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# Understanding Urban Flooding: A Case Study of Delhi 2023 Floods

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**Abstract -** With a focus on the historic flooding incident along the Yamuna River in July 2023, this study investigates the complex causes and significant effects of urban flooding in Delhi. Catastrophic events in major cities over the past 20 years have demonstrated that urban flooding, which differs from rural flooding due to developed catchments and high population density, is a serious and expanding threat both globally and in India. Heavy rainfall in the upper catchment area, the ensuing excessive water release from the Hathnikund Barrage, and systemic urban vulnerabilities were the main causes of the 2023 Delhi flood. Rapid urbanisation, encroachment on the Yamuna floodplains, clogged and insufficient drainage infrastructure, and riverbed siltation are some of these vulnerabilities. Employing a qualitative research methodology involving interviews and fieldwork at three sites, Kashmere Gate, Tibetan Monastery, and Yamuna Bank,the research assesses the impact on marginalised communities residing in low-lying areas. Findings highlight pervasive issues such as delayed flood notifications, lack of adequate shelters, and substantial damage to property and livelihoods. The study underscores that the crisis is compounded by social inequities, forcing vulnerable populations into flood-prone zones due to a lack of affordable housing.

The core objectives are to understand the causes and resultant disruptions, explore the effects on the local community, and underline the systemic interventions required.

***Key Words***: *Urban flooding, urbanisation, marginalised communities, interventions.*

## 1.INTRODUCTION

Urban flooding is a type of flooding that occurs in urban areas, wherein the land or property in a built environment is inundated by water. It is significantly different from floods which occur in rural areas, as urbanisation leads to developed catchments, which increases the vulnerability of the area. Over the last few years, urban areas are increasingly affected by climate-related disasters, which have resulted in increased economic losses and deaths. The main cause of urban flooding is rainfall or other instances that overwhelm the capacity of the drainage systems in a particular urban area. Urban areas are areas of high population density. Thus, people residing in sensitive and unplanned areas suffer the most due to flooding, sometimes even resulting in the loss of property and life. In addition to the direct impacts of the flooding event, the secondary effect of exposure to infections, injuries and water-borne diseases also has its toll in terms of human suffering, loss of livelihood and even deaths in extreme cases. The increasing trend of urban flooding is a universal phenomenon and poses a great threat to planners and policy makers the world over. India is also no exception in this case, as an increasing trend has been seen in the country over the past several years, wherein major cities have been severely affected. Some notable incidents are as follows: Hyderabad in 2000, Ahmedabad in 2001, Delhi in 2002 and 2003, Chennai in 2004, Mumbai in 2005, Surat in 2006, Kolkata in 2007, Jamshedpur in 2008, Delhi in 2009 and 2010 and Guwahati in 2010. These events suggest that the challenge of urban floods is neither new nor going away anytime soon. As per UN-Habitat, flooding is the most common risk to urban ecosystems. The drainage and sewage network of most cities is not equipped to handle excess rainfall as well as runoff.

Delhi is the political nucleus of India and a major centre of economic activities in northern India. The city has an urbanised area of 75.09% in 2011, compared to 46.21% in 1991. Rapid urbanization, coupled with an inadequate drainage system has led to an increase in incidents of surface runoff and urban flooding. A sizeable population of the city of Delhi resides in settlements that have mushroomed in the flood plains of Yamuna. A majority of these settlements is in the low-lying areas, which make them highly vulnerable to flooding events of even moderate intensity. On July 13, 2023, thousands of people were evacuated from their homes in the capital as the water level in the Yamuna hit a 45-year high at 684 feets, breaking the previous record of 681 feet set in 1978. Authorities warned of widespread flooding following days of torrential rains that battered large swaths of northern India. The level of the Yamuna River, which flows through the Indian capital and is a tributary of the Ganges, had breached the danger mark by three meters (about 10 feet). The Yamuna swelled particularly abruptly after authorities released more water into it to relieve pressure on Hathnikund barrage in the neighboring state of Haryana. Water from the swelling

river inundated several low-lying areas and roads. The three plants providing fresh water to about a quarter of the city's population were flooded causing drinking water shortage. Heavy vehicles, except those providing essential services, had to be banned from entering Delhi. More than 16,000 people had been shifted to relief tents pitched under flyovers by the Delhi government. Entire streets were flooded in the capital.

