



Knowledgeable Research –Vol.1, No.10, May 2023

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To Analysis the Impact of Flood on Communities Belong to Various Socio-economic Background in the Highly Vulnerable Regions Along with the Yamuna Catchment Area, New Delhi

¹Vijay Jayswal,
 Ph.D. Scholar, Department of geography
 CSJMU Kanpur,
 Email: vijayjayswal.gonda@gmail.com
²Ashna Gargi,
 Masters in SCDR of JNU Delhi,
 Email: ashnagargi3069@gmail.com

ABSTRACT

Disasters are old-age concerns of the human race. Hazards are the product of natural cycles and physical adjustments of nature to maintain equilibrium. In the course of development, Humans invited disasters through reckless, unplanned, unmindful settlements. They continuously ignored the signs of nature and today reached at the stage that no corner of the earth is safe from disasters. Among, all kinds of disasters, Flood is the most important type of natural disaster. Almost all human civilizations developed around rivers, such as the great Indus Valley Civilization that flourished and perished along the banks of the Indus River. Floods engulfed many great human settlements in seconds and erased many great lands from the world map. Rivers are carried endless opportunities embracing huge resources enough to thrive a large population for years but at the same time, their nature is random, flickering, and devastating when caused disturbance either by nature or humans. The purpose of the current research paper is to understand the impact of the flood on various socio-economic sections of society in Delhi.

Keywords: *Flood, socio-Economic, vulnerability, resilience, awareness.*

Introduction

Flood is an inevitable process that takes place in a river to restore its equilibrium. What concern us is the increased frequency of the flood due to climate change, change in rainfall days, increased soil erosion causing hyper siltation, and vast devastating impact and mortality due to unmindful development, and unplanned settlement along river catchment areas. Floods

have shown long-term devastating impacts by destroying long-established shelters, the economy, infrastructures, and society. In 2015, UN-SPIDER scientifically explained flood as “a temporary general natural state of partial or complete inundation of previously drylands due to overflow of inland or tidal water.” According to WHO/EHA, “Disaster can be defined as an occurrence disrupting the normal condition of existence causing a level of suffering that exceeds the capacity of adjustment of the affected community”. In an article written by Heylin in 1986 disaster is described as a “serious disruption in the functioning of a community or society involving widespread human, material, economic or environmental losses, and its impact exceeds the ability of the society or community to cope using its resources.” Flood has been identified as the most reoccurring fatal natural phenomenon across the world. The fatality due to flood is more derived from human settings rather than geographical or topological settings. Detrembleur et.al 2015 and Kabenge et.al. 2017 in their respective paper mentioned that in the pioneering studies, floods have been reported as a chronic hazard due to global climate change, environmental degradation, rapid urbanization, and climate change. This dissertation will analyze the differential impact of the flood on the socio-economic condition of the people coming from varied socio-economic conditions. This report aims to identify highly vulnerable areas along the Yamuna catchment area and further obtain data for a thorough analysis of the impact of the flood on the socio-economic condition of the population living in these highly vulnerable areas.

With rapidly changing climate and unorganized urban crawl turned urban flooding into a seasonal phenomenon. Many studies have been conducted to analyze the impact of urban flooding on the socioeconomic condition of an area. Floods significantly lead to heavy economic loss. Heavy rainfall is not alone responsible for flooding in urban spaces; ill-planned drainage systems, impervious strata unauthorized settlements, illegal constructions, and obstructing infrastructures are other structural mistakes that cause water inundation in short rainfall periods. Sam et.al (2017) analyzed the vulnerability of the communities to floods using the Livelihood vulnerability Index and Socio-economic vulnerability index with the help of primary data collected via surveying a sample size of 220 respondents. It is found in the results of the paper, Sociodemographic characteristics like low literacy rate, High dependency ratio, and weak housing structure increase the vulnerability of residents. The

author also highlights that access to social networks and social institutions plays a significant role in uplifting poor households. The paper concludes that the vulnerability of a household is governed by non-climatic factors and the incidence of floods.

Tingsanchali (2012) described in a study, “Urban flood disaster management” on flood risk in Bangkok and Had Yai City that construction of human settlement and other infrastructure on the floodplains decrease the water storage capacity of the water body blocking the floodway causing heavy flood disasters resulting into loss of life, infrastructure, economy. This study finds that community participation in flood risk management could have mitigated the flood in Bangkok in 2002 and Had Yai City in 2000. Hammond et.al (2013) in the paper “Urban flood impact Assessment: A State of the Art Review” mentioned various techniques of dealing with different categories of the impact of a flood and their integration to identify the future approach of progress and urban planning. According to the paper, the relationship between flood impact assessment and resilience is crucial for improving urban flood resilience.

