

**Preparing a framework to mitigate impacts of urban floods:
A case of Greater Hyderabad**

*Thesis submitted in partial fulfilment of the requirements for the award of
the degree of*

MASTER OF PLANNING (ENVIRONMENTAL PLANNING)

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2019MEP004

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May, 2021

DECLARATION

I **Supriti Das**, Scholar No. **2019MEP004**, hereby declare that the thesis titled “**Preparing a framework to mitigate impacts of urban floods: A case of Greater Hyderabad**” submitted by me in partial fulfillment for the award of Master of Planning (Environmental Planning), at School of Planning and Architecture, Bhopal, India, is a record of bonafide work carried out by me. The matter/result embodied in this thesis has not been submitted to any other University or Institute for the award of any degree or diploma.



Signature of the Student

Date: 20th May 2021

CERTIFICATE

This is to certify that the declaration of **Supriti Das** is true to the best of my knowledge and that the student has worked under my guidance for one semester in preparing this thesis.

RECOMMENDED



Signature of the
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ACCEPTED



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Place: Bhopal

Acknowledgement

This thesis is an outcome of combined efforts. This thesis work couldn't have been possible without the support, co-operation and efforts of various people who came up to contribute in different ways at different phases during the research work. There are few organizations and countless people who directly or indirectly helped me in successfully carrying out the study. I want to extend my gratitude and thank each one of them from the bottom of my heart because each and every one of them and their efforts matter as it has in some way or the other added value to this research.

I would first like to extend my gratitude to this very institute; School of Planning and Architecture, Bhopal that gave me this opportunity to conduct such a research as a part of fulfilment of the requirements for the award of the degree of Master of Environmental Planning. The institute has given me endless opportunities to learn, observe and implement all my learning to the best of my capability. A very special thing that I have experienced in the institute is its practical, market-oriented and state of art approach in all fronts.

The staff and faculty are highly supportive as well as co-operative and they all have helped me in some way or the other in the span of two years. During thesis, all the faculty members have actively been involved in the process and for this I would like to whole heartedly thank all of them. Starting from the director of our institute, Prof. N. Sridharan who has been there to guide us with all his experiences and knowledge that has proved to be the best suggestion I have received. I can never be grateful enough to thank our Head of Department, Dr. Rama Pandey who has been there for all of us in the toughest of times, our thesis co-ordinators Mr. Shomit Dilip Bade and Mr. Anurag Bagade who have been our constant support as well as guided us all and have always encouraged us to the best of their capabilities in order to bring out the best in us.

This Thesis would nearly have been impossible without the guidance of my thesis mentor, Mr. Govind M.P., one who always had my back and has been there to help, motivate, encourage, suggest and guide me. Most of the times I felt lost and helpless being at home and working in this tough, isolated, pandemic situation. He has been a very special part of this research through his countless and

endless contributions. Sir, I sincerely thank you for all your efforts that have pushed me to perform better than usual.

Not to forget peer members, my entire batch mates (MEP 2019-2021) as they all have indirectly been part of this thesis. A batch that unfortunately had to complete our study being at home, we all had each other's support round the clock. Though all my batch mates have helped me carry out this work and remain sane during all these months but I would like to thank my friend Ishani Garg who has been my constant support from graduation to post-graduation, Shreeya Deosant who has been my tech-savvy friend among many others. Also family has been the greatest support during my thesis as numerous times I lost all hopes and temper due to working in isolation but luckily they have kept me going.

Several other individuals have helped me in collecting the required data and information from various sources and places. I am thankful to Prof. Umamahesh N V (Civil Engineering department, NIT Warangal), Mr. Sagar Kumar (PhD Scholar, NIT Warangal), Mr. Lokesh Kumar D.S. (Commissioner, GHMC) and his personal staffs who have supported me throughout the data collection process, Mr. Bhaskar Reddy (Senior Engineer, SNDP, GHMC), Mr. Dashrat (SNDP, GHMC) and Mr. Shetty (PA to Project Manager, GHMC) who had also helped me in conducting surveys and identifying stakeholders. I would also like to thank all those who have patiently co-operated with me during the field visits because without them this study would have not been possible.

Last but not the least, I would like to thank God for making me what I am today, giving me all the strength, for giving me the opportunity to be able to contribute to the society with this piece of work.

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EXECUTIVE SUMMARY

In current situation where population is increasing at an alarming rate along with a paradigm shift in their choice, way and standard of living are together exerting pressure on nature and natural resources. According to United Nations report on World Urbanisation, India is urbanizing at a pace like never before and this is constantly showing a higher number of urban populations than in its past. With increasing urban population and enhanced urbanization, cities are equally getting exposed and vulnerable to various events of disaster; out of which flood is one of the most prominent and frequent disaster that not just possess problem to vulnerable communities but also pulls back the nation economically by a couple of years. Thus, addressing urban floods and mitigating its impacts has become the need of an hour.

Cities vulnerable to flood requires comprehensive mitigation strategies that should not only be management centric but also focus on mitigation because urban floods are sudden and uncertain as seen in case of various Indian cities in the recent past. Since extreme events are rare, proactive and progressive mitigation strategies become way more important than passive management and mitigation; it is cost effective in long run and easy to execute as well. It has been observed that urban transformation along with excessive flood control and management contributes to urban floods as they fail to address and accommodate sudden and unpredictable hazardous, i.e. there is no room for residual risk, especially in case of flooding. To control and mitigate the impacts of flood is one of the ways to achieve urban resilience which will enhance city's capacity to accommodate and recover from physical and socio-economic destructions caused by the disastrous shocks. Changes in the physical appearance and social composition of cities and its adjacent areas are common. The dramatic pace of demographic, economic and social change is alarming in most cities of developing nations and these overburdens local authorities' ability to provide urban services which is immediately needed in unfortunate events of disaster. This is where comes the significant role of the communities, citizens and administrators who are also the first responders to any disaster that hits the city. This research would study and analyse the communities and their significant role

in mitigating urban floods so as to enhance city resilience and further contribute in achieving Sustainable development goals.

Urban flooding is one of the major problems in various parts of the world and is also one of the most prominent and the occurrence of numerous catastrophic events each year, especially in coastal cities. While an urban flood is a natural disaster that cannot be prevented, it can be managed and mitigated. Flood losses, on the other hand, can be avoided with proper flood management and mitigation planning. Though many researchers like to believe that floods are never natural, rather it is an outcome of various anthropogenic activities such as encroaching low lying areas, illegal dumping, and concretization of wetlands and so on. Urban flooding is described as the inundation of land or property in urban areas as a result of uneven rainfall distribution, massive urbanization, and a lack of proper drainage.

Flood is a situation of water overflow that submerges land which is otherwise dry. All such situations are mostly devastating in terms of life and property. According to World Disaster Report published by IFRC, flood constitutes the largest percent of all known disasters and it adds significantly to social, cultural, economic and ecological losses, especially in developing nations because of their poor adaptation and mitigation strategies. In line with the same, this research would focus up on urban flooding as well as its associated aspects and how it can be minimized through progressive and proactive approach.

As in recent times, we have either seen or at least heard about various urban floods in India such as Chennai floods, Kerala floods, and Hyderabad floods and also for several cities in Ganga and Brahmaputra basin. Urban flooding is now an annual and recurring phenomenon and event. Since urbanization contributes to established catchments, which raises flood peaks and flood volumes, urban flooding differs greatly from rural flooding. Urban areas are heavily populated, and people who live in flood-prone areas suffer as a result of flooding, which can result in death. It is not only the occurrence of flooding that causes human suffering, but also the secondary impact of infection, which results in loss of livelihood and, in severe cases, death. Urban areas are also hubs of economic activity, with critical infrastructure that must be safeguarded at all times. Damage

to critical infrastructure in most cities has ramifications not only for the state and country, but also for the entire world. In India's major cities, there has been a loss of life and property, as well as disruptions in transportation and electricity, as well as the occurrence of epidemics. As a result, the mitigation and control of urban flooding must be prioritized. The rising pattern of urban flooding is a global phenomenon, with issues ranging from minor occurrences to major disasters, resulting in cities being inundated for hours to days at a time.

