location and selection of the Study area

Kolkata is one of the five major metropolitan cities of India and capital of the state of West Bengal. The city is located at 22°30' north latitude, 88°30' east longitude, and is the main port of entry in north eastern India. It is 120 km from the Bay of Bengal and stands on the bank of the river Hooghly (Ganga). It has an area of 187 sq km and has a population of 4,580,544 as per the 2001 census. The existing sewerage network covers a length of about 1610 km and the length of open drain is about 950 km. The city is more than 300 years old and its sewerage and drainage system is about 140 years old. The Kolkata Municipal Corporation (KMC) covers a core metropolitan area of 187 sq. km and has an average population density of about 25,000 person/sq km. Fig: 1 Boundaries of Kolkata Municipal Corporation Source: K.M.C.



In addition about 2 million floating population commutes to the city daily from areas beyond KMC including rural areas. The study comprises of the entire 15 boroughs of the KMC municipal area as well as special emphasis on the added area (ward no 1-6 and 101-141) of Kolkata as because this area consists of main outfall of Kolkata which plays a vital role in discharging the foul water

History of drainage system: Kolkata has been designed as a combined system both for the disposal of storm water as well as for sewerage and dry weather flow in 1855, and laid down between 1860 and 1875.Planning for combined sewage system of Kolkata was proposed under the leadership of the then engineer William Clark in 1855 but construction work was started only in 1859. Various committee were formed for the development work such as lottery committee, fever hospital committee etc. The first concerted effort to provide Kolkata with a drainage facility, was initiated around the year of 1880, when the construction of an underground drainage system for the northern areas of the city was taken up in 1859, the Clark committee introduced many sewer pipe drains beneath the principal streets of the city which again linked with the smaller underground cross sewers, but such schemes took nearly 16 years to complete and as a result of this scheme, Kolkata had 3 miles of brick and 37 miles of stoneware pipe sewers in 1875. In 1930 Kolkata

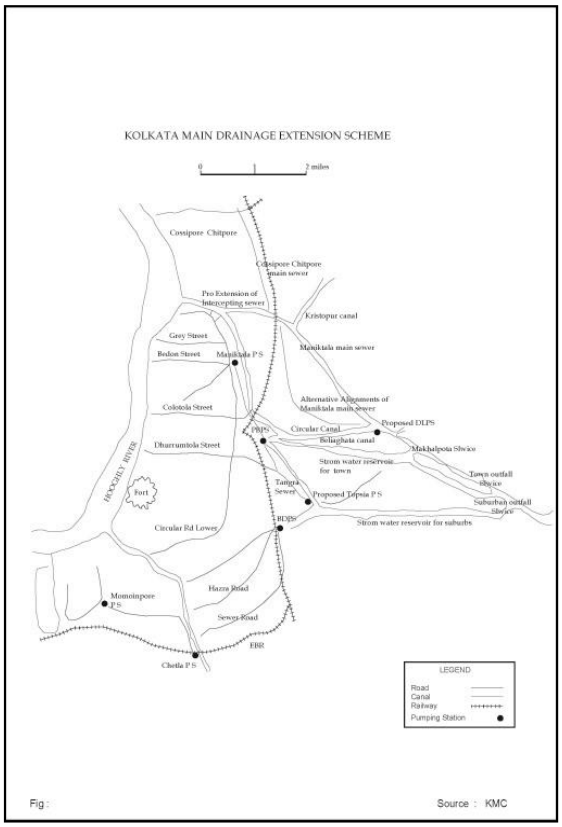


Fig:2 Map of Bidyadhari Committee,1930 sewage system was a combined one, i.e. some set of pipes had to carry the domestic sewage as well as the drain water. The entire system was divided into two distinct components: i) town system and ii) suburban system. The pumping station set up for draining the northern area