Ramachandra (2011) presented a detailed study documenting the flood and post-flood conditions in the Kurnool City of Andhra Pradesh city in October 2009. This paper identified the continuous heavy rainfall within a short period and overflow in Srisailem Dam as the main cause of the flooding in the city. The author highlights the importance of early warning dissemination and the spread of awareness regarding safety measures on time during heavy rainfall and water level projecting towards approaching the flood-like situation.

Price (2008) constructed a paper, “Urban Flood Disaster Management” highlighting the need to manage the urban storm cycle integrated with urban planning. According to the paper urban floods can be mitigated by having a mixture of structural and non-structural strategies selected by the participation of all the stakeholders. Liu et.al (2014) presented a study of the city of Beijing, developing a community-scale simulation model for urban floods and their flow mitigation.

They concluded that the total runoff coefficient was reduced from 100% to 85% and the overall flow was reduced by 8%. As per their studies, the ecological function of urban

ecosystems is enhanced with GI practices. More green infrastructures in urban spaces ensure sustainable living and flood-resilient development practices.

Ajibade et.al (2013) concluded that poverty and poverty and incomes are key drivers of vulnerability in flood. According to him, Women and Children are more vulnerable to men as they are weaker in comparison to men and their roles and responsibilities create a more dangerous situation for women during the flood. The author also analyzed that the harder it is to reconstruct their life after a hazardous event, the more vulnerable they are.

Therefore the objective of the present paper is to Analysis of the differential impact of the flood on communities belonging to various socioeconomic backgrounds in the highly vulnerable regions along Yamuna Bank Delhi.