With the rapid urbanization phenomenon, arise more challenges. Well planned city is something that we need in the current times. In India, flooding in urban areas is becoming a common problem leading to the destruction of life, property and livelihood of substantial amount. In India, floods are becoming more serious, unpredictable, and difficult to control. Floods caused over Rs. 950 billion in damages in India alone in 2018. Urban floods are becoming more common, owing to inadequate drainage and the encroachment of old water bodies in cities and towns.

Despite the fact that many organizations are involved in flood protection, there is a strong lack of cooperation in flood prevention, as well as exclusion of vulnerable communities. Since the public are not involved in the planning and management process, thus their vernacular knowledge is left unused and unheard and as a result, their resilience is hampered. Public participation is an important dimension of planning and management process as they are the first to respond. During the disasters, communities are the first responders, may it be floods or any other event. Here comes the role of individual residents and the communities living in the vulnerable areas. It is therefore vital to at least make the vulnerable communities aware by enhancing their capacities to coping with the disaster. Urban institutions and societies that are adaptive should be able to embrace, fight, heal, and learn from incidents. The aim of this study is to enhance and strengthen urban structures and communities' capacity in each part and step of the flood risk management process, which includes actions such as preparedness, response, and recovery. With this research, certain aspects of flood risk management would be developed through community resilience, such as Reflect, Relief, Resist, Response, and Recovery by proposing a citizen-centric flood management framework to mitigate the flood impacts through an inclusive

and progressive approach. The ultimate aim of this research would be to promote and increase public participation in flood control and management in order to contribute in a way to achieve SDGs.

कार्यकारी सारांश

वर्तमान स्थिति में जहां जनसंख्या खतरनाक दर से बढ़ रही है, साथ ही उनकी पसंद, जीवन स्तर और जीवन स्तर में बदलाव के साथ-साथ प्रकृति और प्राकृतिक संसाधनों पर दबाव डाला जा रहा है। विश्व शहरीकरण पर संयुक्त राष्ट्र की रिपोर्ट के अनुसार, भारत पहले जैसी गति से शहरीकरण कर रहा है और यह लगातार अपने अतीत की तुलना में अधिक शहरी आबादी दिखा रहा है। बढ़ती शहरी आबादी और बढ़ते शहरीकरण के साथ, शहर समान रूप से उजागर हो रहे हैं और आपदा की विभिन्न घटनाओं के प्रति संवेदनशील हो रहे हैं; जिनमें से बाढ़ सबसे प्रमुख और लगातार होने वाली आपदाओं में से एक है, जो न केवल कमजोर समुदायों के लिए समस्या है, बल्कि कुछ वर्षों में देश को आर्थिक रूप से पीछे खींचती है। इस प्रकार, शहरी बाढ़ को संबोधित करना और इसके प्रभावों को कम करना एक घंटे की आवश्यकता बन गई है।

बाढ़ की चपेट में आने वाले शहरों को व्यापक शमन रणनीतियों की आवश्यकता होती है जो न केवल प्रबंधन केंद्रित होनी चाहिए बल्कि शमन पर भी ध्यान केंद्रित करना चाहिए क्योंकि शहरी बाढ़ अचानक और अनिश्चित होती है जैसा कि हाल के दिनों में विभिन्न भारतीय शहरों के मामले में देखा गया है। चूंकि चरम घटनाएं दुर्लभ हैं, सक्रिय और प्रगतिशील शमन रणनीतियां निष्क्रिय प्रबंधन और शमन की तुलना में अधिक महत्वपूर्ण हो जाती हैं; यह लंबे समय में लागत प्रभावी है और निष्पादित करने में भी आसान है। यह देखा गया है कि अत्यधिक बाढ़ नियंत्रण और प्रबंधन के साथ शहरी परिवर्तन शहरी बाढ़ में योगदान देता है क्योंकि वे अचानक और अप्रत्याशित खतरनाक को संबोधित करने और समायोजित करने में विफल रहते हैं, यानी अवशिष्ट जोखिम के लिए कोई जगह नहीं है, खासकर बाढ़ के मामले में। बाढ़ के प्रभावों को नियंत्रित करने और कम करने के लिए शहरी लचीलापन हासिल करने के तरीकों में से एक है जो विनाशकारी झटकों के कारण होने वाले भौतिक और सामाजिक-आर्थिक विनाशों से समायोजित और उबरने के लिए शहर की क्षमता को बढ़ाएगा। शहरों और उसके आस-पास के क्षेत्रों के भौतिक स्वरूप और

सामाजिक संरचना में परिवर्तन आम हैं। जनसांख्यिकीय, आर्थिक और सामाजिक परिवर्तन की नाटकीय गति विकासशील देशों के अधिकांश शहरों में खतरनाक है और इससे स्थानीय अधिकारियों की शहरी सेवाएं प्रदान करने की क्षमता पर असर पड़ता है जो आपदा की दुर्भाग्यपूर्ण घटनाओं में तत्काल आवश्यक है। यह वह जगह है जहां समुदायों, नागरिकों और प्रशासकों की महत्वपूर्ण भूमिका आती है जो शहर में आने वाली किसी भी आपदा के पहले प्रतिक्रियाकर्ता भी होते हैं। यह शोध शहरी बाढ़ को कम करने में समुदायों और उनकी महत्वपूर्ण भूमिका का अध्ययन और विश्लेषण करेगा ताकि शहर के लचीलेपन को बढ़ाया जा सके और सतत विकास लक्ष्यों को प्राप्त करने में योगदान दिया जा सके।

शहरी बाढ़ दुनिया के विभिन्न हिस्सों में प्रमुख समस्याओं में से एक है और यह हर साल सबसे प्रमुख और कई विनाशकारी घटनाओं में से एक है, खासकर तटीय शहरों में। जबकि शहरी बाढ़ एक प्राकृतिक आपदा है जिसे रोका नहीं जा सकता है, इसे प्रबंधित और कम किया जा सकता है। दूसरी ओर, बाढ़ के नुकसान को उचित बाढ़ प्रबंधन और शमन योजना के साथ टाला जा सकता है। हालांकि कई शोधकर्ता यह मानना पसंद करते हैं कि बाढ़ कभी भी प्राकृतिक नहीं होती है, बल्कि यह विभिन्न मानवजनित गतिविधियों का परिणाम है जैसे कि निचले इलाकों का अतिक्रमण, अवैध डंपिंग और आर्द्रभूमि का कंक्रीटीकरण आदि। शहरी बाढ़ को शहरी क्षेत्रों में असमान वर्षा वितरण, बड़े पैमाने पर शहरीकरण और उचित जल निकासी की कमी के परिणामस्वरूप भूमि या संपत्ति की बाढ़ के रूप में वर्णित किया गया है।

बाढ़ पानी के अतिप्रवाह की स्थिति है जो भूमि को जलमग्न कर देती है जो अन्यथा सूखी होती है। ऐसी सभी स्थितियां जीवन और संपत्ति के मामले में अधिकतर विनाशकारी होती हैं। IFRC द्वारा प्रकाशित विश्व आपदा रिपोर्ट के अनुसार, बाढ़ सभी ज्ञात आपदाओं का सबसे बड़ा प्रतिशत है और यह सामाजिक, सांस्कृतिक, आर्थिक और पारिस्थितिक नुकसान में महत्वपूर्ण रूप से जोड़ता है, विशेष रूप से विकासशील देशों में उनके खराब अनुकूलन और शमन रणनीतियों के

