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Mumbai - Sangli Flood: Its Causes and Solutions

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Abstract - *Climate is sometimes mistaken for weather. Climate is a long-term phenomenon characterized by significant changes in global temperature, precipitation, and wind patterns, unlike weather which can change day to day or year to year. This is evident in the case of Mumbai, the capital city of Maharashtra, which experiences frequent flooding during rainy seasons and high tides due to its low-lying and saucer environment. Social work intervention becomes essential when natural calamity like flood occurs and it makes hazardous to society. The MCGM has carried out various projects to reduce floods every year, but all in vain. Similarly, Flood situation has become disastrous during the years 2005 and 2006 in later part of July and early August in upper Krishna basin. It is also important to note that floods are aggravated phenomena by human and natural activities. About 27.72% of the geographical area of the upper Krishna basin of southern Maharashtra is affected by floods of which about 2.12% of total population of Upper Krishna basin has suffered in 2006. The present research paper attempts to analyze and provide solution on probable causes of flood situation and their solution in Mumbai region as well as Sangli, Kolhapur.*

Key Words: **Mumbai Flood, Mithi River, Drainage System, Sangali Flood, Krishna River, Storm Water.**

1.0 INTRODUCTION

India is primarily an agricultural country. India which lies between 8°N and 37°N latitude and 68°E and 97°E longitude, experience is 3 major seasons: winter, summer and the monsoon. Winter months (November-March) are bright and pleasant with snowfall in Northern Himalaya Mountains. Summer time (April-June) is hot in most part of India, and it is then that the numerals hill resorts provide cool retreat during monsoon rainfall is heavy along the West coast between June and September, and along the east coast between October and December. India is more susceptible to floods due to heavy rains associated with monsoon and cyclonic activity. The coastal areas are more susceptible to heavy cyclonic rainfall than the interior parts. Apart from 0cyclonic effect floods induced by monsoon rainfall also cause severe damage in India. Of the two the summer monsoon is more significant as the Indian subcontinent receives 70% of its annual rainfall during this year. The floods are commonly associated with snow melt in Himalayan region however the floods caused by cyclones and the monsoon rainfall is more destructive. India is considered to be among the nations that are susceptible to flooding on a global scale. Floods occur yearly in India affecting about 10% of area. Illegal colonies in mega cities cause natural drainage restrictions, causing urban floods. Urban areas experience flooding from various sources, including river floods, flash floods, coastal floods, excess water release from reservoirs or dam failures, increased rainfall intensity, blockage of drainage systems due to silting, waste material dumping, and encroachment over natural drainage and water bodies. are the various cause of urban flood. Urban floods disrupt daily life and cause significant disruption. Flood causes high economic damages and limited casualties. City streets experience gradual water rise. Floods refer to high, overflowing flow over river banks. Rainy season causes increased river flow, sometimes exceeding carrying capacity. Overflow water overflows river banks, submerging villages, agricultural lands, and surrounding areas. This phenomenon is known as flood.

Flooding is a natural phenomenon that occurs when water bodies, such as rivers, lakes, or oceans, overflow their banks or break through levees, causing water to escape its usual boundaries. It can also happen when rainwater accumulates on saturated ground, resulting in an aerial flood. Given that water covers more than three-fourths of the Earth's surface, it's no wonder that our planet has been aptly named the "watery planet" or the "blue planet." However, it's important to note that only a small fraction of Earth's total water resources is actually usable. In fact, more than 99% of the Earth's water is un-utilizable, with oceanic waters accounting for 97.2% of this un-utilizable component. While water is essential for life and plays a vital role in shaping our planet's landscape, it can also pose significant challenges when it exceeds its boundaries and causes flooding. Thus, the utilizable surface waters constitute a very meagre percentage in the total global water resources.

1.1 Objective

1) To understand flood situation at Mumbai & Sangli, Kolhapur districts as a climate change result.

2) To highlight the causes of the flood in Mumbai as well as Sangli (Kolhapur).