2. Materials and methods;

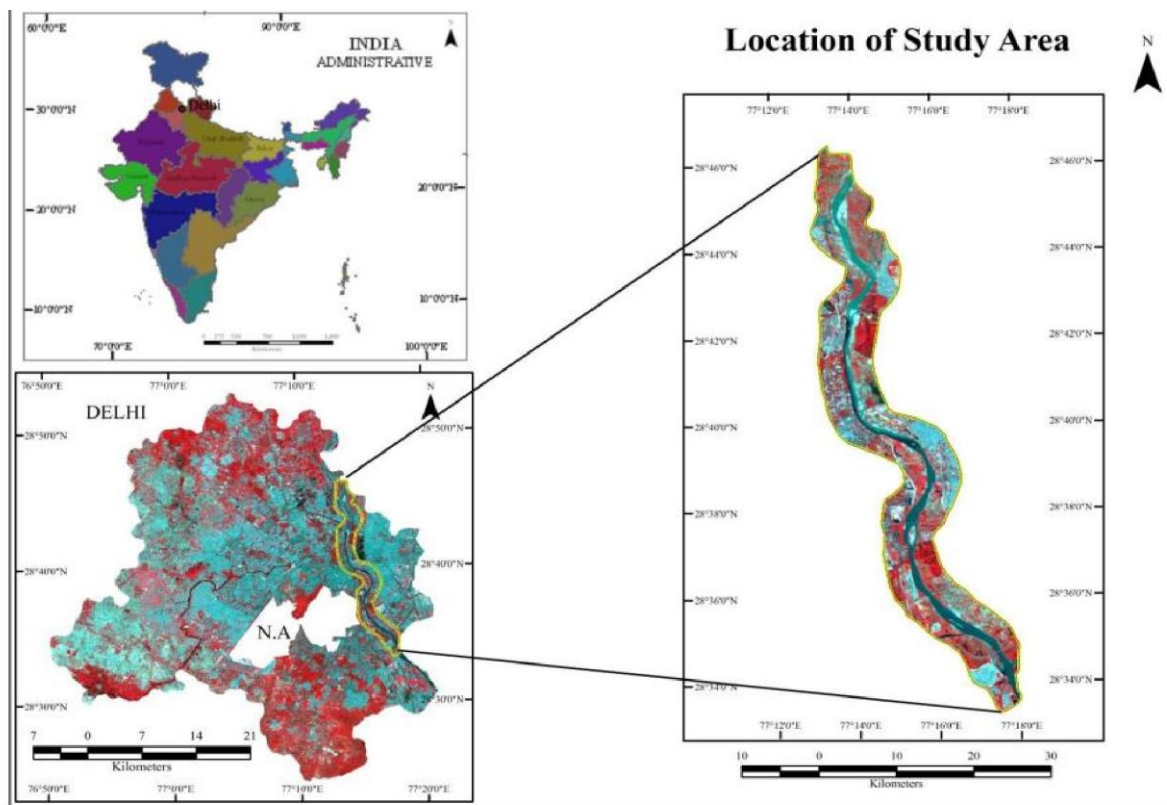
2.1 Study area

The geographical profile of an area influences the vulnerability, susceptibility, and resilience of that area significantly. This also helps in validating the data available in the public domain by comparing it with the data collected in the field and highlighting the changes that took place in the meantime This city is bounded by the Indo-Gangetic alluvial plains in the Northeast, arid desert in the west and Aravalli hills in the south. The study area demarcated for this paper lies in the eastern part of the city which is part of the eastern ridge of Aravalli and extends up to Okhla in the South. The city relies on the river Yamuna for water, religious activities, last rights, and other ethnic beliefs. It enters Delhi near Palla village after a long journey of 224 from Yamunotri to Kalanaur. Delhi segment of the Yamuna River stretches from Okhla Barrage to Wazirabad Barrage. According to the Central water commission, “Whatever water flows in the downstream of Wazirabad barrage is the untreated or partially treated domestic and industrial wastewater contributed through several drains along with the water transported by Haryana Irrigation Department from Western Yamuna Canal (WYC) to Agra Canal via Nazafgarh Drain and the Yamuna. After 22 Km downstream of Wazirabad barrage there is another barrage, barrage Okhla, through which Yamuna water is diverted into Agra Canal for irrigation. A very small quantity of water is allowed to flow through the

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Okhla barrage during the dry season. Whatever water flows in the river beyond the Okhla barrage is mostly contributed through domestic and industrial wastewater generated from East Delhi, Noida, and Sahibabad and joins the river through Shahdara drain” (Central Water Commission). The total catchment area of Yamuna in Delhi encroaches on an area of 1485 sq. km contributing 0.4% of the total Yamuna catchment area of the country. River Yamuna covers a journey of 48 km touching 5 out of 7 constituencies of the National Capital Territory. The most affected districts by the flood are No South-east

STUDY AREA MAP



Physiographical Profile

New Delhi, spread over an area of 42.7 km², is a part of the National Capital Region. These areas were part of the Aravalli range; the remaining part of them is the Delhi Ridge. The area is a landlocked town situated on the flood plains of the Yamuna River. Seismic zone IV and becomes vulnerable to many other disasters like urban floods, heat waves, cold waves, etc. Ecologically, the ridge slows the movement of dust and wind from the desert and has a moderate effect on temperature. The Yamuna River and the Aravalli Hills are the two main geographical features of the city. The Aravalli mountain range is covered with forests that help in maintaining the environment. Yamuna River is the source of drinking water for the residents and a major river.

2.2 Data Source; Based On Primary Survey, 2022

The paper is based on both primary as well as secondary data. Primary data from should be collected through a Questionnaire prepared for the field survey in Google form consisting of 34 questions exploring socio-economic vulnerabilities, resilience, awareness, exposure, and adaptations for flood hazards in the community. A total of 146 respondents were surveyed representing various sections of the society and diverse demography of the study area. Visited various authorities related to disaster management, flood mitigation, and social welfare like NIDM, CWC, DJB, NGO (Hope), etc. to acquire more reliable data and cross-check research analysis. Secondary Data also be used for making quantitative analysis that will give an insight about how these community responders during a flood situation. And Google Scholar from January 2021 to June 2022. A manual search of the references was carried out. Articles from several non-academic sources (e.g. news websites etc.) were also accessed.

3. Result and Discussion;

In the past decade, the Yamuna catchment area passing through Delhi NCR experienced a reoccurring flood. In the last 33 years, the river had crossed the danger line 20 times (DDMA 2014-15). In 2010, floods in the Yamuna River brought huge devastation, causing heavy damage to life and property. In the same flood year, about 169 relief camps had been set up by the government of Delhi to displace people from hundreds of informal households

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submerged in flood water. It was also the year of the commonwealth, and water lodging in posh areas of Khelgaon and Akshardham impacted the international image of the country. Long-term water stagnation in the Khelgaon led to an epidemic like a situation like dengue fever and malaria. Studies clearly state that the frequency of flooding and extent of damage is increasing with time even after taking many structural and nonstructural measures. So, the question that arises here is, what is more responsible for the heavy loss of life and property, the reoccurring flood, or the vulnerability of the society to disasters like a flood? This chapter has been constructed to find the answer to this question and for the achievement of the second objective of this dissertation which is to investigate the socio-economic vulnerabilities of the highly vulnerable flood plain areas identified in the third chapter of this report. A study on “Urban flooding and its management” by the irrigation and flood control department of the Delhi government identified that the Maximum part of East Delhi lies in a flood-prone zone and most vulnerable to flood. In the previous chapter, the Area between the Kashmiri gate to ITO has been demarcated as highly vulnerable area. Flooding is a natural phenomenon; it is unstoppable but can be effectively managed by better planning. Its disastrous impact can be minimized significantly by legalized construction, decreasing the socioeconomic vulnerabilities of the society, and replacing the traditional approach with modernized assessment tools. The author aims to analyze the socio-economic vulnerabilities in highly vulnerable geographical regions.