of the city which was designed to accommodate 6.3 mm ½" rainfall/hour at 100% run off in addition the D.W.F., and suburban system meant for draining the southern area of the city which was designed to accommodate 4.23 mm (1/6" rainfall/hour) at 100% runoff in addition to the D.W.F. In 1930 Bidyadhari special committee report highlighted the problem of outfall in Kolkata which is mainly caused due to presence of very large quantities of silt in the water. Although many schemes and master plans were prepared after the independence to find out the solution of the problem, but all the works, schemes, steps are in vain due to heavy siltation, encroachment along the canals, throwing of materials into canals, handicapped pumping station, and many other causes. So as a result the same picture remained the same in 1999 as in year 1978 and year 1991. In the year 2000, November, Asian development bank came forward to change the drainage & sewerage system of Kolkata and its suburbs.

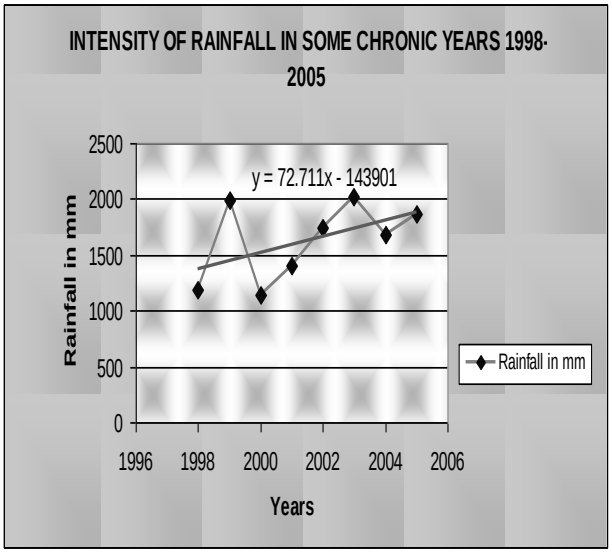


Fig: 3 Intensity of Rainfall Source: Computed by authors

The scheme was known as 'Kolkata Environmental Improvement Project' (KEIP). As an outcome of the project the span of waterlogging time has reduced to some extent, but still if the rainfall occurs for a long duration then the condition become worst, particularly in the added areas.

Issues related to urban flood in Kolkata:

The citizens of Kolkata for many years now have been experiencing the problem of water logging. Though much time voices have been repeatedly raised over this issue, but nothing has led to any qualitative improvement in the conditions over the past four decades. The causes for such persistent water logging are numerous, while the adverse impact of water logging on the economic, social and cultural life of the city is extensive

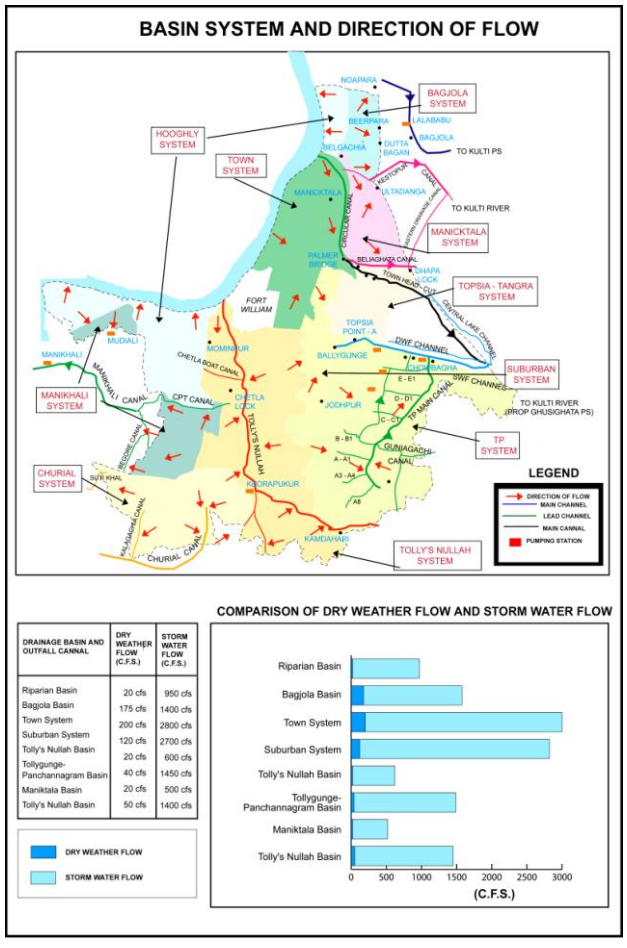


Fig: 4 Basin System and Direction of Flow in Kolkata Source: Computed by authors .

