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Hazard Risk and Mitigation with Reference to Kolkata, West Bengal, India

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Abstract:
Kolkata, formerly known as Calcutta is the capital of West Bengal located on the east bank of Hooghly river with coordinates from 22 ^{0}34"N latitude to 88 ^{0}22"E longitude. Kolkata lies in Gangetic Delta with elevation of 1.5 to 9mt (5-30ft). It is located over Bengal basin with predominantly alluvial soil. Earthquake, flood, cyclone, heat wave, land subsidence, health hazard is prevailing in Kolkata as hazard. Due to over population and high rise the condition is being more vulnerable. The risk of this type of hazard is being more dangerous for climate change. The Sundarbans mangrove forest found in the south of Kolkata is now in vulnerable condition. Before, this dense forest cover resisted Kolkata from storm surges and flood. But now after reduce of mangrove belt frequent storm and flood affect Kolkata. The manmade flood is seen in Kolkata due to unplanned housing, improper drainage condition etc. Due to increase in population, Kolkata is facing land subsidence for unplanned use of ground water in many areas of Kolkata. Another type of hazard which might be more dreadful to Kolkata is earthquake. Kolkata is lying over a fracture known as Eocene Hinge zone which is inactive for years if it turns hyperactive it will cause an earthquake measuring not less than 6 on Richter scale. It may cause human casualties and property loss due to destroy of high rise, multi-storied buildings, several old buildings etc. Heat wave is another type of hazard which is increasing nowadays due to climate change and global warming causing a man's death due to heat wave on April 2016. Kolkata faces various types of disease causes by bacteria, viruses, parasites etc. The predominant diseases are malaria, cholera, swine flu, HIV, tuberculosis etc. So to save Kolkata from these hazard risks we need to take proper hazard mitigation measures and preparedness.

Keywords: *hazard, vulnerable, mitigation*

1. Introduction

Hazard may be defined as those extreme events either natural or manmade which occur rarely and exceed the tolerable magnitude make human adjustments very difficult and result in colossal lose of property, human and animal lives destruction of settlements and vegetation etc. (*Singh, S.2014*). Kolkata with a population 4,496,694 in 2011 census and population density is 24,429/km2 is highly vulnerable due to climate change. According to geography of Kolkata, Kolkata is located over Bengal basin and it is lying over a hinge zone which is about 25 km wide at a depth of about 45,000mt below the surface. The shelf and hinge zones have many faults; among them some are active. According to Bureau of Indian Standards the city lies inside seismic zone iii. In past two decades rain fall is very uneven due to climate change. There is no rain for several weeks and sudden bursts at the end of monsoon and it causes flooding in the city areas. And also intensity of several storms and floods have enhanced due to climate change. Like Aila, Hudhud effect Kolkata very much. In monsoon due to heavy down pour of water with unplanned housing and improper drainage condition it causes water logging and several problems in daily life.