1.2 Scope of Work

Mumbai and Sangli are one of the cities are highly prone to flooding every year in the monsoon seasons due to varies reasons. This study focuses in the understanding the flooding situation in Mumbai as well as Sangli. Simultaneously, this study also focuses on finding out those

primary reasons which are responsible of the flood. so that respective authorities can take corrective measures to avoid the havoc scenarios.

2.0 Methodology

2.1 Data is Source and Research Methodology

The present case study has based on primary and secondary data however the primary data is the main source to meet the objective of the study therefore the correlated data has collected observation method.

Primary data regarding natural and anthropogenic causes of flood disaster has collected through post flood filled work and secondary data has collected from various topographical maps books journals newspaper and several websites etc. which have explained under references.

2.2 Method of data analysis

After the collection of primary and secondary data it has process the process data tabulated and presented in a form of information

3.0 FLOODS IN MUMBAI

Mumbai is a city of Maharashtra state on the West coast of India is located in Shasti Island which was known as "City Island" in Portuguese. Shasti Island is located right at the tip of Ulhas River. The coastline of the city is intended with numerous base and tidal creeks Criss crossing the area. Much of the Mumbai is closed to the sea level with an average elevation of about 8 m, accept the northern hilly part of the city, which has pick elevation of 450 m. The city spreads over an area about 468 km2. This dense forest reduces the impact of flood that occurred on July 26 2005. The record annual rainfall total of the city 345.2 cm during 1954 the Mumbai rains of 26 July 2005, 94.4 cm, are the highest rainfall recorded on the single day. As mention above Mumbai is a city located on the coast of Arabian sea, is said to be the financial capital of India and also the capital city of Indian state of Maharashtra. Low-lying area experiences annual flooding.

Floods in Mumbai are said to be caused by heavy rains a company with high tides but, these factors are not solely responsible for the annual floods in Mumbai; rather, a multitude of other factors, in conjunction with these, contribute significantly to the severe flooding in the region. Mumbai is mention before is a fine is the financial capital of India, this floods cause use heavy damages to Indian economy along with this day also cause a huge loss of life property and cattle, giving rise to diseases and emotional disturbance is for those who survived. It is found out that in today's scenario overall 35% of Mumbai's population leaves within 250 m of BMC identified flooding hotspots.

BMC's 2022 and 23 budget shows Mumbai has 386 chronic flooding spots, with 265 completed. The updated figure shows 282 locations with flood control measures, with 104 remaining to be addressed. The majority of these spots are in western suburbs, while eastern suburbs like Juhu, Khar, Santacruz, Bandra, Dadar TT, Hindu colony, Hind Mata, Gandhi market, and Chembur, Govandi, and Mankhurd are prone to waterlogging annually due to flooding. which means 104 flooding spots are still to be handled of this 68 are in the western suburbs 20:05 in the island city and Levin in the eastern Suburbs areas like Juhu, Khar, Santacruz and Bandra in the western parts, Dadar TT, Hindu colony, Hind Mata and Gandhi market in central Mumbai and Chembur, Govandi and Mankhurd in the eastern suburb are prone to waterlogged every year due to flooding.

3.1.Reasons of Mumbai Flood

Heavy Rains and Rising Sea Levels

In Mumbai, heavy rains exceeding 240 mm are a frequent phenomenon during the onset of monsoons. Subsequently, as the monsoon progresses into its active phase, the conditions become favorable for the occurrence of extremely heavy rains over Mumbai. These rains are typically a consequence of the formation of a low-pressure belt over the sea, and as some suggest, the intensifying effects of global warming on sea levels, leading to high tides during the monsoon season in Mumbai.