Major inadequacies in the existing sewerage and drainage system

After thorough observation the study of the causes of waterlogging, the major inadequacies as could be identified are:

- Poor drainage network in majority of the cases.
- Inadequate capacities of the drains.
- Absence of drainage network in many areas.

- Poor or no maintenance of the drains resulting in carrying capacities.
- Deposition of solid waste in sewer line due to connection of surface drains with sewer .
- Missing of proper synchronization of pumping stations in system creating flooding in one area with operation of pumps in other area.
- Back flow of water due to tidal effects of Hooghly River.
- Encroachment along drainage courses.
- Laying of branch sewers and laterals over surface drains without proper bedding resulting to uneven settlements and preventing smooth drainage.
- Surface drains laid through inaccessible areas in many cases virtually leading to no maintenance.
- Nikashies(discharging channel) encroached at several locations and maintenance becoming a chronic problem to the nikashies in inaccessible stretches.

It is known that the entire storm runoff generated drains into the canals/nullah. So the canal system must have adequate capacity to drain off the total discharge up to the ultimate disposal point. But the canal system is also getting defoliated, so it cannot cope up with excess foul water in monsoon period these may be attributed to;--

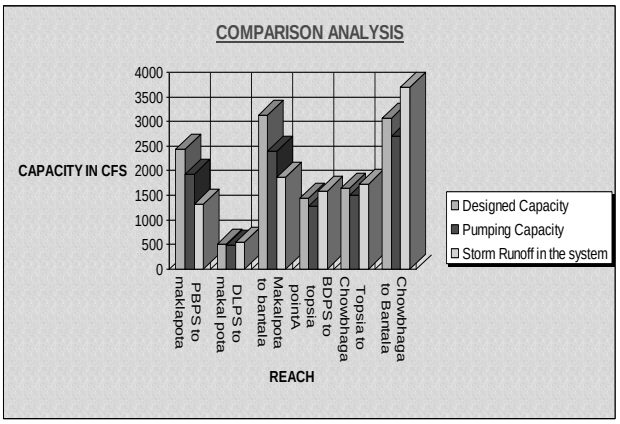


Fig: 5 Comparison analysis of outfalls Source: Computed by authors

- Most of the canals are silted up the extent of which ranges from 0.2 to 2.0 m. for a few canals viz. CPT, Suti, Kalagachia etc, where the original design data for the canals are not available. In such cases, it is not possible to assess correctly the extent of

siltation. The main cause of siltation is attributed to inadequate maintenance as well as indiscriminate dumping of solid wastes in the canals at various locations. Due to this bed levels of the canals have gone up considerably creating obstruction to free drainage.

- Extensive vegetative and weed growth has been observed in major canals, affecting flow through the canals considerably.
- Canal bank walkway/road is non existent, so the poor accessibility for cleaning of canals at such stretches is a chronic problem. Varied degree of encroachments has been observed in the canals which has considerably reduced the canal sections.