## 2. RATIONALE OF THE STUDY

Researchers have been working on various methods to study and mitigate the destructive impacts of urban floods, especially in areas prone to frequent flooding. The Yamuna River has posed significant flood challenges in the Union territory of Delhi, submerging extensive areas during the flood season and severely affecting the daily lives of the residents. Nearly every year, the Yamuna River experiences some level of flooding, whether it is of low, moderate or high intensity. One of the key objectives of this report is to understand the risks, impact of floods and vulnerable population of the Yamuna floods in Delhi for better risk management. This paper introduces a novel approach that combines field work and secondary sources to understand the issue of urban flooding in Delhi comprehensively. What makes this research unique is its focus on urban areas where flooding is not solely due to heavy rain but also due to poor drainage infrastructure, improper disposal of waste leading to the clogging of drains and sewers, increased impervious surfaces reducing natural drainage, and increasing urban development. Residents in low-lying areas suffer the most. They often express frustration over the recurrent flooding, which not only disrupts transportation but also poses a threat to their lives, facing the risk of property damage and health hazards due to stagnant water. Additionally, the economic consequences are severe, with businesses suffering from damage and disruptions. The inadequate waste management system compounds the issue, as clogged drains and stormwater inlets contribute to the flooding. Many blame unplanned urbanisation and encroachments on water bodies for exacerbating the problem. Emergency services struggle to navigate flooded streets, and rescue operations become challenging. Despite government initiatives to address the problem, the perceived lack of effective planning and implementation decisions in Delhi concerning urban flooding are felt keenly by the local people. Urgent measures are needed to address the deficiencies in infrastructure, implement sustainable urban planning and prioritize the resilience of vulnerable communities to mitigate the adverse effects of flooding in the future.

## 3. OBJECTIVES

- To understand the causes of flooding and resultant disruptions in the city.
- To explore the effects of the flooding on the local community and society at large.

## 4. STUDY-AREA

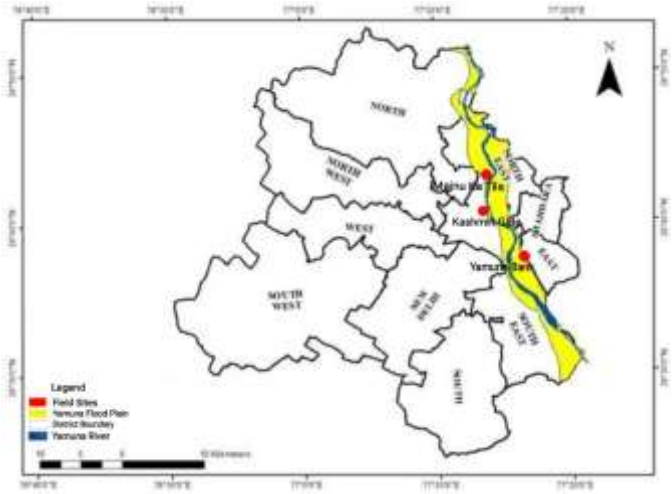


**Fig -2**1: Map of Study Area (highlighted in red)

This study was conducted at three field sites in Delhi, namely, Kashmiri gate, Tibetan Monastery, and Yamuna Bank.

Kashmiri Gate or Kashmere Gate is a gate located in Old Delhi in UT of Delhi, India. Kashmiri Gate has been a pivotal area, marked by its strategic location and historical significance. Its proximity to the Yamuna River, coupled with its densely populated surroundings and intricate urban infrastructure, renders it a microcosm of the broader challenges associated with urban flooding in Delhi.

Majnu ka Tilla, located in North Delhi along the banks of the Yamuna River, is a prominent Tibetan colony and neighborhood known for its cultural vibrancy and historical significance. It serves as a home to a sizable Tibetan community in Delhi, with numerous Tibetan restaurants, shops, and religious institutions dotting its lanes.