Faltering Drainage Systems

Mumbai's storm water drainage system has significantly contributed to the city's flooding. City's stormwater drainage system is complex, involving simple rivers, creeks, and ponds. The network consists of a hierarchical system of roadside surface drains, underground drains, laterals, major and minor canals, and over 180 outfalls. These drains discharge surface runoff into rivers and the Arabian Sea. Outfalls from these outfalls can drain into Arabian Sea or Mahim Creek, Mahul Creek, or Thane Creek. Storm water from western suburbs drains into sea, while remaining out-falls discharge into Mithi River, joining Mahim creek.

Mumbai's Natural Drain

Mithi River: Mithi river is crucial for city's SWD system. The river's location is crucial for the city as it divides it from its suburbs and disrupts traffic on five transport corridors: Central Railways, Western Railways, Western Express Highway, Eastern Express Highway, and Harbor Railway Line.

The river's stormwater drainage is encroached by numerous settlements, making it difficult to define its path. The unprocessed sewage, wastewater, refuse from unauthorized settlements, and industrial effluents are directly discharged into the river's course, leading to its obstruction and consequent elevation of water levels during periods of heavy rainfall.

Incapable Storm Water Drains

The Mumbai storm water drainage system, built during British Rule in 1860, has a capacity of about 400 km of underground drains and laterals. It is designed to handle rain intensity of 25 mm per hour at low tide, but if rain intensity exceeds 25 mm per hour and a high tide occurs, inundation is possible.

The system is designed to handle normal rainfall, but most drains are occupied by garbage and solid deposits. The inundation that hit Mumbai on July 26, 2005, demonstrated the decrease in the system's capacity, as the city was unaware and unprepared to deal with the crisis. The city's drains were not capable of releasing excess water, causing further inundation.

Decrease in the catchment area of Mithi river

Mithi River flooding is exacerbated by land reclamation, affecting traffic on five transport corridors: Central Railways, Western Railways, Western Express Highway, Eastern Express Highway, and Harbour Railway Line.

Bandra - Worli sea link

The Bandra Worli sea link construction has significantly impacted Mumbai's flooding by constricting the Mithi River mouth at Mahim Bay. This causes water surges and overflows during high tides, causing devastating floods.

The course of the Mithi River is being altered as a result of the construction of the runway at Chhatrapati Shivaji International Airport (CSIA).

The runway at Chhatrapati Shivaji International Airport (CSIA) has been extended along the course of the Mithi River, which has undergone a shift in its trajectory. High rainfall causes water to climb above land surface, causing floods in cities, as it descends with great pressure and continues to rise

4.0 FLOOD IN SANGLI (KOLHAPUR)

Sangli district, situated in western Maharashtra, is surrounded by Satara, Solapur, Bijapur, Kolhapur, Belgaum, and Ratnagiri districts. It is situated in the river basins of the Warna and Krishna Rivers. The district's physical settings showcase vast landscapes influenced by relief, climate, and vegetation. The climate varies from the rainiest in Chandoli (Shirala) to the driest in Atpadi and Jath tehsils, with an average annual rainfall of 500 mm.

Vegetable cover varies from monsoon forests in the western parts to scrub and poor grass in the eastern parts. The Mouje Digraj was one of the most saver leaves flood affected village of The Mirage tehsil. It is located on 16°54’40”N latitude and 74°31’24”E longitude. it lies on the Left Bank of river Krishna. according to 2001 census, the population of the Mouje Digraj is 4455 persons.

In July and August 2019, Sangli & Kolhapur districts in the Krishna sub basin experienced severe floods lasting for long periods, causing significant losses to life, property, and crops. The 2019 flood event was more severe, lasting over a week, and causing higher losses. The cause is attributed to heavy rainfall in the Krishna River basin, resulting from the excessive water released from the Koyana dam. Improper water flow between Koyana and Almatti Dam caused a flood due to improper co-relation, resulting in a resulting situation.

4.1. Reasons of Sangli Flood

1) The Secretary of Water Resources, Rajendra Pawar, has stated that the discharge from the dams was carried out in accordance with the statistical data of the past 40-45 years. However, the unexpected rainfall of 400 percent above the normal has caused unforeseen consequences. In light of this, a committee is being established to reassess the flood-line norms. Environmentalists have contended that the primary cause of floods and devastation is the construction in prohibited floodplain zones.