Cause and Challenges of Delhi floods:

In the second chapter of this report while exploring the geographical profile of the study area we observed that Delhi features moderate rainfall which not very capable of bring flood like situation but the rapid siltation in river bed due to discharge of high amount of untreated waste drastically impacting the drainage capacity. In a recent report published in Time of India the alarming condition of Yamuna has been highlighted. According to the report, “The desired environmental flow in Yamuna should be at least 50% of the total flow available in any season and normal depth should range from 10 feet to 1.1 feet varying across different seasons but the current depth is less than 6 inches as extreme heat dried the river to an extent

of 20 km.” (Times of India, 2022). Decreasing depth implies to decrease in the drainage capacity and storm water capacity leading to drastic seasonal floods.

According to a report published by TERI, vulnerabilities of megacities like New Delhi multiplied in recent years due to following reasons:

- Unpredictable rainfall o Unplanned mindless urbanisation
- Unauthorized encroachment along natural drainage system.
- Sprawling illegal colonies beyond prohibited O-zone of Yamuna floodplain: ex: Geeta colony, okhla
- Over concretisation of surface leads to loss of permeability and surface runoff.
- Unwatched filling of urban lakes and floodplains to turn into high value urban land.

Construction of high value built-up like Akshardham Metro station, Akshardham temple, sports complex and 400 KV substations in the flood zones multiplied the vulnerability of the region many folds and it is a clear example of short sightless of authorities and open invitation to major disaster. A long-term battle has been going between National Green Tribunal (NGT) and DTC (Delhi Transport Corporation)

The bus depot set up near Akshardham during the Common Wealth Games is significantly increasing the Biochemical Oxygen Demand of Yamuna water, which is contributing to the eutrophication of the river. According to the committee report released by NGT, “Yamuna releases 20 kilo liters of treated wastewater from sewage treatment plant to wash thousands of buses and huge amount of dirty water, engine oil, fuel and chemicals goes into the river which is dangerous. Already asked for narrowing of Yamuna floodplain and immediate shifting of bus depot.

Field Survey

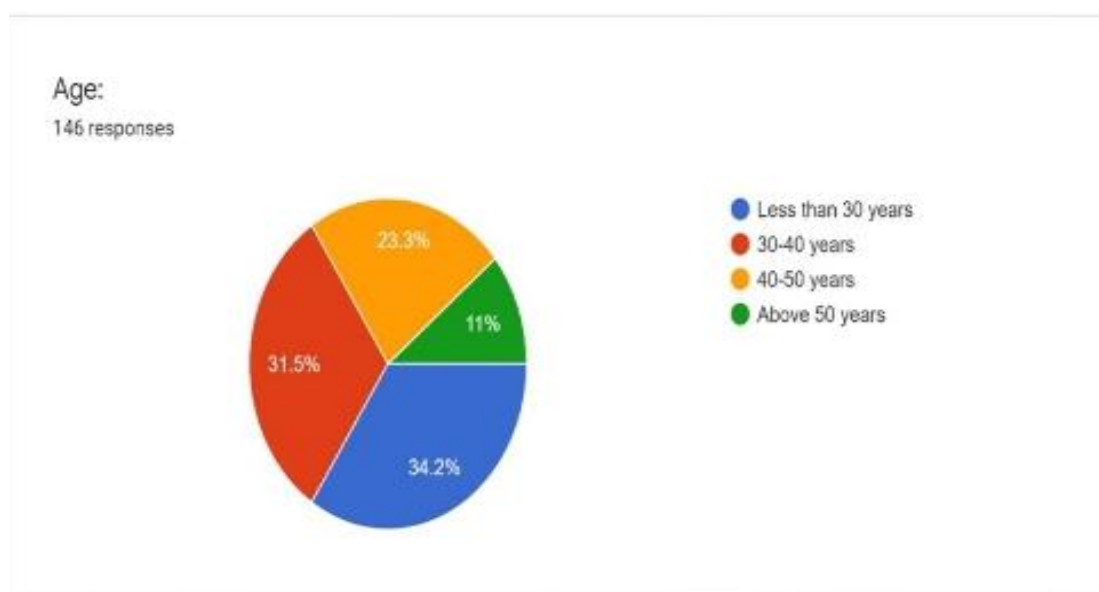
A field survey has highly vulnerable been conducted using stratified random sampling technique in the areas: Wazirabad, okhla, Akshardham, Geeta Colony and ITO. Total 34 question were included in the digital questionnaire considering various indices of socio

economic vulnerability prepared on google forms and response of a sample size of 146 respondent have been included in the discussion of this chapter