The Yamuna Bank in Delhi refers to the areas along the banks of the Yamuna River that flow through the city. This stretch of the river has been a focal point for both developmental and environmental concerns. Over the years, the Yamuna Bank in Delhi has witnessed significant infrastructure developments, including the construction of the Yamuna Expressway and the establishment of parks and recreational spaces along its shores.

## 5. METHODOLOGY

The study was done to document disaster management strategies and approaches and to assess the impact of flash floods on human lives, health hazards and future implications of a natural disaster. A qualitative research method has been used in this paper including Interviews, FGDs, Observations and Case studies. Both primary and secondary data has been used. The site survey of three field sites in Delhi, namely, Kashmiri gate, Tibetan Monastery, and Yamuna Bank, in which qualitative interview was conducted to have a perception of communities living on the fringes of Yamuna on disasters faced by them and how much help and relief they received from the government. A thorough literature review was conducted to accomplish the research's goal.

## 6. LITERATURE REVIEW

Mukesh Kumar et al., (2017)1 in their study state that flooding is a common issue in India, particularly in Delhi, which has experienced numerous floods in recent decades due to rapid urbanization. The low-lying areas of the city are at a higher risk of flooding, even during moderate intensity floods. The study recommends a combination of structural and non-structural changes to mitigate flood risks. Some of the structural measures stated were construction of dams to reduce magnitude of the flood in downstream, construction of a barrage at Palla region to provide additional storage facility, diversion of floodwaters into retention basin, strengthening of drainage system and building sustainable ones, strengthening of embankments and controlled localised dredging of river etc. On the other hand, afforestation and watershed management, coordinated barrage operation, flood plain zoning and formation of Yamuna basin authority were some of the non-structural measures recommended in the study. Kavita Chowdhury (2023)2 in her news article presents the reader how illegal encroachment of the floodplains of Yamuna led to the aggravation of the floods that occurred in Delhi in July 2023. The article highlights that the construction of various structures like Commonwealth Games Village, Akshardham,Yamuna Bank Metro Station, Delhi Secretariat,etc. have left very little space for the Yamuna river to flow. The victims of this flood were the people who inhabited the low-lying areas of the Yamuna. The National Green Tribunal (NGT) had foresaw this "environmental disaster" if no action was taken to resolve the issue of heavy construction on the aforesaid site. The author portrayed the post calamity scenario as a series of blame game among the politicians and various stakeholders. However, the article does not elaborate much on the action plan that is necessary to prevent such situations in the future. Kumar et al. (2023) in their seminal work highlights the major casualties of floods faced by the people. These include mainly loss of habitat due to inundation and loss of life. The immediate effect of the floods was the evacuation of thousands of people following the disruption caused by the heavy rains in northern India. The flood affected areas which homed many migrant workers were inundated and they had to flee to take temporary shelter alongside the roads near it. The residential areas like Civil Lanes too could be saved from the fury of the flood as they were also flooded. During this season, the Himalayan state of Himachal Pradesh has suffered severe impacts from heavy rains, resulting in the loss of at least 45 lives. The region also experienced extensive damage to infrastructure valued in millions of dollars. In Haryana, thousands of acres of crops have been destroyed due to the adverse weather conditions. Meanwhile, in Uttarakhand many were stranded as roads leading to four significant Hindu pilgrimage sites remain blocked for several days. The authors also state the problem of water shortage that was likely to accompany. It can be attributed to the damage caused to three water treatment plant in the capital. Kumar et al. elaborated on the widespread humanitarian and economic challenges posed by the monsoon-related disasters. It was done rather in a very generalized manner without looking into the nuances of the impacts.The authors do not speak of the gender specific post disaster impacts on men and women which they tend to experience exclusively. The Situation Report - 02 Flood in Delhi/NCR (2023) of Sphere India discusses on the flood situation in Delhi. Areas such as Red Fort, ITO, Kashmiri Gate, Central Secretariat, Civil Lines, and others were severely affected by waterlogged drainage and continuous rainfall, resulting in stranded trucks, vehicles, and people. In response, Delhi police and other agencies evacuated over 750 people and 250 cattle from low-lying areas near Garhi Mandu village at the Signature Bridge in Wazirabad. Due to rising water levels in the Yamuna River, entry and exit at Yamuna Bank metro station on the Blue Line were temporarily closed by the Delhi Metro Rail Corporation (DMRC). The district administration of Gautam Budha Nagar identified over 50 vulnerable villages along the Yamuna banks, urging residents to evacuate to safer areas before the river reaches dangerous levels. The report also highlights the extent of preparedness and response. In Noida, flood response includes a dedicated control room and rescue operations by the fire department, saving 300 cattle. Media reports cite flooding of 250-300 acres with crops. NGOs like HAI, SEEDs India, and Sewa International provide relief efforts, while Sphere India plans inter-agency coordination.