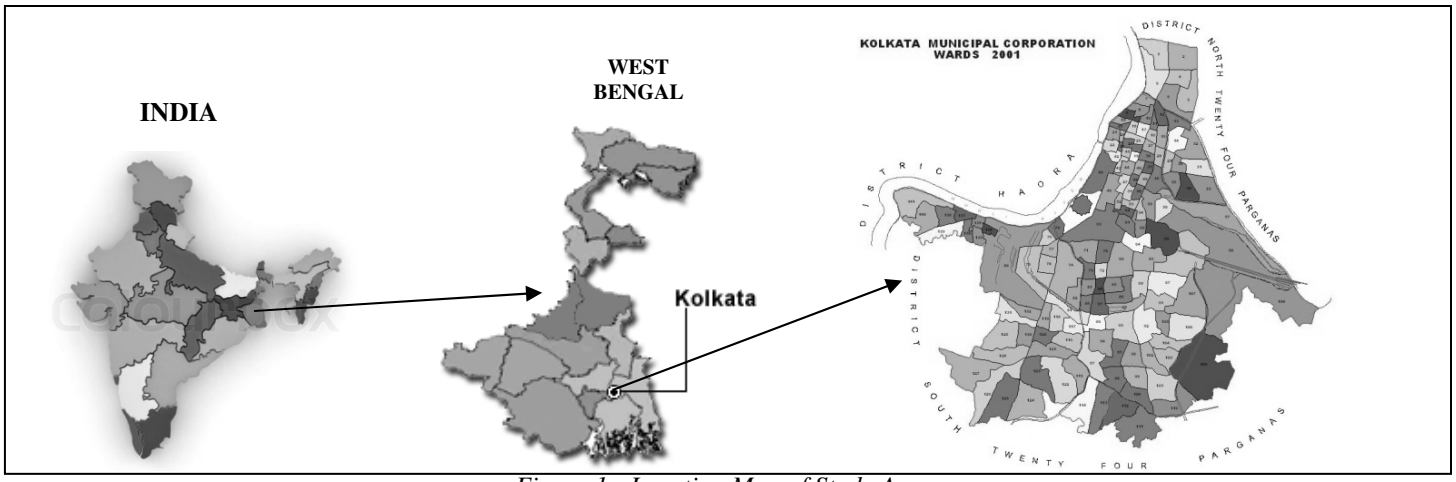

Figure 1: Location Map of Study Area

Behala Bansdroni, Dhakuria, Amherst Street and several places of Kolkata remain in water. The land subsidence is seen at Dhakuria, Kasba, Gariahat with damage of roads, buildings, bridges, and other constructions. Heat wave is now a burning issue for Kolkata due to climate change. The temperature of April'16 is 40^0c or above for consecutive days which is 4^0c or 5^0c above normal temperature. All primary and secondary schools have been ordered to close for this hazard. It caused a man's death while he was travelling by a minibus. Kolkata suffer from various types of contagious or non contagious diseases due to climate change, air pollution, water pollution etc. Dengue, Malaria, Cholera, Tuberculosis, HIV. Swine flu are common cause of illness and mortality of Kolkata. Over population, slum population, lack of proper drainage, improper sanitation system is increasing more unhygienic condition in Kolkata. So to cope with several hazards Kolkata should adopt hazard fighting strategies. These strategies may reduce the hazard risk. The most common few strategies are land use planning, afforestation, establishment of pumping station, drainage cleaning or management, earthquake resistance building material, vaccination and health consciousness etc.

2. Material and Method

For the purpose of writing this paper I have collected secondary data, literature, information, scientific data from public domain like newspaper report, official websites of different government and non-government agencies. Maps were collected from different websites. My own experience and perception help me for writing this paper as I am a citizen of Kolkata. Finally, I have analyzed and reproduced the data and information for the purpose of my study.

3. Hazard Risk of Kolkata

There is a threat of several challenges of Kolkata which is increasing nowadays due to climate change. Over population of Kolkata may take shape of a great hazard. We have no way to stop population explosion but we must take some necessary steps to prevent or reduce the loss occurred by such calamities.

3.1. Earthquake

Earthquake is mild or severe tremor occur on the earth crust. If the magnitude of earthquake exceeds 6 on Richter scale, there will be high chances of damage. Kolkata is located over Bengal Basin with alluvial in origin. The quaternary sediments consist of clay, silt and several grades of sand and gravels and these sediments become sandwiched between two clay beds. So it is prominent that Kolkata lies on a such type of soil which is more spontaneous to earthquake. In spite of that Kolkata lies over a fracture known as Eocene Hinge zone is inactive for years but if it once becomes hyperactive will it cause an earthquake not less than 6 on Richter scale. And it could turn into debris 300 years old Kolkata. If the energy is accumulated in fracture zone and if it is release the energy through the fault line causing massive earthquake and its would turn Kolkata into ruin. The continuous stress and strain turn the fault line into hyperactive zone and causes massive earthquake including damage of several old and new multistoried building and other construction.