• **SAMPLING PROFILE**

Age

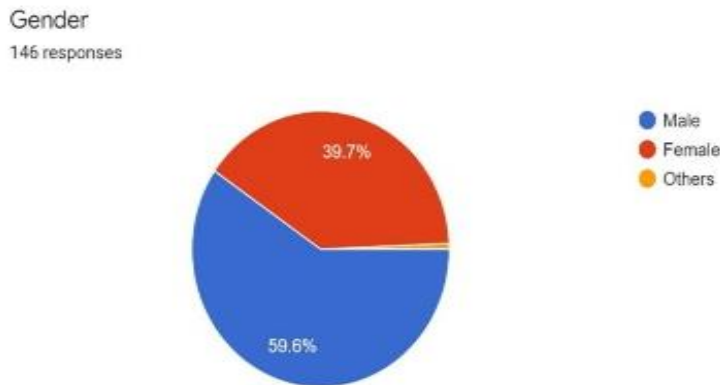
: Total 146 respondent of different age group participated in the survey. Age of majority of the respondent that is 34.5% was less than 30 years where group and 11% were aged more than 50 years.



Data Source; Based On Primary Survey, 2022

Gender

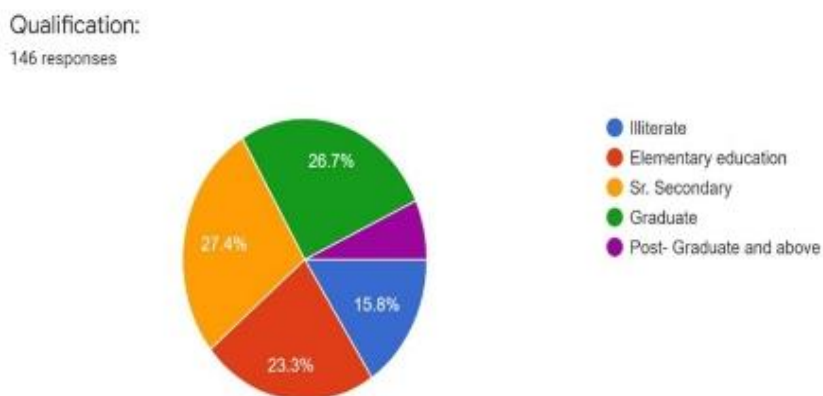
59.3% male participated in the where 40% was the female respondents. Out of 146 respondents 86 were male, 58 were female and 1 was from third gender.



Data Source; Based On Primary Survey, 2022

Qualification

Qualification was satisfyingly diverse in sample size. Majority were qualified to senior secondary that is 27.4% of the respondent where 15% was illiterate. Only 1 respondent among all was post graduate and working as High school teacher. Almost similar proportion of Elementary level educated and graduated respondent participated.

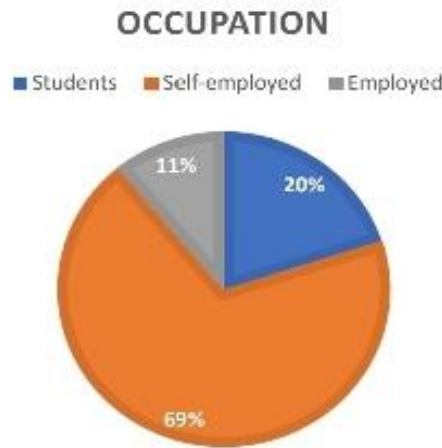


Data Source; Based On Primary Survey, 2022

Occupation

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It was kept as an open question in the questionnaire for the continence of the responders and to know the job profile each responder. Later, it is categorised into three major of employment status manually by the surveyor to broadly analyse the employment composition of the region. The three categories were student, Employed and self-employed.