कारण। उसी के अनुरूप, यह शोध शहरी बाढ़ के साथ-साथ इससे जुड़े पहलुओं पर ध्यान केंद्रित करेगा और इसे प्रगतिशील और सक्रिय दृष्टिकोण के माध्यम से कैसे कम किया जा सकता है।

जैसा कि हाल के दिनों में, हमने भारत में विभिन्न शहरी बाढ़ों के बारे में देखा है या कम से कम सुना है जैसे चेन्नई बाढ़, केरल बाढ़, और हैदराबाद बाढ़ और गंगा और ब्रह्मपुत्र बेसिन के कई शहरों के लिए भी। शहरी बाढ़ अब एक वार्षिक और आवर्ती घटना और घटना है। चूंकि शहरीकरण स्थापित जलग्रहण क्षेत्रों में योगदान देता है, जो बाढ़ की चोटियों और बाढ़ की मात्रा को बढ़ाता है, शहरी बाढ़ ग्रामीण बाढ़ से बहुत भिन्न होती है। शहरी क्षेत्र भारी आबादी वाले हैं, और बाढ़ प्रभावित क्षेत्रों में रहने वाले लोग बाढ़ के परिणामस्वरूप पीड़ित होते हैं, जिसके परिणामस्वरूप मृत्यु हो सकती है। यह न केवल बाढ़ की घटना है जो मानव पीड़ा का कारण बनती है, बल्कि संक्रमण का द्वितीयक प्रभाव भी है, जिसके परिणामस्वरूप आजीविका का नुकसान होता है और गंभीर मामलों में मृत्यु भी होती है। शहरी क्षेत्र भी आर्थिक गतिविधियों के केंद्र हैं, महत्वपूर्ण बुनियादी ढांचे के साथ जिन्हें हर समय सुरक्षित रखा जाना चाहिए। अधिकांश शहरों में महत्वपूर्ण बुनियादी ढांचे को नुकसान न केवल राज्य और देश के लिए, बल्कि पूरी दुनिया के लिए भी प्रभाव डालता है। भारत के प्रमुख शहरों में जान-माल का नुकसान हुआ है, साथ ही परिवहन और बिजली में व्यवधान के साथ-साथ महामारी की घटना भी हुई है। नतीजतन, शहरी बाढ़ के शमन और नियंत्रण को प्राथमिकता दी जानी चाहिए। शहरी बाढ़ का बढ़ता पैटर्न एक वैश्विक घटना है, जिसमें छोटी-छोटी घटनाओं से लेकर बड़ी आपदाओं तक के मुद्दे हैं, जिसके परिणामस्वरूप शहर एक समय में घंटों से लेकर दिनों तक जलमग्न रहते हैं।

तेजी से शहरीकरण की घटना के साथ, और अधिक चुनौतियां पैदा होती हैं। सुनियोजित शहर एक ऐसी चीज है जिसकी हमें वर्तमान समय में आवश्यकता है। भारत में, शहरी

क्षेत्रों में बाढ़ एक आम समस्या बनती जा रही है जिससे जीवन, संपत्ति और पर्याप्त मात्रा में आजीविका का विनाश हो रहा है। भारत में, बाढ़ अधिक गंभीर, अप्रत्याशित और नियंत्रित करने में कठिन होती जा रही है। करोड़ रुपये से अधिक की बाढ़ अकेले भारत में 2018 में 950 बिलियन का नुकसान हुआ। अपर्याप्त जल निकासी और शहरों और कस्बों में पुराने जल निकायों के अतिक्रमण के कारण शहरी बाढ़ अधिक आम होती जा रही है।

इस तथ्य के बावजूद कि बाढ़ सुरक्षा में कई संगठन शामिल हैं, बाढ़ की रोकथाम में सहयोग की भारी कमी है, साथ ही कमजोर समुदायों को बाहर करना भी है। चूंकि जनता नियोजन और प्रबंधन प्रक्रिया में शामिल नहीं है, इस प्रकार उनका स्थानीय ज्ञान अप्रयुक्त और अनसुना रह जाता है और परिणामस्वरूप, उनकी लचीलापन बाधित होता है। जन भागीदारी योजना और प्रबंधन प्रक्रिया का एक महत्वपूर्ण आयाम है क्योंकि वे सबसे पहले प्रतिक्रिया देते हैं। आपदाओं के दौरान, समुदाय सबसे पहले प्रतिक्रिया करते हैं, चाहे वह बाढ़ हो या कोई अन्य घटना। यहां व्यक्तिगत निवासियों और कमजोर क्षेत्रों में रहने वाले समुदायों की भूमिका आती है। इसलिए यह महत्वपूर्ण है कि कम से कम कमजोर समुदायों को आपदा से निपटने के लिए उनकी क्षमताओं को बढ़ाकर जागरूक किया जाए। शहरी संस्थान और समाज जो अनुकूल हैं, उन्हें घटनाओं को गले लगाने, लड़ने, चंगा करने और सीखने में सक्षम होना चाहिए। इस अध्ययन का उद्देश्य बाढ़ जोखिम प्रबंधन प्रक्रिया के प्रत्येक भाग और चरण में शहरी संरचनाओं और समुदायों की क्षमता को बढ़ाना और मजबूत करना है, जिसमें तैयारी, प्रतिक्रिया और पुनर्प्राप्ति जैसे कार्य शामिल हैं। इस शोध के साथ, एक समावेशी और प्रगतिशील दृष्टिकोण के माध्यम से बाढ़ के प्रभावों को कम करने के लिए एक नागरिक केंद्रित बाढ़ प्रबंधन ढांचे का प्रस्ताव करके सामुदायिक लचीलापन, जैसे प्रतिबिंब, राहत, प्रतिरोध, प्रतिक्रिया और पुनर्प्राप्ति के माध्यम से बाढ़ जोखिम प्रबंधन के कुछ पहलुओं को विकसित किया

जाएगा। इस शोध का अंतिम उद्देश्य बाढ़ नियंत्रण और प्रबंधन में सार्वजनिक भागीदारी को बढ़ावा देना और बढ़ाना होगा ताकि एसडीजी हासिल करने के लिए एक तरह से योगदान दिया जा सके।

CHAPTER 1: INTRODUCTION

The chapter begins with the introduction of the research topic along with the basics so as to understand the background, problems, gaps and other associated factors. Introduction is comprehensively covered as it is the foundation for the entire research and thus it has been inferred and taken up mostly from publications, researches and various reports.

1.1. Background

Urban flooding is a major problem in many parts of the world, as well as one of the most visible and recurrent natural disasters that occur every year, especially in coastal cities. While an urban flood is a natural disaster that cannot be prevented, it can be managed and its effects reduced if sufficient precaution is taken at the right time. Hence, the losses associated with such disasters could be prevented by proper, proactive and inclusive flood management along with practical mitigation planning (Kulkarni, 2018). Urban flooding is described as the inundation of land or property in urban areas as a result of uneven rainfall distribution, massive urbanization, and a lack of proper drainage.

As in recent times, we have either seen or at least heard about various urban floods in India such as Chennai floods, Kerala floods, and Hyderabad floods and also for cities in Ganga and Brahmaputra basin. Urban flooding is now an annual and recurring phenomenon and event.

Since urbanization contributes to modified and established catchments, which raises flood peaks and flood volumes, urban flooding differs dramatically from rural flooding. Since urban areas are heavily populated, there are more people living in vulnerable areas than in rural areas, and as a result, they suffer from flooding, which can result in death. Human suffering is caused not only by floods, but also by the secondary effect of infection, which results in loss of life and, in extreme cases, death. Urban areas are also hubs of economic activity, with critical infrastructure that must be safeguarded at all times. Damage to critical infrastructure in most cities has ramifications not only for the state and country, but also for the entire world. In India's major cities, there has been a loss of life and property, as well as disruptions in transportation and electricity, as well as

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the occurrence of epidemics. As a result, the mitigation and control of urban flooding must be prioritized. The rising pattern of urban flooding is a global phenomenon that presents a significant challenge to urban planners around the world. The problems associated with urban flooding vary from minor occurrences to significant occurrences, resulting in cities being flooded for hours to days to months. As a result, the effects may be widespread, resulting in temporary relocations, disruption to public facilities, loss of water quality, and the threat of epidemics. (NMMC, 2018).