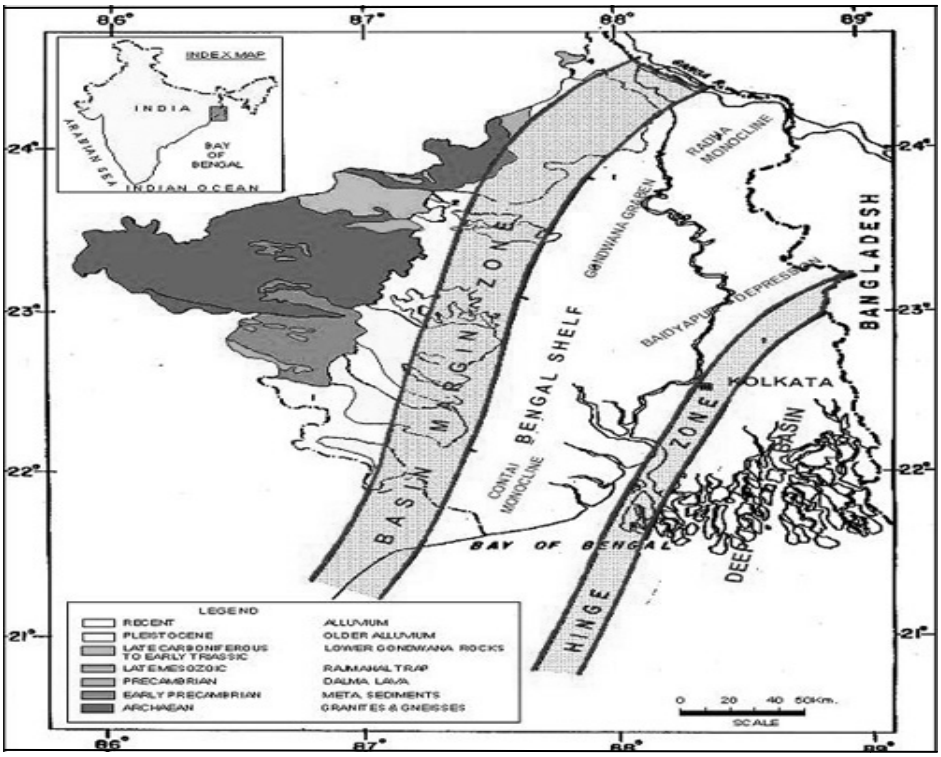

Figure 2: Picture showing Kolkata located on hinge zone

1737	Death of 300000 people
2011	Earthquake tremor felt in Kolkata
25th April 2015	Tremor felt in Kolkata
28th June2015	Tremor felt in Kolkata
14th April 2016	Earthquake tremor felt in Kolkata

Table 1: list of some significant earthquake of Kolkata

3.1.1. Consequences of Kolkata Earthquake

- Land liquefaction in different areas of Kolkata
- Human casualties which occur in 1737 earthquake
- Fracture in building and other construction
- Injury due to panic
- Snapping of mobile phone links
- Cracks on walls
- Suspension of metro rail service for sometimes and speed is restricted
- The shanty dwellers lost their houses and need to construct again

3.1.2. Necessary Steps during Earthquake

- Turn of gas cylinder and electricity switch
- Don't panic
- Rush to open grounds
- Don't use lifts use staircase
- Take cover under bed or table
- If in bed stay protecting the head with pillow

3.1.3. Preparedness for Earthquake

- To follow earthquake resistant architecture design for construction of building
- To stop high rise in earthquake prone zone
- To restrict ground water use as it causes land subsidence

3.2. Flood

Flood means the submergence of land area under water for several days. Flood is most common phenomena in India. In recent trend over populated Kolkata is in alarming state due to flood mainly in monsoon. Kolkata is lying beside Hooghly river which situation is increasing flood condition. The main reason is poor drainage condition. The drainage of Kolkata is old and is not able to cope with rain water as lack of proper maintenance or fully or partially filled by city garbage. The concrete road, high rise building, slums are making obstruction the natural way of rain water passing. So as a result water logging condition in Kolkata for several days. Another cause of water logging in Kolkata is hiding in its structure. The structure of Kolkata cannot drain out the excess water smoothly. According to Netherlands and University of Leeds nine coastal cities including Kolkata are more vulnerable due to flood with large population exposure to storm.