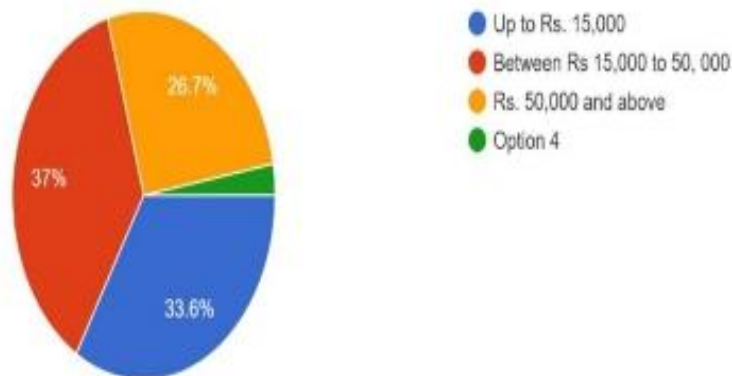


Data Source; Based On Primary Survey, 2022

Monthly Income

Income plays major role in deciding the extent of vulnerability of a household. Lower income group has less savings, less financial safety, lower chance of successful rehabilitation, hence, more vulnerability due low coping mechanism. In this survey data of monthly family income has been collected to analyse the financial vulnerability of the study area. Majority of the respondents falls into middle income group followed by low-income group that is 37% and 33.6% respectively. 26.7% of the respondent belong to high income group and out of 146, 4 respondent who are female, don't know their family monthly income.

Monthly Family Income
146 responses



Data Source; Based On Primary Survey, 2022

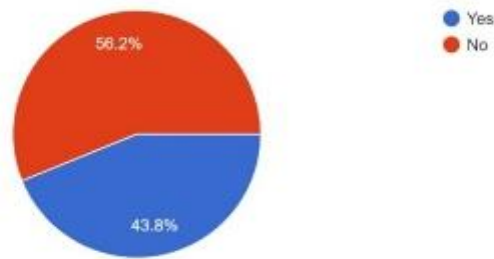
• SOCIO-ECONOMIC CONDITION:

To analyse the physical and social element at risk, it is essential to gather idea about the socio-economic condition of the sample.

Property Ownership status

Majority of the respondent (56.2%) found to be living in rented property migrated to Delhi in this decade and percentage of property owners are 43.8% which significant in terms of property risk. These properties were found to be in highly vulnerable zones like Geeta colony, Akshardham, okhla vihar etc. that implies their hard earn money and years of savings invested in highly vulnerable properties that can degrade their socioeconomic status any time.

Do you own the property?
146 responses

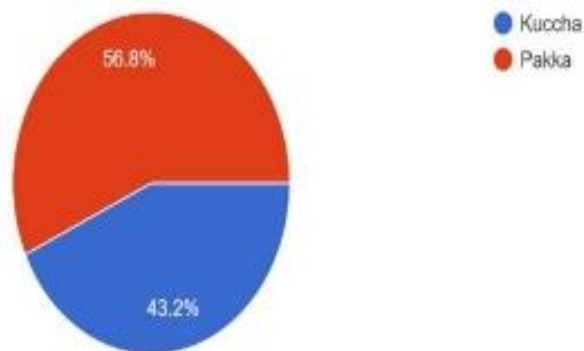


Data Source; Based On Primary Survey, 2022

Type of Accommodations and Dwelling:

Structurally Pacca Structure is more resilient in comparison of kaccha structure. Concrete house can endure more water for long time than kachha structure. In the survey it was found that Majority of respondent lives in pukka houses due to various government schemes and upgradation of the economic condition of the household. These people mainly dwell in colonies and apartments settled in Akshardham, Pandav Nagar, small pockets of Wazirabad. But majority of the houses were not constructed according to guidelines. They were compact, unorganized and built just for the shake of accommodation or rent purpose except some posh apartments. Rest 43.2% were accommodating kuccha structures in compact slums and area around Yamuna floodplain in okhla where mainly farmers and farm labourers live for vegetation cultivation.

Type of Accommodation
146 responses



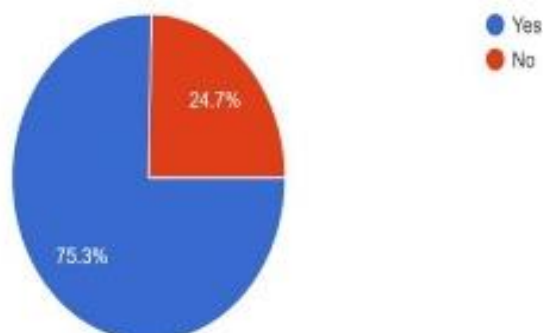
Data Source; Based On Primary Survey, 2022

IMPACT OF FLOODING

Experience of Flood or water logging

As observed in the process of constructing this paper, riverine floods are experienced after 2 to 5 years of duration in Delhi but short-term rainwater flooding is experienced every once or twice in year. In the survey, 75.3% of respondent experienced flooding while 24.7% experienced no flood like situation.