In the event of any unfortunate incidents, such as flooding or other mishaps, communities are the first responders. Individual residents and families living in disadvantaged areas play an important role here. As a result, it is critical to at least raise awareness among disadvantaged populations while also improving their coping abilities. Urban institutions and societies that are adaptive should be able to embrace, fight, heal, and learn from incidents. The aim of this study is to enhance and strengthen the capacity of urban structures and communities in each phase of the flood risk management process, which includes actions such as preparedness, response, and recovery. Certain aspects of flood risk management, such as Reflect, Relief, Resist, Response, and Recovery, will be built through community resilience in this study. (Batika, Resilience in Flood Risk Management).

1.2. Problem Statement

In the recent past, multiple researches and studies have been carried out on how to handle and manage these ever-increasing floods, their frequency, magnitude, intensity and uncertainty; but there has been scant mention of proactive and progressive measures, integrated and inclusive flood management, citizen-centric mitigation strategies along with vernacular knowledge that would best fit the event.

1.3. Need for study

Floods in various Indian states have recently wreaked havoc on lives and land. There are also man-made causes that lead to floods, in addition to natural ones. India is extremely vulnerable, as the majority of its land area is subject to annual flooding. The high losses and damages caused by floods demonstrate India's

weak adaptation and mitigation capabilities, as well as its disaster management and preparedness deficiencies.

Since communities are the first responders in the event of a disaster, it is critical to educate, train, and prepare them for such events. This would not only avoid economic and physical losses, but it would also enable the relevant authorities to respond to the situation more quickly. It's not just about getting better; it's about getting better quicker. Nobody else is available to deal with the crisis on the scene soon after the disaster has occurred. Thus, such research will help in addressing urban issue along with achieving Sustainable development goal 11 i.e. 'Sustainable cities and communities' that will further help in making the city inclusive, safe resilient and sustainable.

Thus, there is a need study and explore ways out for an inclusive and holistic flood management and mitigation framework along with practicable strategies. There are reasons behind selecting this as a research topic and those are:

1. Rapid urbanization: Since urbanization in India is taking place at a faster rate with over thirty four percent India's current population is living in urban areas, as per UN World urbanization Report.
2. Urban flood is contemporary: Urban flooding has been in news for quite a long time now and it's prominent, how most of the Indian metropolitan cities are falling prey to it.

1.4. Research Gaps

Although a significant amount of work has been done in the field of urban flood management in India and abroad, the problem has remained the same for decades with little change. Furthermore, only minimal flood research and its effects on the lives and livelihoods of the affected communities has been carried out. This is a warning to recognize the gravity of the situation and recognise the holes that must be filled in order to achieve the aim of urban flood control and minimize the effect on the physical and socio-economic identity of the city. Plethora of research papers is available that also address the significant yet overlooked gaps such as the gap in epistemological (Knowledge and awareness), an institutional gap, and a strategic gap (Albris, 2020).

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According to India's Comptroller and Auditor General (CAG) audit report on "Schemes for Flood Control and Flood Forecasting" 2017, the major problems with flood management in India are (CAG, 2017).

1. Poor flood forecasting system- The flood forecasting network of CWC is not sufficient to effectively cover or monitor the nation. In addition, not all current flood forecasting stations are functional.
2. Poor flood risk mapping- In 2006, the CWC established a special task force that did not complete the assigned task of flood risk mapping. India's vulnerability atlas has also stopped flood zoning, along with inefficient assessments of flood damage.
3. Delays in completion of projects under flood management programs, majorly due to the lack of assistance from the Centre.
4. Flood management operations are not taken up in an integrated manner; rather in India it is looked at and worked on in isolation on as and when required basis.
5. In India, most of the dams do not have disaster management plans and associated strategies for mitigation. Only about 7% of the nation's total large dams have emergency action plans and/or disaster management plans.

Few other lacunas in existing flood management plans are:

1. Age old approach

In India, the strategy has been and continues to be "passive," meaning that current proposals emphasize only structural steps. Community engagement, zoning and preparation prior to implementation, non-structural interventions, coordination between different entities for smooth operation, and strategic implementation of any system, regulation, or program are not included. This is the chosen solution (local administration and government) because it requires little to no effort in terms of both time and money, and it is a strategy in which the administration is activated only after a catastrophe has occurred and lives and property are at risk (S.Duggal, 2019). This approach is similar to operating on a contract basis as required, and it has little to do with flood preparedness, mitigation, or other aspects of flood management. This mind-set must change before it

is too late to adopt a passive approach to coping with urban flooding. As it is rightly said, "Success is a success only when it is continuous," implying that in order to make a successful flood management strategy, we must continue to adapt our strategies, resources, and interests in response to changing circumstances in and around us.

2. Poor implementation

We have been taught about ethics since we were children, but when it comes to us, we seem to forget. We frequently read about delays in flood management project investigation, finalization, and timely implementation, especially in India (WB, 2019). There are a variety of explanations for this, including violations of laws and guidelines, corruption, fund diversion and parking, and a lack of funds (S.Duggal, 2019)

3. Missing out on collaborative governance and inclusion

Existing plans and policies in India are exclusive and are designed in isolation by various departments as well as the structure is such that it does not bother about multiple dimensions that affects and influences certain event such as flooding (ESC, 2015). There are endless departments, organizations and agencies working for and in line with the same but it will be effective only if all these organizations, departments and agencies work together in one direction so that in case of disaster, it is easy and known to all what is to be done as well as the series of action and steps are well defined to avoid any confusion. Similarly, including first and primary responders is important because they are the ones who can take the first steps in the event of a disaster. Their (local) expertise and strategies for dealing with the situation should be included in the plans; capacity building should be based on them because they come in the first place to support themselves and also to help those in need; and more awareness should be shared as part of the preparedness effort. Awareness camps, promoting stakeholder engagement, improving communication to reduce the risk of confusion, teaching strategies for efficient use of scarce resources, adaptability to future situations, building capability, and creating resilient societies will all help to achieve inclusion (S.Duggal, 2019).

4. Improper management

There are numerous management plans in India, both current and historical, but none of them are effective enough to serve the purpose (Liao, 2012). The explanation for this is that our management plans do not account for residual risk that can occur at any time without notice, a lack of implementation of multiple steps, the creation and maintenance of a shared data base, and most importantly, management and maintenance (S.Duggal, 2019).

1.5. Aim and Objectives

Preparing framework to mitigate impacts of urban floods: A case of Greater Hyderabad

This research aims to study the diversity in communities based on their socio-economic status and analyse their proactive participation, especially the ones who belong to the vulnerable communities in all phases of urban development and decision making (Junmookda, 2014) (Liao, 2012) (S.Duggal, 2019). Thus my aim is to propose strategies and mitigation techniques that are inclusive in nature and also addresses flood management pro-actively for the study area because this would ensure speedy recovery from any similar situations in future. To do so, there are four objectives and they are as follows:

1. To identify and study the relationship between floods and community dynamics in urban areas.

The first objective would focus upon building conceptual clarity on what floods are, its types, what causes flood and how are the immediate communities affected by the same. In line with the same, it will also emphasis upon inter-relation between flood vulnerability and to what extent various communities are impacted (pulled back) by the disaster. Various researches have established an inverse relationship between vulnerability and socio-economic status of the citizens i.e. higher the income and living standard, lower will be the vulnerability or we can also say higher would be their capacity to bounce back to their previous condition. Such study will help in understanding the community dynamics of the city, their losses and also their behaviour in flood events. These will be covered through an extensive literature study based on various secondary data that is available.