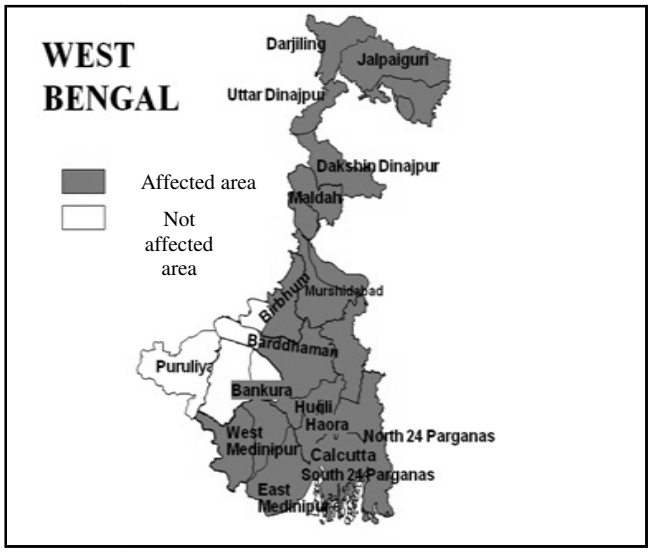

Figure 3: Flood prone map of West Bengal showing Kolkata

There is a prediction that due to climate change the temperature of Kolkata will rise from 1.2^0c to 1.8^0c by 2050 with an increasing rainfall and the sea level will rise 27 cm above with severe storm. The top vulnerable wards of the city are14,57,58,63,67, 108 which are located along Bypass separating them from East Kolkata Wetland. In Bypass there mostly seen unplanned residential complex mushroomed everywhere. The 63 and 74 ward are more vulnerable due to flood. Lack of proper drainage condition predicted that there will be a loss of 10,800 crore rupees by 2050 of one in 100 years flood condition with increasing climate change. The several wards of north and south Kolkata are in knee deep water. Amherst street, Shyambazar, A.J.C. Bose Road, M.G Road, Ultadanga, Kankurgachi, Phoolbagan, New Alipore, Southern Avenue, Deshapriya Park, Sovabazar, Central Avenue, Park Street, Theatre Road, Diamond Harbour Road is in water logging state. According to Organization of Economic Co-operation and Development Kolkata will be the list of top ten vulnerable cities of the world.

1986	Flooding due to heavy rain in some areas of Kolkata
1999	Torrential rain affected areas of Kolkata
2006	Heavy rain, large part of Kolkata is under water and subsequently 2000 people are evacuated from the city
2007	51 people lost their lives and 3.2 million people were affected