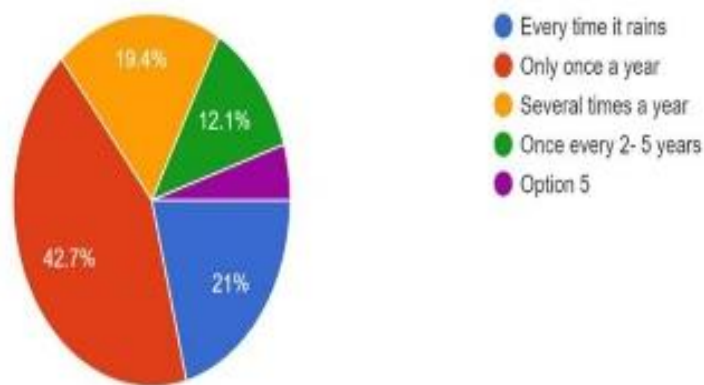
Does rainwater cause flooding or ponding on your property or road frontage?
146 responses



Data Source; Based On Primary Survey, 2022

Time period of flooding

Total 42.7% of respondent experienced flooding in every rainy season due rainwater logging and drainage overflow while 12.1% experienced it in 2 to 5 years due to overflow of river while 21% have experienced it every time it rains.



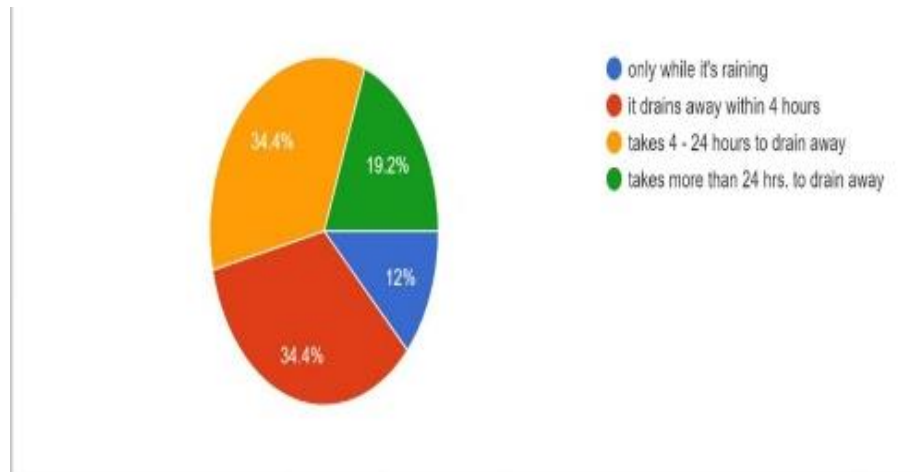
Data Source; Based On Primary Survey, 2022

Duration of water logging

A sum of 68.8% of respondent said that water log clears between 4-24hrs where 19.2% said it stays for more than 24hrs and 12% said after rain ends water also clears along.

A female respondent named Suman Bharti who work as a house help stated that, “Paani ghar ke andar rehta hai jab tak hum balti se nahi nikalte, sara kaam cchor kar pura family isi me laga rehta hai barish ke time kyunki paani rehta hai to na toilet jaa pate hain na khana bana paate aur kaam par bhi nahi jaa pate” meaning water only clears from their house when they manually remove it using buckets and it hold their life for the whole day. The more water stays, the more issues arise, water stagnation for long duration leads to epidemic like situation, weaking the house, damaging properties, obstructing essential services like

transportation, supply of food and water, medical facilities etc. making the area more vulnerable to big disasters.



Data Source; Based On Primary Survey, 2022

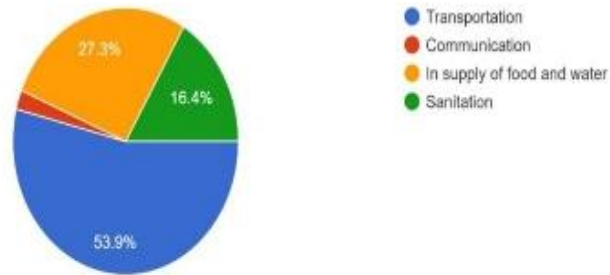
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What prior obstructions you face during water lodging ?

128 responses



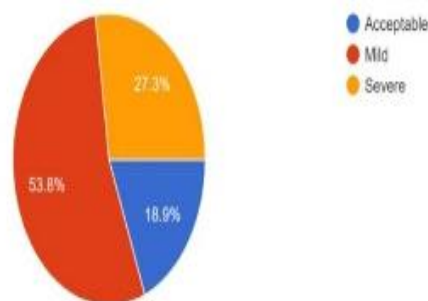
Data Source; Based On Primary Survey, 2022

Extent of severity of flood

Half of the respondent (53.8%) rated their flooding situation as mild while for 27.3% it was severe and 18.9% have no issues who belong to high income group.