## 7. FINDINGS AND DISCUSSIONS

The main cause of the rampant floodings has been attributed. to the encroachment of the floodplains. Another reason was the buildup of silt due to heavy rains in a short span of time. This caused the water levels of Yamuna to rise.

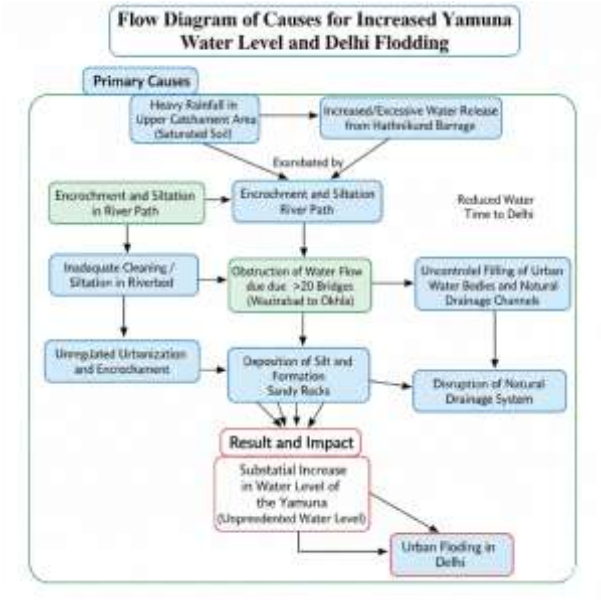


**Fig -2**:
Flow Diagram of Causes for Increased Yamuna Water Le vel and Delhi Flooding

The interviews conducted with the locals of these areas provided with helpful insights into the disaster. Even though people had experienced cases of floodings earlier, the floods of 2023 were of much higher intensity. They were evacuated at 11 pm. at night without prior notice. The individuals residing along the Yamuna Ghats predominantly hail from Bihar and Uttar Pradesh, having migrated to these areas due to the lack of job opportunities and land availability in their home states. When questioned about their reasons for migrating, they consistently cite the absence of viable employment prospects and the scarcity of land as the primary drivers behind their relocation. Regarding the causes of flooding, their perspective diverges from attributing blame solely to the river itself. Instead, they highlight the inadequate availability of housing and the exorbitant rents in alternative locales as key contributors to their vulnerability. Forced to construct temporary shelters along the riverbanks during the dry summer months, they are compelled by circumstances to seek refuge in areas prone to flooding. Despite their efforts, the absence of permanent housing solutions exacerbates their precarious situation, worsened by governmental regulations prohibiting settlement elsewhere under the guise of encroachment laws. In recounting the events of the last flood, they attest to the unprecedented volume of water during the monsoon season, inundating their low-lying dwellings and amplifying their plight. The deluge, far from being an isolated incident, underscores the systemic vulnerabilities inherent in their living conditions, underscoring the urgent need for comprehensive solutions to mitigate future disasters. Embedded within their narratives lies a poignant tale of resilience amidst adversity, a testament to the indomitable spirit of human perseverance amid the relentless vicissitudes of nature and governance alike. Their voices, often marginalized and overlooked, serve as a poignant reminder of the enduring struggle for dignity and recognition in the face of systemic neglect. As the waters of the Yamuna continue to ebb and flow, their stories reverberate as a clarion call for collective action and solidarity in the pursuit of justice and equity. Beyond the confines of statistical abstraction, they represent the human toll of systemic inequities and institutional apathy, beckoning us to confront the entrenched structures perpetuating their marginalization. In amplifying their voices, we bear witness not only to their individual narratives but also to the broader injustices ingrained within the fabric of our society. Their struggles are emblematic of a larger struggle for social and economic justice, demanding a concerted effort to address the root causes of their disenfranchisement and chart a path towards a more inclusive and equitable future for all. In the face of adversity, they embody the resilience of the human spirit, a testament to the enduring power of hope and solidarity amidst the tumultuous currents of existence. As we heed their call to action, we reaffirm our commitment to building a society founded on principles of justice, compassion, and dignity for all its members, regardless of their circumstances or background.