Table 2: List of some significant flood and water logging condition of Kolkata

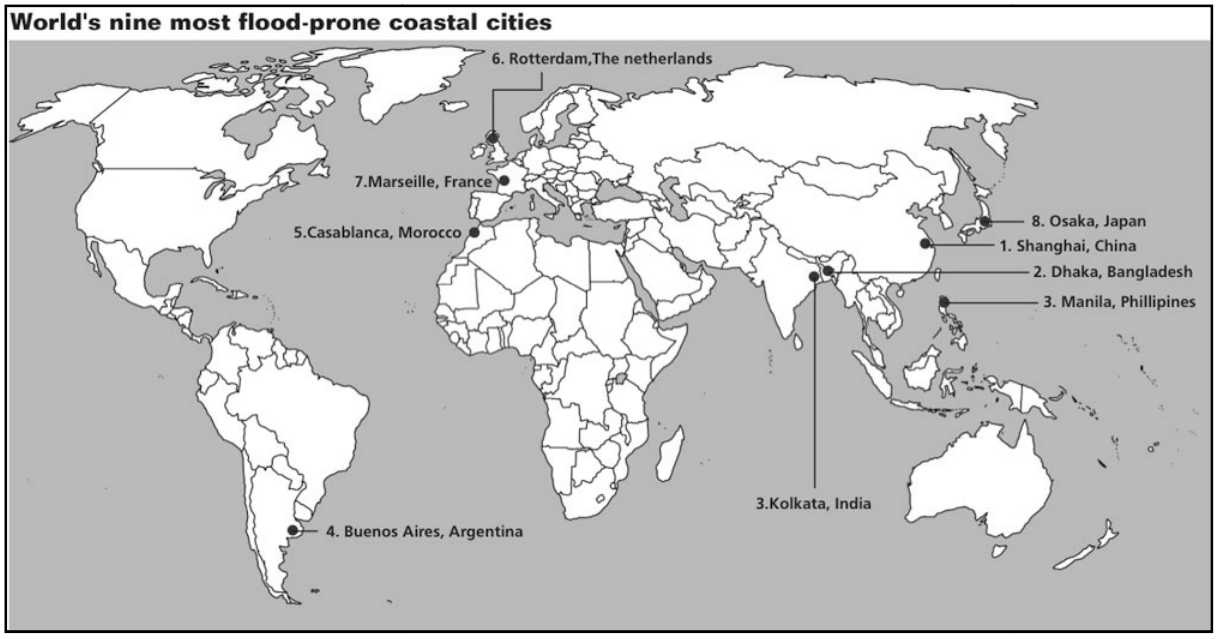

Figure 4: showing Kolkata is the nine most flood-prone coastal city in World

3.2.1. Consequences of Water Logging and Flood Hazard in Kolkata

- Heavy downpour causes water logging in several areas of Kolkata
- Transportation system adversely affected
- Footpath hawkers are very much affected as their income get stopped or reduced
- Traffic congestion, disruption of communication, decrease traffic speed and increased travel time
- Some areas are completely cutoff from other places
- Increase shortage of drinking water and supply of water for domestic and industrial purpose
- Increase water borne disease like typhoid, malaria, dermatitis, conjunctivitis, wound infections and ear, nose and throat infection
- Causes vector borne disease like malaria, dengue, encephalitis etc.
- Water logging in flyover and bridges
- Standing water causes the birth of mosquitoes
- Electric supply and thermal power plant are highly disrupted
- Many local and express trains are cancelled
- Trouble for pedestrians to walk on water logged roads
- Loss of earthen house and shanty houses
- Causes environmental refugees
- Worse effect in health and commerce

3.2.2. Prevention and Mitigation Strategy

- Proper land use planning
- Repairing of old drainage
- Cleanup the drainage and sewage
- Improvement of activity and number of pumping station
- Afforestation
- Community awareness with proper training
- Early warning system by radio, tv, newspaper report
- Dredging of canal belt
- Supply of food, tripol, garment, medicine in flood affected areas
- Help of common people or government and non-government agencies

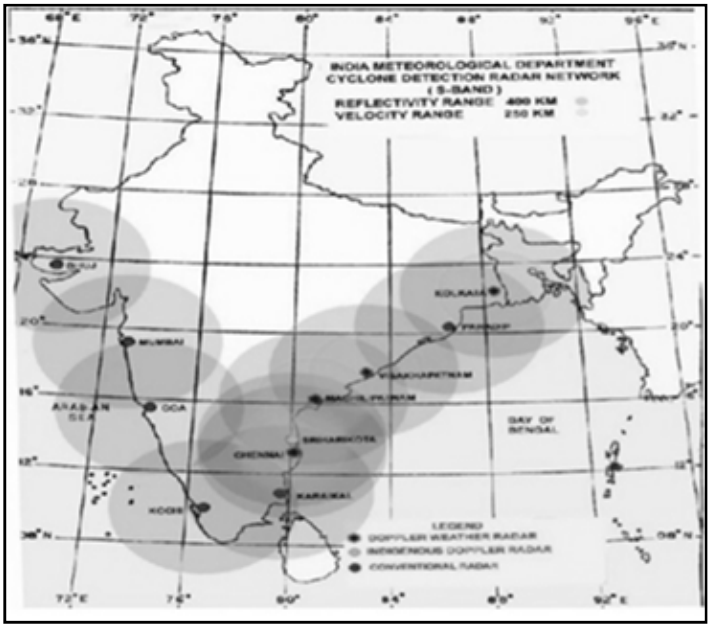

Figure 5: Cyclone detection radar network in India showing Kolkata's condition

3.3. Cyclone

Tropical cyclone is most common phenomena in India. It causes storm surges, heavy rain and strong gusty wind. In summer the Bay of Bengal is heated due to intense heating and warm humid and unstable air goes up and produces cyclone. It generally occurs April to November. Another cause of cyclone is climate change which disrupts the mangrove belt and the intensity of cyclone is more severe than before. In Kolkata the most cyclone affected areas are South Kolkata, near Maidan, West Kolkata. In 2005 a cyclone named Aila stuck Kolkata with a speed of 80-90km/hr with heavy rain and storm surges uprooting 3000 trees, telephone line, water supply and electricity was disrupted. Another cyclone, Hudhud originated in Andaman Sea causes heavy storm and torrential rain and interrupted its daily life.