How would you rate your flooding problem?

131 responses



Data Source; Based On Primary Survey, 2022

FINDINGS

- The study area geographically and topographically, covers an area of 9.32 sq km from Kashmere Gate to ITO, which is 26.65% of the total Yamuna catchment area of Delhi-NCR, which has been identified as a flood-prone area.

- Due to the water logging area, since 2010, we face flood disasters in recent years.
- During the survey it was found that most of the slums in Okhla and Geeta Colony on the O-Zone side of the Yamuna floodplain are migrant labour communities.
- These communities are affected by low literacy, low income, and crude housing with minimal intervention from the administration.
- On the other hand, the socio-economic condition appears to be more advanced in the small colonies of Okhla and ITO, some distance from the flood plains. • Semi-pucca to pucca houses have been constructed here through government schemes, but the houses are small and haphazardly constructed.
- Being built below street level makes the house more vulnerable to frequent water logging inside the house.

SUGGESTIONS:

- There is a need to incorporate advanced scientific methods for flood management.
- NIDM needs to start building capacity in different languages at the ground level.
- There is a need to rehabilitate unauthorized settlements in Geeta Colony, Okhla, Wazirabad.
- There is a need to promote capacity building and adaptation at the community level by removing people's dependence on government schemes and compensation.
- A community-oriented approach is needed.
- There is a need to give different approaches to mitigation to women, the elderly, and children.
- It is necessary to tell the indirect effect of environmental degradation. NGOs are more trusted in these areas than authorities, these organisations need to be actively included in the capacity building.

- Compensation can be made more accessible by checking and removing middlemen through the involvement of volunteers like ASHA and Angan Vari Sevika.
- Regular campaigning and creative advertisement can aware people of disaster mitigation and environmental awareness.
- Plans should be more simplified, accessible, and visible on the field rather than just confined to official papers and university webinars.

The collaborative approach of NGO and State:

- State can build trust among the people with the help of NGOs like Anthropos India Foundation doing commendable work in the upliftment of the marginalised section and promoting more research on anthropogenic activities.
- NGOs can bridge the gap between policies on paper and its implementation on the ground.
- Illegal settlement is the major hurdle in the flood mitigation, the state government should work with the centre in the impactful implementation of Awas Adhikar Yojna which aims to legalise the settlement in the O-II Zone of the floodplain but this scheme has many loopholes which can be misused by affluent section of the society.

Summary & Conclusion

Every year during the monsoon, the Yamuna River spill emerges as a major challenge for the national Capital. The alarming bio-physical, environmental and socio-economical vulnerability of the eastern suburbs of Delhi-NCR has led the base for this study. Increasing annual revenue loss and expenses in the post-disaster process motivated the objective of this paper to analyse and investigate the major issues and challenges behind the failure of the existing mechanism. After using two different methodologies for the gradual achievement of two objectives aimed for the study, we obtained a Flood Vulnerability Map zoning out the highly vulnerable areas and Socio-Economic Vulnerabilities among communities living in identified areas by conducting a field survey through a digital questionnaire. After analysis

Knowledgeable Research, Vol.1, No.10, May 2023, ISSN: 2583-6633, Vijay Jayswal & Ashna Gargi.

and discussion, Okhla, Geeta colony, Wazirabad, ITO and Akshardham has been identified as the most vulnerable to flood geographically by integrating thematic layers of Agriculture land, Forest area, settlement, elevation and roads in GIS using the AHP technique. Further, these marked areas have been chosen for field surveys to observe socio-economic vulnerabilities based on the various socioeconomic indices like literacy, sex ratio, income, dwelling units, awareness, resilience, adaptation, administrative interventions etc. (Refer to chapters 3&4) After a thorough discussion of the result obtained, it is clearly observed that the human factor is dominated over geographical factors responsible for the high vulnerability of the study area. Impacts of flood include widespread desertification due to thick sand deposition, inundation of valuable agricultural land along with infrastructure and property loss. Ignorance of people and authorities is the major cause of the misery. The marginalised section is more vulnerable in comparison to the middle-income group due to a lack of financial savings and backups. Socially, Women appeared to be overburdened with the extra responsibility of clearing the water, taking care of elders and kids during waterlogging, staying in contaminated water for a long time during their menstruation during heavy rains etc. This paper is concluding its study in this final chapter highlighting major findings and suggestions.

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