2) Activists blame Maharashtra government for Kolhapur deluge, claiming Panchganga River flood lines were redefined for builders' benefits.

3) Many believe excessive rains caused floods in Maharashtra. In 2005, Sangli experienced 200 percent rain in 31 days, while in 2019, it occurred in nine days.

4) Kolhapur has encountered an unparalleled downpour, amounting to 160 percent over a period of 31 days and 180 percent within a span of nine days. The present deluge situation is attributed to the cumulative impact of the Krishna, Koyna, and Panchganga rivers.

5) Kolhapur's 2010 development plan mistakenly marked flood levels as flood lines, causing Panchganga River floodplains loss to real estate. Each one of them was overflowing following incessant rains between 5 to 8 August 2019, total around 900 mm of rain, which was over 400 percent above normal, an official data from India Meteorological Department.

6) Massive construction along rivers in Sangli and Kolhapur reduced riverbed carrying capacity, causing flooding and causing banks to rupture, causing devastation due to heavy rainfall and flooding through houses.

7) According to Vikrant Tongad a renowned environmentalist, Floodplains, the flat land along river, provide the space for rivers to spread their waters. Encroaching river ecology, causing deforestation and sand mining, significantly impacts river ecology and increases vulnerability to floods.

8) Riverbed encroachment reduces floodwater carrying capacity. India lacks regulations for protecting river floodplains, experts warn.

9) Manoj Mishra, a river expert, explains that irrigation departments in various states conduct periodic assessments of flood lines to protect rivers from industrial pollution.

10) The Union Ministry of Environment, Forest and Climate Change drafted a River Regulation Zone (RRZ) notification a decade ago, but it has not yet been implemented. The RRZ policy is now under the purview of the newly formed Jal Shakti Ministry, further causing delays.

11) The notification is crucial for river ecology and the lives of people living in floodplains due to a lack of knowledge. Flood lines are marked along the banks of rivers, indicating potential flood threats.

12) The innermost "blue line" indicates a flood occurrence within the last 25 years, while the outer "red line" indicates a 100-year flood occurrence. Construction is prohibited up to the blue line, while restricted construction is allowed between the blue and red lines. Green line land has no restrictions.

5. Effect of Flood

1) A large Number of people are stranded on the streets during the rains, thousands lose their houses and properties.

2) Large number of businesses are disturbed, banks are closed down.

3) Nation's economy is negatively impacted by nearly two-day stock market closures.

4) Mumbai, India's financial capital, faces significant losses during flooding due to flooding.

5) Outbreak of epidemics like Leptospirosis (disease caused when organs like skin, eyes, mouth or nose comes in contact with the flood water that has been affected by animal urines).

6) Land submergence causes destruction of buildings and roads, impacting rebuilding costs.

7) Damaged buildings often serve as business sites, causing revenue loss and economic detoriation in production and industry.

8) Repetitive floods can discourage foreign investments, weakening the economy.

9) Water cover on agricultural lands damages crops and livestock, leading to food shortages and increased prices.

10) Furthermore, regions that have been inundated are rendered inaccessible, unappealing, and deficient in essential amenities and facilities. Consequently, there is a possibility of a transient reduction in tourism.

11) Contaminated water can cause water-borne diseases, causing illness in people directly.

12) The cost required for reconstruction of the damaged structures is huge

13) Recovery costs for the affected victims rounds up to nearly or more than ten million.

6. Measures for Flood Problems

1) CLEANING OF MITHI RIVER:

The Mithi River, a major part of the city's stormwater drainage system, is contaminated with plastics, garbage, and effluents from commercial buildings. This makes it difficult to drain water during heavy rains, causing flooding. The first step is to clean the river to prevent further contamination and ensure safe water flow.