**Fig -3**: Problems identified by the participants

I. ***Damage to business and property***

Floodwaters caused extensive damage to the properties of the people. Local businesses were interrupted due to the production being stopped, non-accessible assets and closure of markets leading to loss of income. Moreover, in case of Delhi flood 2023, people receive any monetary beneficiaries as promised by the government.

***II. Delayed notifications***

There is a delay in providing information about the likelihood and severity of flooding. This leads to the lack of preparedness among the public, inadequate deployment of resources and slower emergency responses. This forces people to evacuate their homes immediately and seek temporary shelter. In context of urban flooding, where timely action is crucial, the delay in disseminating alerts and information can contribute to the severity of the situation.

***III. Lack of shelters***

Though, the government provides relief camps but these camps can accommodate a certain population and majority of displaced individuals often face difficulties in finding adequate accommodation and suffer from the loss of personal belongings. This is particularly problematic for marginalized communities and those residing in low-lying regions, as they often bear the brunt of flooding due to insufficient shelter options.

***IV. Inadequate drainage systems***

Another serious challenge that the localities faced is the lack of proper stormwater drainage systems and sewage infrastructure. The old and poorly maintained drainage systems lead to a backflow of elevated water level in the city's drains. The city's drainage infrastructure appears inadequate to handle the volume of water during heaving rainfall or flooding incidents. The existing drainage systems may be overwhelmed, leading to water logging in various areas.

***V. Insufficient investment in infrastructure***

Insufficient investment in infrastructure stands out as a prominent cause of urban flooding in Delhi. The inadequacy of resources directed towards developing robust and modern infrastructure systems has left the city vulnerable to the impact pf heavy rainfall and the resultant overflow of rivers and drains. Insufficient investment in measures such as resilient embankments, advanced stormwater management systems and well-maintained drainage networks leaves Delhi ill-prepared to manage and mitigate the effects of heavy rainfalls. Consequently, urban flooding becomes a recurrent issue.

## 8. CONCLUSION

Urban flooding is a complex and multifaceted issue, with various contributing factors. Thus, the solutions for the same often need to be tailored to the specific characteristics and situation, level of infrastructure development as well as the surrounding topography of the urban area. This means that a specific solution adopted by one particular state may not work for the other. Implementing sustainable urban planning, creating green spaces and enhancing and improving drainage systems are vital long-term solutions to combat urban flooding in Delhi.

The flood-like situation in Delhi in July 2023 was the result of heavy rainfall and the overflowing of the Yamuna River, leading to significant damage and displacement at various sites of Delhi e.g. Kashmere Gate, Yamuna Bank area, Tibetan monastery, etc. The city's infrastructure and flood control measures were not adequately prepared to handle such casualty, highlighting the need for better planning and coordination between the state and central governments, as well as neighboring states. The flooding impacted water supply, transportation, and the relocation of thousands of people to safer locations. The event also raised concerns about the lack of focus on municipal infrastructure and climate adaptation measures. As the water receded, questions were raised about the improvement of civic amenities and the long-term governance lessons to address future flood risks. The unprecedented nature of the flooding and its impact underscored the importance of proactive measures to mitigate the effects of such extreme weather events. This flooding was stark reminder of the vulnerability of the urban areas to the extreme weather conditions. It also highlighted the social, environmental and economic factors in shaping the impact of natural disaster. The lesson learned from this event can guide proactive measures to build a more resilient and sustainable future.

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