Chronic water logging prone areas:

The people of Kolkata for many years are the sufferer of the problem of water logging. Though voices have been raised repeatedly over this issue, but any qualitative improvement in the conditions has not been worked out Kolkata's drainage system, basically designed for two months storm frequency, which proves to be inadequate and if rainfall is more, leads to water logging Some of the chronic waterlogging zones of each system are:

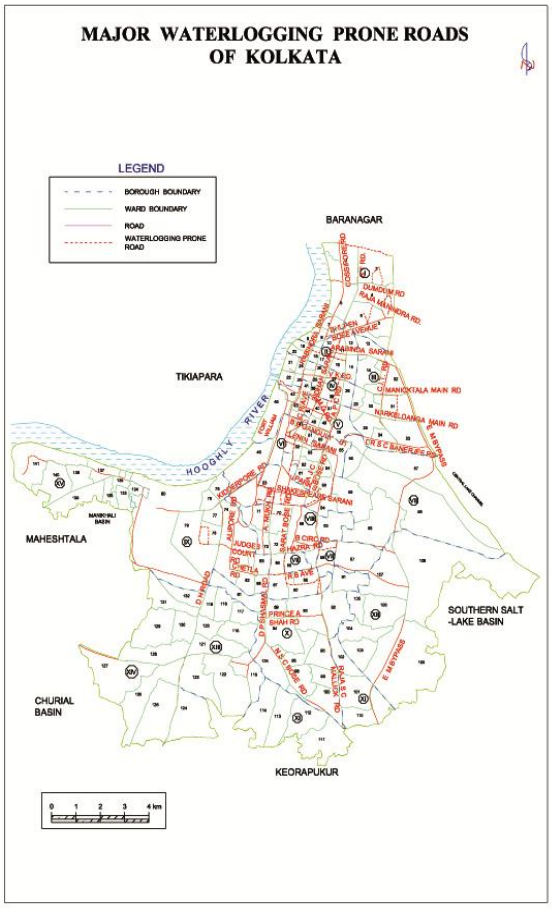


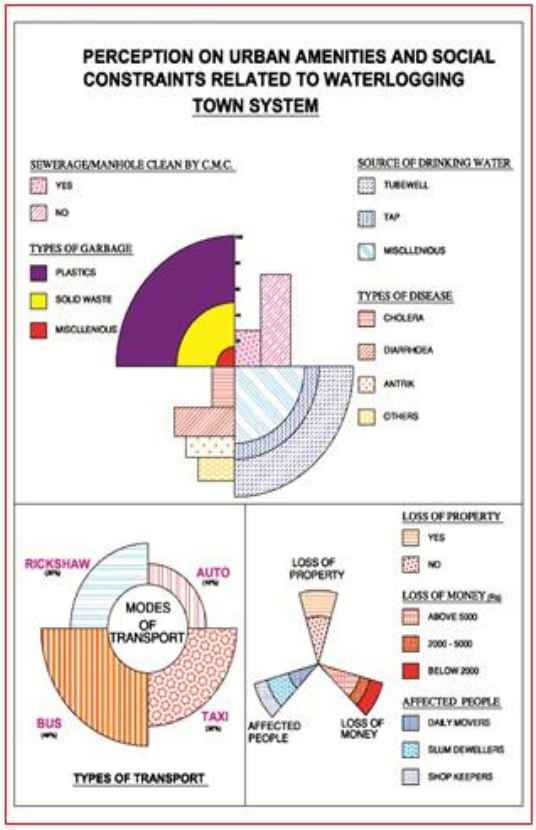
Fig: 6 Major waterlog prone Roads of Kolkata Source: Computed by authors