2. To delineate study area and identify factors contributing to floods along with assessing its impacts on various socio-economic groups of the community.

To study a certain thing it is very much important to specify the location because, situation varies from place to place. A situation (flood event) could be disastrous for one location but at the same time it could be insignificant for other locations. Thus, it is vital to delineate study area before proceeding further with detailed study and analysis. Also, once the site is selected, we can look into the site-specific aspects, information and existing knowledge and this would help in structuring our research accordingly. Site selection would be based upon few criteria such as:

- An urban area with high frequency of flood occurrences despite of being in no major flood zones of the country*
- An urban area with decent range of topography to compare the impacts in low lying areas and areas at higher altitude*
- An urban area with repetitive flood incidences*

3. To assess flood vulnerability and identify extent of public participation in the process of mitigating the impacts.

To assess flood vulnerability, one must map the flood prone areas along with areas that are comparatively safer and also delineate areas that are safe yet experiences flooding due to various reasons or aspects. This will help in identifying the causes of flooding at various locations, variation in intensity of impacts, variation in vulnerabilities from one catchment to other, how people behave in flood events depending upon their capacities and lastly variation in resilience because all these together defines the urban resilience. As known to all, in present context urban resilience is one of the most important dimensions for planners as well as developers while planning, designing and implementing various urban issues. Also in order to enhance communities' resilience, one needs to work on involving public in the decision making as well as mitigation processes as this will eventually grade up the existing level of public participation in the entire flood management process.

4. To incorporate progressive approach in preparation of flood management process.

As mentioned in various research papers and journals that we in India, lack progressive and proactive measures when it comes to dealing disasters. This is the root cause of failure and partial success in existing flood management plans of our country and even abroad. As it is always beneficial to learn from others and our own mistakes as well as take lessons from past experiences and produce better, effective and positive results in future. Similarly, learning from all the failures or partially successful cases and implementing the newer and better measures and steps to bridge the gaps would take us a step forward towards the goal i.e. mitigating flood impacts by involving the public of the study area in order to improve community resilience and eventually achieve urban resilience.

1.6. Scope

We do not include progressive measures in flood control strategies and related policies, as per some existing management plans. As a consequence, my emphasis will be on integrating non-structural measures with established expertise and a passive approach that focuses solely on structural measures in the event of flooding. As seen in numerous hi-tech countries around the world, even they aren't prepared to avoid and fully monitor flooding, and this is due to communities' isolation from the planning and decision-making phase.

Only the wards that have been exposed to recent and past flood events will be studied and analysed in this report. This can be accomplished by determining the factors that contribute to the disparities in their results. The aim of this study will be to reduce casualties and economic losses, optimize locally available resource value, and prepare communities so that they can recover from disasters as quickly as possible, regardless of their socio-economic status. Capture live experiences of people and the adopted strategies to overcome the event.

1. Including communities in development process to efficiently address the local issues
2. Incorporating progressive measures in flood management framework by integrating non-structural with structural measures

3.To minimize losses and increase efficiency in recovery

Non-structural interventions are those that do not include physical development but instead rely on knowledge, practice, or understanding to minimize disaster risks and impacts, such as policies and regulations, public awareness, training, and education. It can be thought of as a collection of mitigation and/or adaptation strategies that do not rely on conventional flood defences. They mitigate destruction by removing people and property from flood-prone areas without affecting the current of the flood case. Elevated buildings, land buyouts, permanent relocation, zoning, subdivision, and building codes are all examples of these. Land use, for example, is a non-structural flood control measure. Non-structural flood control initiatives, including land use legislation, flood forecasting and warning system, flood proofing, disaster mitigation, preparedness, and response mechanisms, have minimal environmental implications and should be aggressively considered as viable alternatives, either independently or in combination with structural flood management measures.

1.7. Limitations

With a growing interest in the subject but insufficient time, as well as the pandemic situation, researchers face a difficult situation. As a result of the aforementioned conditions, this study has certain limitations, which are as follows:

- 1.This research will not consider any of the financial aspects that may directly or indirectly be associated with the study
- 2.Excluding study of flood events aging more than a decade
- 3.Primary focus would be affected communities and no other measures associated with urban flooding
- 4.The study would not go into the structural and technical details of the proposed framework

1.8. Methodology

Methodology is the road map for researchers and those that will refer to the analysis in the future, as it outlines the steps that must be taken in the research process.

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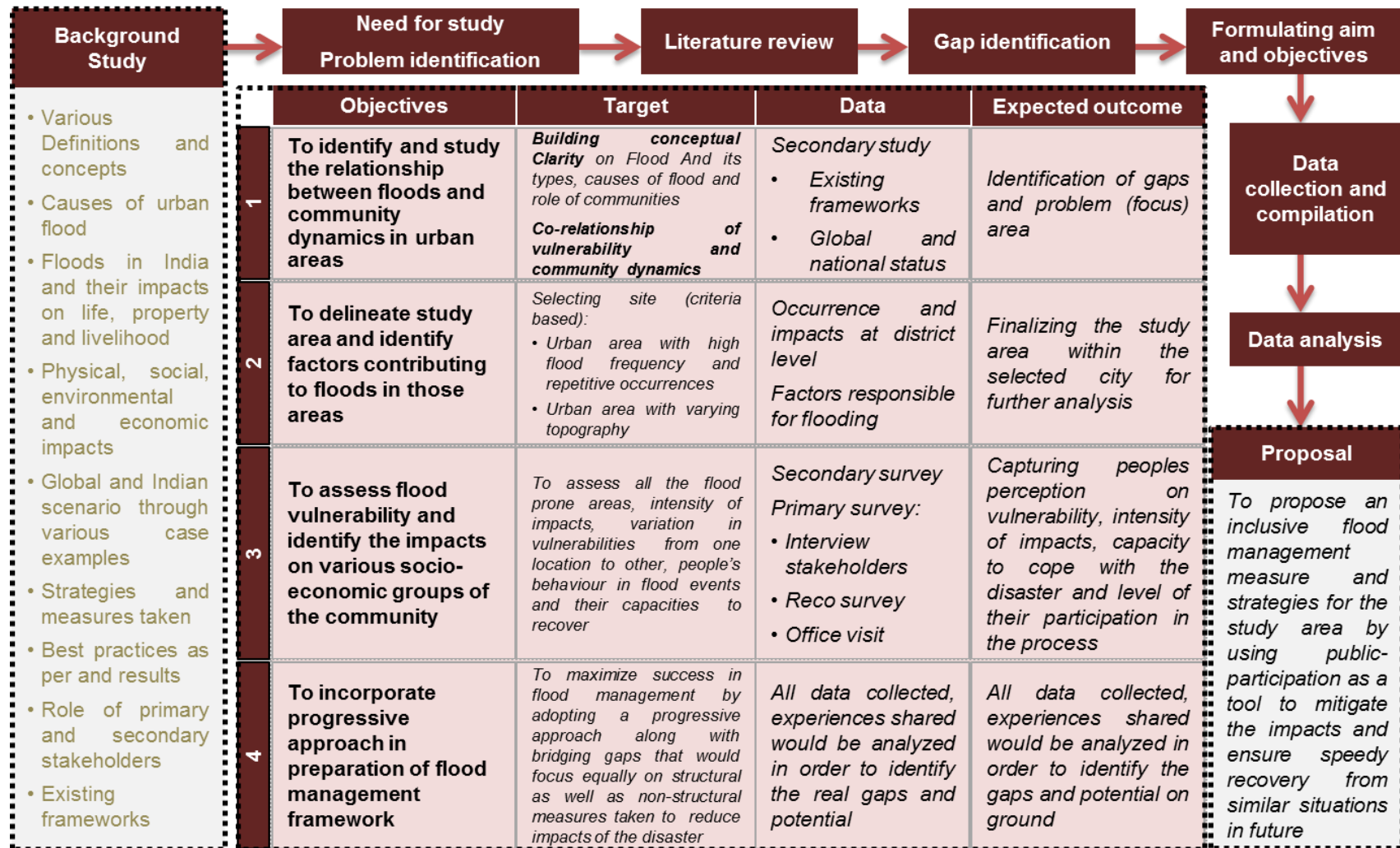


Figure 1: Thesis Methodology

Source: Author

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A systematic literature review was conducted as part of the study to achieve a certain degree of clarification and to better understand the significance, its global status, and how it affects the local people. It has also aided in the identification of measures in place to cope with or react to flood events. I was able to recognise the study's problem and need after reading a broad and varied range of literature. Following that, I went on to study further research articles in order to arrive at my current goal and objectives.