1737 Hooghly river cyclone	Earthquake possibly coincided with storm
1854	Surge went up 12mt and water level increased in Kolkata
1864 Calcutta cyclone	Killing 60000 people, anemometer was blown away,100 brick home and ten thousand of tiled and straw huts are destroyed
1867 Great Calcutta Cyclone	Anemometer blown away
2005 Cyclone Aila	Heavy rain with storm surges, uprooting trees
2014 Cyclone Hudhud	Heavy storm and torrential rain, daily life is interrupted

Table 3: list of some significant cyclone of Kolkata

3.3.1. Consequences of Kolkata Cyclone-

- Trees are uprooted
- Electricity, cable, telephone lines are cutoff
- Earthen and tile roofed houses destroyed
- Shortage of pure drinking water due to contamination
- Causes of water logging condition
- Many local and express trains are cancelled

- Road transportation system disrupted
- Loss of income due to loss of business
- Infrastructural loss
- Spread dengue, malaria, diarrhea, encephalitis etc.
- Increase poverty
- Rise of the problem of unemployment

3.3.2. Preventation and Mitigation Strategy-

- Proper land use planning
- Better communication system for rapid alarming community
- Afforestation
- Build up a stable cyclone shelter in slum or shanty areas
- Community education system for tropical cyclone
- Renovate the old buildings and weak structure
- Supply of water, food, cloth, medicine and temporary shelter from government and non-government agencies

3.4. Heat Waves

According to World Meteorological Organization heat waves occur when average temperature exceeds 5^0c more than 5 consecutive days. In India heat waves occur with high temperature with low relative humidity which causes extreme dry air condition. The criteria for temperature in heat waves vary from one region to other. The causes of heat waves are global warming and climate change. Other causes are deforestation, urbanization, industrialization, and human activity.

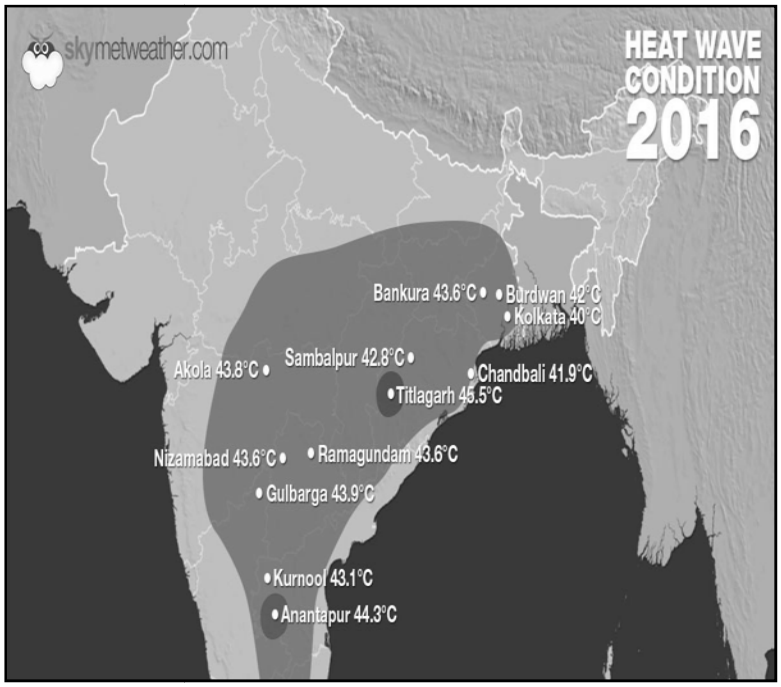

Figure 6: Heat wave map of India showing Kolkata's temperature

Majority of scientists believe that varying condition of upper air and ground pressure and unusual and unprecedented atmospheric air circulation cause heat waves. Normally the temperature of Kolkata is increasing from May but in this year temperature in above normal from the month of April.

16/04/16	40^0C
17/04/16	41^0C
18/04/16	42^0C
19/04/16	41^0C
20/04/16	40^0C
21/04/16	40^0C
22/04/16	41^0C

Table 4: Some dates of April 2016 temperature in ^{0}c
Source: www.accuweather.com

In April the normal temperature of Kolkata is 30.2^0c and warmest temperature is 35. 4^0c.So it is observed from the temperature of April 2016 that it is higher than normal.