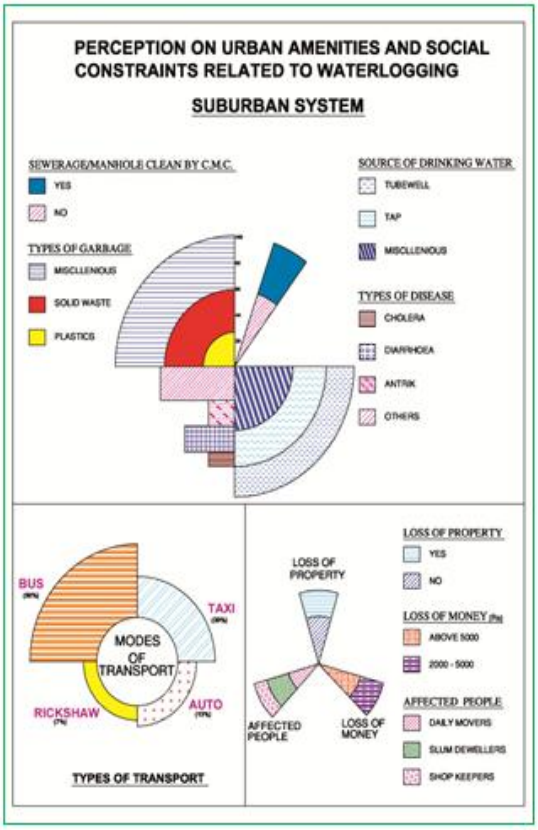
Town System: Raja Rammohan Sarani, Bidhan Sarani, Shyambazar R.G. Kar Street Area, Chitpur area, College Street area, B.B Ganguly Street and Central Avenue crossing, Lalbazar Street near Writer's Building, Kali Krishna Tagore Road area, Park Street, Camac Street area,Raja Dinendra Street area, Mirja Ghalib Street .

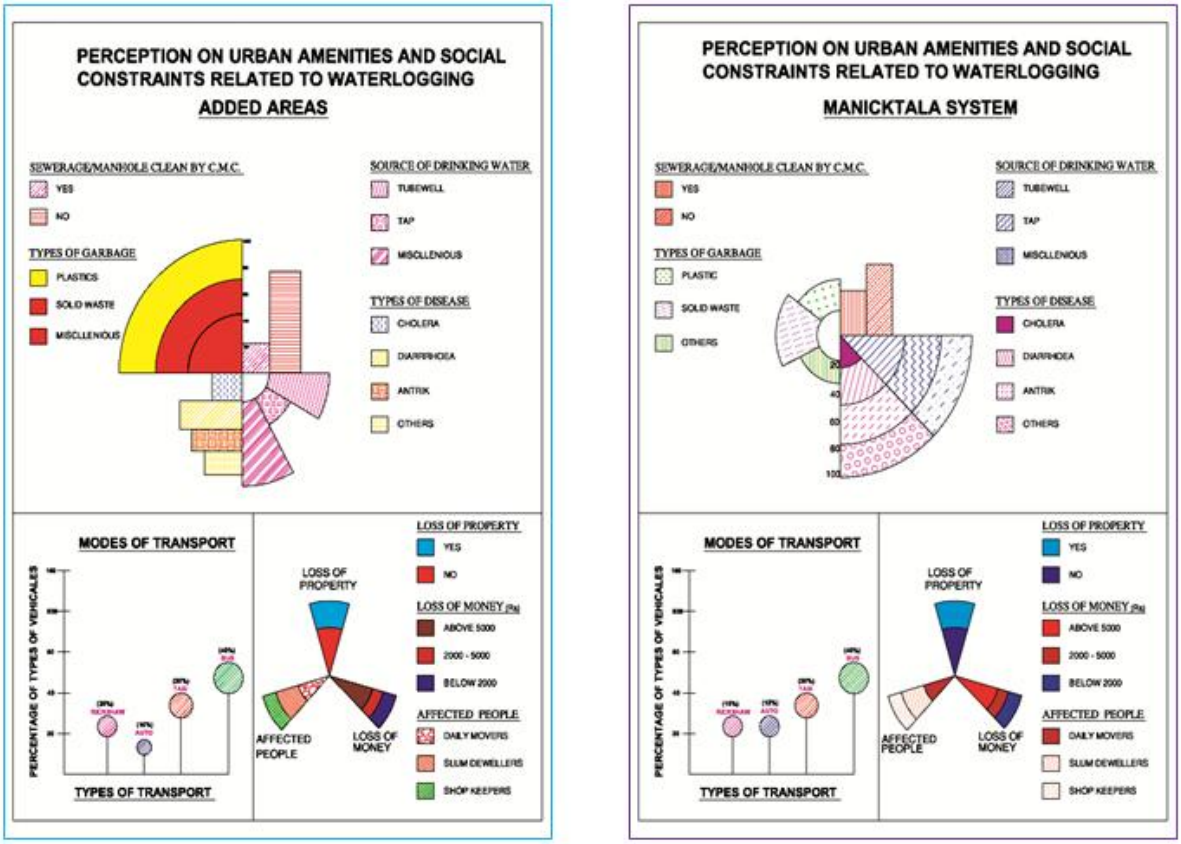
Suburban System: Hide Road area, Swinhoe Street area, Ballygunge Phanri area, Bhawanipur, Chakraberia and Elgin Road area, Baker Road and Gopal Nagar area,National