The first objective is to identify and study the relationship between floods and community dynamics in urban areas with the goal of resolving problems and identifying gaps.

The second objective is to delineate study area and identify factors contributing to floods in those areas and it aims at achieving the target of finalizing the study area within the selected city for further analysis.

The third objective is to assess flood vulnerability and identify the impacts on various socio-economic groups of the community and it aims at achieving the target of capturing peoples' perspective on vulnerability as well as intensity of impacts and how well equipped the communities are to cope with the floods.

The final goal is to implement a progressive approach in the planning of a flood management framework, and this is a proposal-oriented goal for which spatial and policy level initiatives will be provided with the aim of minimizing the flood impacts and preparing citizens to bounce back as quickly as possible from any such or similar situation in the future.

1.9. Expected Outcomes

The research's final product will be a series of policies and interventions that will increase community engagement in the flood prevention, preparedness, mitigation, and recovery processes, as well as regeneration and overall growth processes. This could only be accomplished by increasing neighbourhood resilience and implementing such spatial and policy strategies.

CHAPTER 2: LITERATURE REVIEW

The chapter demonstrates the conceptual as well as the theoretical concepts associated with the topic and theme. The chapter includes existing research, reports, documents, other literature works, concepts, case examples and existing frameworks that have made me equipped enough to understand why and how this thesis title is relevant to research in the present circumstances and why such a study is required despite the fact that there are numerous similar studies available for reference on this subject and theme.

2.1. Concepts

Flooding is a condition in which water overflows and submerges land that is otherwise dry, with low-lying areas being the primary victims. Flooding may occur as a result of an overflowing water body or as a result of an irregular rainfall distribution that leads to water accumulation at specific points. In terms of life and property, both of these conditions are usually disastrous.

2.1.1. Flood and its impacts

Floods account for the largest percentage of all known disasters, according to the IFRC's World Disaster Report, and they contribute significantly to social, cultural, economic, and ecological losses, especially in developing countries due to weak adaptation and mitigation strategies. In line with this, my study will concentrate on urban flooding and its related issues, as well as how they can be reduced through a constructive and progressive approach.

Flood not only disrupts citizens' daily lives and the environment, but it also kills farm crops (if any), disrupts transportation, communication links, and other infrastructures that provide services in the region. Flood victims are vulnerable to multi-dimensional environmental issues, as well as loss of life and property, as a result of this crisis-like situation. In the vast majority of cases, they are unable to adapt to changing circumstances of various socio-political, economic, and cultural strategies in order to survive in the face of multiple problems.

2.1.1.1. Global Scenario

Flood is the most serious catastrophe, whether in terms of its frequency or the number of people who die as a result of it. Owing to climate change, there is a

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growing trend of urban flooding and the resulting damage around the world. However, in Asia, only a few cities have built urban flood proofing and flood management strategies so far, and much more needs to be done by city councils and local governments. Because of its geographical position, India has been hit the hardest by floods economically, making the situation in the country worrying. According to a report by the Central Water Commission (CWC) on floods and the damage they cause, approximately 1600 Indians have died as a result of flooding. When heavy rains occur, the current drainage system is unable to handle the excess water, and the water overflows, inundating municipal facilities and structures. Similarly, for a better and safer future, urban flood proofing and management using both passive and progressive approaches is needed.



Figure 2: Global Disaster Status
Source: World Disaster Report, 2020

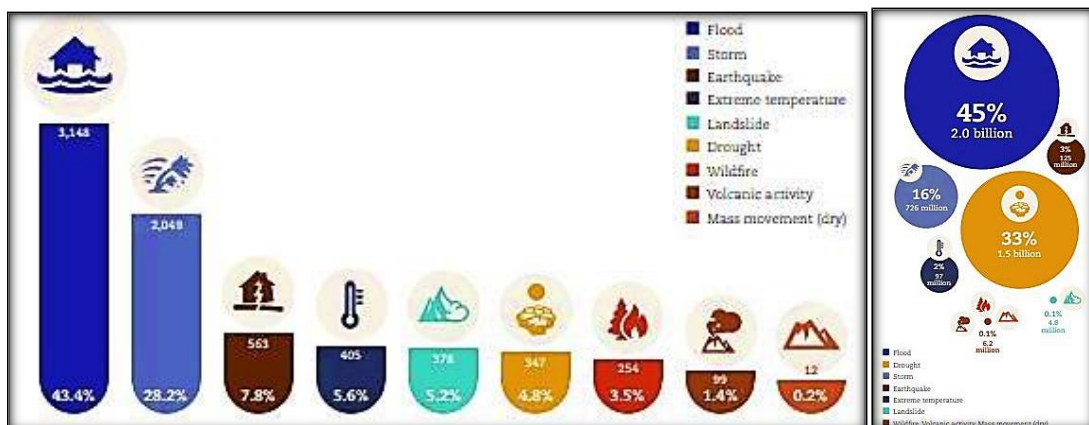


Figure 3: Disaster occurrence and intensity of its impact
Source: Report on Global Disaster Statistics by CRED (Disasters, 2017)

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2.1.1.2. Indian Scenario

More problems emerge as a result of the rapid urbanization phenomenon. The need for a well-planned city is urgent. In India, flooding in urban areas is becoming more frequent, resulting in significant loss of life, property, and livelihood. In India, floods are becoming more serious, unpredictable, and difficult to control. Floods caused over Rs. 950 billion in damages in India alone in 2018. Because of insufficient drainage and the encroachment of old water bodies in cities and towns, urban floods are becoming more frequent.

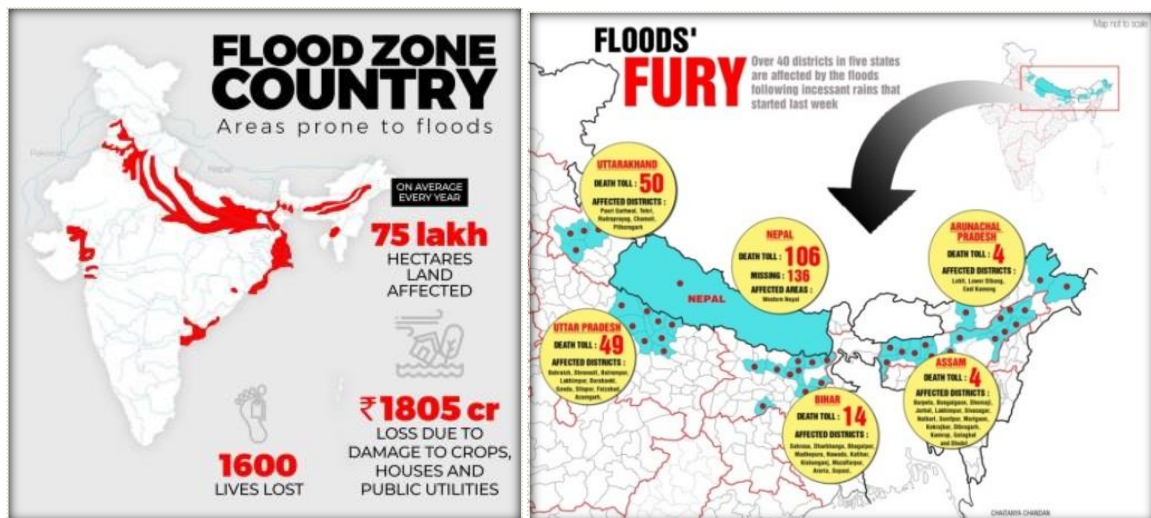


Figure 4: National Disaster Status

Source: Annual National Disaster Report, 2019 (NDMA, 2019)