3.4.1. Consequences of Kolkata Heat Waves

- Mortality,9th April a man named Susovan Sarker (51) died from sunstroke at around 2:30 p.m. while travelling by a minibus for Rajbazar
- Health hazard like sunstroke, hyperthermia, dehydration, exhaustion causes due to heat waves
- Psychological and sociological effects like mental stress, physical stress, sleepiness, and irritation
- Economic effect like consumption of electricity is higher as use of air conditioner, air cooler causes frequent power cut

3.4.2. Preventation and Mitigation Strategy

- Installation of cooling device as air cooler and air conditioning machine
- Don't stay outdoor as much as possible
- Drink enough water to avoid dehydration
- Wear loose and light coloured dress
- Use umbrella, sunglass, cap etc.
- Afforestation or creation of green belt
- Make temporary shelter beside roads or open space
- Community education system for heat wave

3.5. Land Subsidence

Land subsidence is a now common problem in India. It is noticed in many places of Kolkata as Kasba, Dhakuria, Gariahat, Ultadanga, Machhua Bazar, Salt Lake City, Calcutta University, Raja Bazar Science College. It has been noticed that the subsidence rate of Kolkata is 13.53mm/year. The subsidence rate of per meter drop of ground water is 3. 28cm.The subsidence rate of Ultadanga is very high as 18.23mm/year.

Kolkata lies on soft alluvial soil which more spontaneous for subsidence. The land subsidence is caused by unplanned mining of ground water. As population of Kolkata is increasing day by day the use of ground water also increasing high for different purposes. The over extraction of ground water causes lowering of piezometric pressure, so tensional force increases in the layer material as a result layer material is compacted and causes land subsidence.

3.5.1. Consequences of Kolkata Heat Wave

- Damage of infrastructure e.g. roads, bridges
- Flooding due to improper drainage
- May cause earthquake if line of weakness in layers are activated
- Indirect effect in change in gradient of streams or drains
- Economic loss for the damage of infrastructure

3.5.2. Prevention and Mitigation Strategy

- Control of population
- Use of ground water in planned way
- Afforestation
- Construction of building and other structure after surveying the soil characteristics
- Rain water harvesting
- Don't misuse ground water

3.6. Health Hazard

Health hazard is a biological hazard which causes harmful effect on health causing fatal disease on human as well as plant and animals. This type of hazard causes bacteria, viruses, parasites etc. The causes of biological hazards are-

1. Air pollution – it causes respiratory disease, lung cancer, asthma, tuberculosis etc.
2. Disease caused by contaminated water that is typhoid, cholera, diarrhea, jaundice etc.
3. Low standard of living and low income
4. Poverty alleviation
5. Lack of consciousness about health
6. Over population and slum condition spread rapidly contagious disease
7. Improper drainage and sanitation condition
8. Open drain system of Garia, Behala, Baguihati is increasing the vector borne disease like malaria, dengue, cholera etc.
9. Climate change causes different types of health hazard

Some predominant diseases in Kolkata are dengue, cholera, tuberculosis, HIV/AIDS, swine flu etc. These diseases occur generally in slum and shanty areas. In Kolkata, percentage of dengue affected people is 63.76%. Dengue is of prime concern in Kolkata. It has been noticed that Maniktala, Beliaghata, Phoolbagan are the worst affected areas with an alarming rate of cholera i.e. 25 to 30 %, whereas in Tiljala the rate is 20-20%, in Tangra and Beniapukur it is 15 to 20%, in Metiaburz, Garden Reach and Khidderpore it is wide spread. In Kolkata at Sonagachi about 5.17% of 3000 prostitutes are found having HIV positive.

3.6.1. Prevention and Mitigation

- Proper medication system
- Health consciousness
- Be hygienic
- Vaccination
- Pest and vector control
- Use of mosquito net, mosquito repellent, musk
- Stop water stagnation indoor and outdoor
- Free treatment and medicine
- Keep yourself clean and keep city clean

4. Conclusion

Kolkata the capital of West Bengal is vulnerable to climate change as well as different types of hazard. The risk of Kolkata is very high for its over population. Over population plays a dual role as it provokes the intensity of hazard and it also are adversely affected by the hazard. We cannot stop the natural hazard but we can prevent man made hazard. Consciousness and some sustainable approach will be fruit full to reach our goal. If we reach our goal Kolkata will be healthy to stay. Last of all we must follow the legislation as well as creating green belt barricade, retrofitting building roofs, microzonation of areas, stop immigration to save KOLKATA.

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