Medical College, Lady Brabourne College and Darga Road,Southend Park and Panchanantola area,
Manicktala System*:* Ultadanga area, Manicktola main Road (between Kankurgachi island and E.M. Bypass), Kankurgachi and Beliaghata area, Narkeldanga

Impacts and mitigation process:
However despite the numerous adverse effects of waterlogging hardly ,any attempt has been made to estimate the social cost of this phenomenon; some of those constituents are as follows: (a) days lost due to ill health caused by waterborne diseases like malaria, dysentery, fever etc.,(b) Low number of attendance in offices and other work places, (c) Road damage and the consequential maintenance cost, (d) Disruption in telecommunication linkages causing loss of production, (e) loss of trade especially when the waterlogged areas happen to be major marketing centers,(f) loss of earning of daily wage workers.(g)degradation of natural support system)economic loss., i)exposure of poor people to impeded drainage condition, j)exposure to undisposed solid waste, k)travel delays due to waterlogging, etc.







Source: Primary survey. Fig: 7 Peoples' Perception on impact of water logging in livelihood structure

Mitigation measures

Apart from the techno-economic aspects, consideration of environmental issues and mitigation measures associated with the implementation of the master plan proposals are also very important. Some of the mitigation measures are:

- To identify the potential adverse environmental impacts that may be encountered during the implementation of master plan proposals.\
- Proper operation and maintenance of pumping station, silt clearing from gully pits through out the year.
- Lock gates must be operated timely.
- Increase the capacity of pumping station and slump.
- Laying of sewer line in unsewered areas.
- To recommend steps to be taken to bring in and sustain an overall environmental improvement to be realized through the implementation of the master plan proposals. It is of utmost necessity when people are working for road repair, proper management should be given like marking flags at working site or flagmen etc.
- The workers who are working for the manhole repair in the roads should be given proper attention. Sufficient insurance coverage of all risks including surrounding property damage, third party liability, workers compensation and transit insurance, equipment, permanent works including construction equipment and machineries.
- All occupational health and safety requirements for workforce will be adhered to like workers in the manholes with mask and goggles.
- Appropriate control measures and avoidance of creation of stagnant water pool to prevent insect and vector borne diseases.
- Minimization of water logging and flooding thereby removing unhygienic conditions and transport disruption.
- Improvement of sanitation facilities especially in slum areas.
- Expected reduction in the incidents of insect and vector borne diseases such as gastroenteritis, cholera, typhoid, hepatitis, malaria, etc.
- Efficient collection of wastewater and transport to the sewage treatment plant, reducing flow of polluted water to Hooghly River and the canal system of KMC area and thereby improving their

water quality.

- Minimization of contamination of the local ponds by preventing overflow of raw sewage.

II. CONCLUSION AND SUGGESTIONS:

From the study it is very clear that the problems of waterlogging are a prime issue of KMC in every year. As per topological characteristics it is next to impossible to solve the problem forever but if corporation, different organization and last but not the least the inhabitants can work together, cooperate each other throughout the year then this problem can be solved to some extent, by reducing the duration and area of waterlogging. But the fact is that the solvents are known to all and also highlighted in every master plan, meetings, task force etc but the recommendation or strategy was not implemented due some constraints. The concept of ad-hoc flood emergency and proactive approaches, reliable early-warning system, Community based action and local public education can also be a good solution for the public to overcome this urban flood.

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