Since India is a flood-prone country with a population of 1.38 million people, the situation is complicated and difficult to handle. Various agencies, authorities, and organisations have taken a variety of systemic and emergency management initiatives to minimize the likelihood of occurrence and mitigate the impacts, but the milestone has yet to be reached. The Indian Meteorological Department had forecasted a regular monsoon for the 2020 monsoon season, but regional rainfall fluctuations have resulted in urban flooding. Severe rainfall events have risen in recent decades, resulting in irregular and heavy rain at short intervals, but factors such as inadequate drainage, excessive ground cementing, encroachment of water bodies – such as ponds and reservoirs – and unplanned waste disposal have exacerbated the situation. Despite the fact that many organizations are involved in flood protection, there is a strong lack of cooperation in flood prevention, as well as exclusion of vulnerable communities. Communities' vernacular wisdom is left unused and unheard because they are not included in

the planning and management process, and as a result, their resilience is hindered. Public participation is an important dimension of planning and management process as they are the first responder.

2.1.2. Urban Flooding

Various Indian cities have recently been in the news, and some are still in the news, due to urban floods that have claimed lives and destroyed property, which is an annual occurrence in most cities. The arrival of monsoons in India is becoming more pronounced, causing daily activities of the vast urban population to be disrupted. Urban flooding is a normal occurrence in most cities around the world.

Flooding is a form of water overflow that submerges land and occurs when water inundates normally dry land. India is one of the world's most flood-prone nations. River floods account for roughly 60% of the country's flood damage, while cyclones and heavy rainfall account for 40% (NMMC, 2018). In general, urban flooding is neither a recent phenomenon nor an unknown occurrence in both the world and India. Urban flooding is defined as the inundation of land or property in densely populated areas due to unequal rainfall distribution, storm sewers coupled with organic urbanization, occupying and filling up natural drainage channels and urban reservoirs to use high-value urban land for impermeable structures, and occupying and filling up natural drainage channels and urban reservoirs to use high-value urban land for impermeable structures. Since urbanization leads to existing catchments, which increases flood peaks and volume, urban flooding varies significantly from rural flooding. Another issue that planners, officials, and politicians are concerned about is the loss of urban water bodies; whether lakes, wetlands, springs, or rivers, they are all influenced in some way by urbanization. Over-exploitation affects the majority of it, while over-extraction affects some, and illegal settlements and industrial discharge affect others.

2.1.3. Floods and Urban Resilience

In towns, such as Calcutta, Chennai, Delhi, Hyderabad, and others illegal filling of urban water bodies is common. The majority of India's geographical area is susceptible to annual floods, making it extremely vulnerable. The high losses and

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damage caused by floods in most of India's flood-prone cities demonstrate India's low adaptation and mitigation status, as well as inadequacy in disaster understanding, preparedness, management, and mitigation. Floods must be managed and their effects mitigated, but prevention, in my opinion, is more critical than control because disasters are always uninvited, unexpected, and unpredictable, with no warning of their magnitude and intensity. This makes mitigation even more important, as it is a post-disaster phase that must be completed in order to ensure protection in the metropolitan area with the fewest possible deaths and physical damage.

Urban resilience is a term that describes a city's ability to tolerate and withstand flooding, as well as the ability to reorganize physical harm and socio-economic disruption in order to avoid deaths and injuries and maintain existing socio-economic identity (Liao, 2012). It is also claimed to be the city's capacity to rebound from a flood event in order to return to normal levels of functionality, and this can be accomplished using a "build back better" strategy. In order to protect development progress and promote poverty reduction, cities must resolve an increasingly complex spectrum of shocks and stresses with a greater concentration of people and assets in urban areas. Urban resilience seeks to assist communities in adapting to a broader range of changing conditions and enduring shocks while maintaining essential functions. The control of disaster risk and the impact of climate change have long been a major focus of urban resilience (WB, 2019). Resilience is not a one-time event; rather, it is a long phase in which all residents of a community engage in overtime in order to achieve urban resilience, which is critical in all aspects of ensuring urban protection and sustainability. Cities are constantly evolving and developing, and the risk vulnerability profile within a city is changing and developing as well. (Junmookda, 2014).

2.1.4. Public participation

Although public involvement can help with recovery planning, post-disaster situations present specific challenges and opportunities that can either increase or decrease participation based on recovery policies and planning features. This study will concentrate on including residents in an open process that fosters hope and allows recovery champions to obtain support for their initiatives. However,

planning when unprepared, participant homogeneity, and skipping deliberation can restrict the voices of disadvantaged citizens in decision-making and undermine the proposals' implementation. This research will also look at the practices of community involvement in flood prevention around the world, as well as the difficulties that local governments face in this regard.

Via intentional outreach campaigns tailored to their situations, under-represented economically disadvantaged populations should be included in all phases of recovery planning. To improve the efficacy of post-disaster participatory preparation, interested stakeholders should participate in deliberation rather than simply soliciting feedback, with the help of experienced planners and technical experts.

2.1.5. Community-based mitigation strategies

Even before there was a structured structure of governance and government, community-based mitigation methods existed. Community-based disaster risk mitigation has been coined to assist societies in a systematic manner (Shaw, 2016). The local government and civil society are the two most important actors in the event of a disaster. By the end of the century, people living in low-lying coastal areas in India would be at greater risk of being displaced due to floods (IPCC, n.d.). Since communities are the first actors and responders in any tragic or dangerous incident, and they share the value of enhanced DRR and growth, community-based interventions have a better impact everywhere they are instituted and implemented. This will eventually lead to safer conditions, more secure livelihoods, and sustainable growth, achieving Sustainable Development Goal 11 of Sustainable Cities and Communities.

2.2. Case Examples

Researchers have used case studies in a variety of fields for a long time. It has been widely used in the social sciences as a qualitative research tool for investigating current problems in real life and as a foundation for the implementation of ideas and methods.

2.2.1. Global: Jingdezhen, China

Jingdezhen is a city in South-East China that has a population of about 1.8 million people. The town has a total area of around 400 square kilometers.

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The Changjiang River flows from north to south through the district, with many tributaries such as the Sanlvniao River, which flows toward east from west, and the Nanhe River, which flows from east to west. Extreme floods hit the city almost every year, causing massive economic losses and widespread devastation. However, the city's regular floods have turned it into a porcelain capital, earning it the moniker "City of Chinaware" (Sun, 2017). The art of creating beautiful chinaware artefacts has made this a common tourist destination where flooding is a problem. The only concern of the officials in charge and the government has been to control flood events as well as eliminate factors that affect floods and associated losses (Wang, 2018).



Figure 5: Jingdezhen – Location

Source: Analysis of the Public Flood Risk Analysis (Wang, 2018)

Need of Study

1. Flash floods are prominent during longer storm periods, especially in the hilly region of the city which further results in large amount of water discharge to the city. Similarly when the river Nanhe reaches its tank capacity, it contributes to the same as well.
2. Condition is getting worse with passage of time because population is increasing and on the other hand, storm drainage systems are proving to be insufficient even in catering the present population size.

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3. In case of heavy rainfall and exceptional monsoon pour, the low-lying areas are at higher risk of getting flooded than other parts of the city.
4. Advanced hydrological as well as hydraulic models are absent which if would been in place, could have helped in dealing with the storm runoff.