2) BORES ALONG WITH THE STORM WATER DRAINS:

Increased storm water drain size requires boring pile holes to allow floodwater to enter bores and meet the ground water table. This is beneficial when tide levels exceed expected levels and pumping stations fail to pump out water.

3) PERCOLATION TANKS:

Mumbai lacks its own water source and relies on water from Nashik. A percolation tank with gravity-driven flood water diversion could serve as a water source during water scarcity and reduce flood impacts.

4) PLANTING AND PRESERVING OF MANGROVES:

The previous storm water drains in Mumbai were designed to absorb rainwater, but land reclamation has reduced water absorption. This concretization prevents water from penetrating the ground, causing stagnant soil and flood situations. To protect mangroves and replant them, strict rules must be established for their preservation. Land reclamation over mangroves has led to stagnant soil, causing flooding.

5) INCREASING THE CAPACITY OF STORM WATER DRAINS:

The previous storm water drains, built during the period when British ruled India were of the capacity of 25mm per hour with a run off coefficient of 0.5. BRIMSTOWAD project expanded storm water drains to 50mm per hour with a run off coefficient of 0.01. High-rise buildings' foundations directly impacted storm water drains, making it impossible to increase their size. Despite the augmentation of the capacity of the stormwater drains (SWDs), their outfall continued to discharge into the sea. Consequently, during high tides, the water surged back into the drains instead of being discharged, resulting in stagnant water in the city and causing flooding.

6) INSTALLATION OF STORM WATER PUMPING STATION:

The BRIMSTOWAD committee developed a plan for pumping stations to handle high tides and floods. These stations discharge water by gravity during low tides and pump 6-meter cubes per second during high tides. The system relies on electricity and diesel generators, ensuring power failures and fuel shortages are stopped. Meter gates are constructed based on the maximum tide height, as natural disasters cannot be predicted and flooding problems may arise if tide height exceeds predicted levels.

7) INSTALLTION OF FLOOD WARNING SYSYTEM:

Install a flood warning system to alert people during high floods in flood-prone areas, ensuring they move to safe areas and monitor water levels.

8) SAFE PUBLIC MIGRATION:

Families affected by floods should be relocated to safe areas with basic amenities like food, shelter, and medical facilities. Local NGOs and youth should be prepared to assist those affected.

9) RECAPITALIZATION OF PEOPLE:

Donations, medical care, and guidance should be provided to help rebuild and help others recover from adversity. Authorities should assess flood damage and provide immediate compensation for those affected. Temporary healthcare units should be provided in affected areas to provide immediate support. Proper instructions and guidance should be given to help people return to their normal lives.

10) WATER BORNE & VECTOR BONE DISEASES PREVENTION:

Safe drinking water is crucial for reducing waterborne diseases. Chlorination is effective against most waterborne pathogens, and hepatitis A vaccination can be administered to both individuals and workers. Larvicides, space spraying, and insecticide sprays can reduce mosquito populations, breaking the vector-borne disease cycle. Mosquito repellents, liquid vaporizers, and coils can control mosquito bites at individual or household levels. Early clinical and laboratory detection of diseases is crucial for assessing cases and providing laboratory support in cases of malaria or dengue complications.

7. CONCLUSIONS

Mumbai is a natural hazard zone with extreme monsoon weather, causing significant damage to humans and the economy. To reduce the impact of these hazards, proper flood plan management and accurate mapping are essential. Transportation facilities must be strengthened to ensure people can move quickly during peak and emergency times. The main cause of flooding is the weak and old drainage system in Mumbai. The Sangli-Kolhapur flood situation was caused by non-communication between the Maharashtra and Karnataka governments, leading to water scarcity in Sangli and Kolhapur. The water conservation department should work on this issue. Tree planting on river banks is also necessary to cope with the situation. A flood alarm system will provide information on water levels during rainy seasons, raising awareness. NGOs and youths can work together to provide food, shelter, and basic medical facilities to flood-suffering individuals. Future plans should be developed to face future floods in the coming years.

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