Figure 6: Picture illustrating the situation during flood
Source: (Zhang, 2020)



Figure 7: Community participation in rescue process
Source: (Zhang, 2020)

Causes of flood in the city

1. One of the major causes behind Jingdezhen city's annual flooding has been its approach that keeps no room for extremity or severity pertaining to floods.
2. Another reason contributing to floods is encroachment on low lying areas of the city, mostly along the Changjiang River.
3. Inefficient and insufficient sewage as well as storm water drainage systems are yet another factor resulting annual flooding in the city.



Figure 8: Level of inundation post-flooding

Source: (Wang, 2018)

Inference

1. It is vital to identifying vulnerable areas through available tools, techniques and models is the primary task for reducing risk of flooding in the present time where we are surrounded by plethora of technology driven solutions to all our tradition problems.
2. Regular maintenance and up-gradation of drains, sewers and water channels are a must for flood-proofing in the city where low-lying areas are most exposed to the risk of flooding.
3. It has been seen that even general and basic level of awareness and preparedness among the vulnerable communities could save lives and lower the losses.
4. It has now become important to integrating all the non-structural and structural measures known to us for a holistic flood proofing as well as management.

2.2.2. National: Chennai, India

Madras was the previous name for Chennai. Chennai is the commercial capital of South India and one of India's major ports; as a result, it has developed into a metropolitan city and is now the country's fourth largest city. Chennai is a coastal city with the world's second largest beach. It is a gracious, charming, and culturally rich city. It is the capital of Tamil Nadu and a crossroads for South Indian cultures. During the British period, this fishing town came together.

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Despite the fact that Chennai is a beautiful and clean city with architectural wonders and green areas, it was devastated by floods in 2015. Vardah (Cyclone) weakened into a Severe Cyclonic Storm on December 12 before making landfall near Chennai, Tamil Nadu, with winds of 65 miles per hour (105 kilometres per hour).

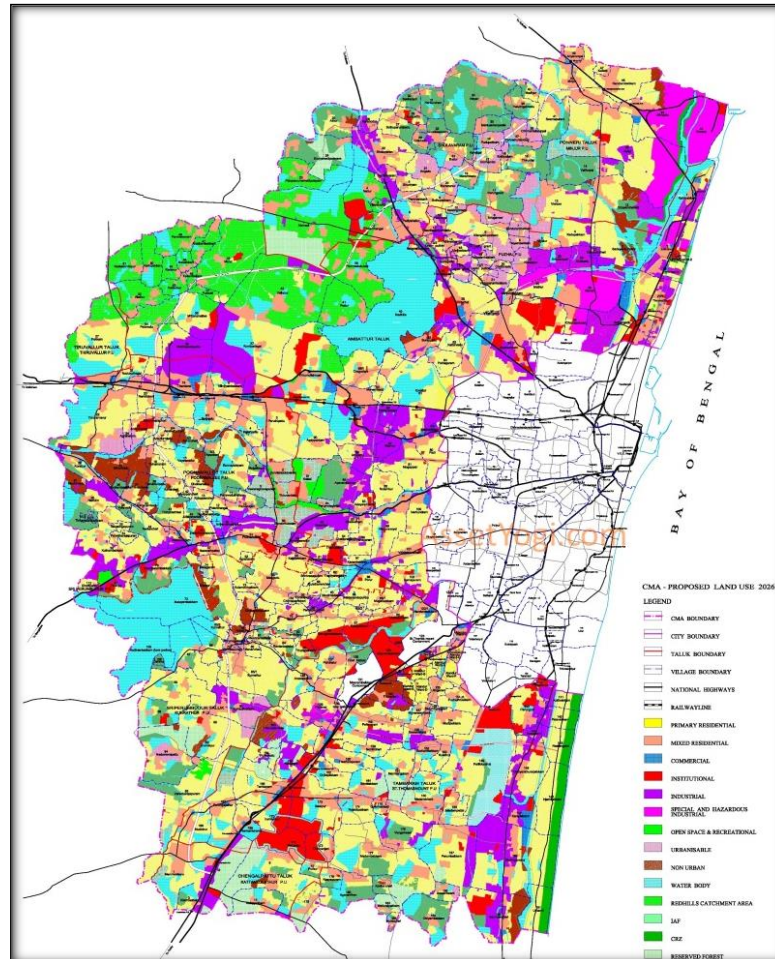


Figure 9: Chennai Metropolitan City
Source: Chennai Master Plan 2026

The Chennai floods are said to be a man-made tragedy because the city's urbanization increased by nearly 20 times in just four decades (IISC, 2014). It was very simple to turn wetlands into lands for other purposes until the state amended the Tamil Nadu Town and Country Planning Act to bar the conversion of wetlands for other purposes. The district collector, not the tehsildars, may grant permission for the conversion of wetlands to other or particularly residential uses under this act. However, the public claims that this did not save the wetlands from being encroached upon.

Need of Study

- 1.To understand the present condition of lakes, rivers, marshes and tanks and canal in Chennai city also its historic and contemporary infrastructure and what new systems are needed
- 2.To understand the natural drainage systems in Chennai and evaluate their current and past effectiveness in protecting the city against floods (Hindu, 2015)
- 3.To suggest recommendations for their improvement in functioning and maintenance through maps as well as social, economic and legal proceedings as well as community participation



Figure 10: Encroachment along river

SOURCE: (Pande, 2016)



Figure 11: Community participation in evacuation

SOURCE: (John, 2017)

Causes of floods in the city

1. Emerging settlements on marshes and mangroves have polluted and congested naturally existing drains, resulting in extensive and largely irreversible damage to sources of water and biodiversity.
2. Integration of natural (sea level rise) and man-made (inefficient drainage systems + poor coastal protection)
3. Reduction in natural drain capacity of the surrounding (age-old systems and encroachment of ESA, marshes, wetlands, permeable and open areas)
4. Fragmentation of existing channels and water bodies through informal and unauthorized settlements (Hindu, 2015)

Role of communities

The 2015 Chennai floods, which were triggered by heavy rains, brought the city to a halt. It impacted the city's and surrounding areas' socio-economic conditions, vital infrastructure was destroyed, animals and people were trapped, services were disrupted, and substantial parts of the city were flooded. (Ramachandran, 2016).

1. Patients, infants, women, the elderly, and pets were saved by young men and specially trained fire officials.
2. Various agencies and departments received additional assistance in the form of mechanized boats from Chennai's fishermen group to carry out rescue operations.
3. Private enterprise, such as restaurants, taxi companies, and car repair shops, teamed up with the government to help flood victims.
4. Kolapasi, a Chennai-based restaurant, has been converted into a temporary food distribution centre.
5. Privately owned media outlets were used to raise funds as well as raise awareness, and people of all ages backed the initiative.
6. Community-based organizations (CBOs) such as Oxfam offered assistance by supplying electricity and fuel to households.
7. Slum dwellers, manual labourers, and villagers in the worst hit areas were given a rehabilitation kit, which included a kerosene stove, water filter,

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utensils, disinfectant, activated EM, composters, and other products, by private companies and non-affected citizens.

8. Rescue, relief, recovery, and restoration efforts were carried out by volunteers from different communities.



Figure 12: Community initiative in recovering post-flood
SOURCE: (Anon., 2015)



Figure 13: Rescuing the stranded elderly
SOURCE: Overcoming agony that drowned Chennai, Document 2016 (Embrace the world- Chennai flood)

2.3. Existing Framework

Frameworks are the guideline that helps us through the entire process by making it easier.

2.3.1. The Hyogo Framework for Action

The International Strategy for Disaster Reduction (ISDR) was adopted by the United Nations Member States in December 1999, with the aim of guiding and coordinating the efforts of a wide range of stakeholders to achieve significant disaster loss reduction and create resilient nations and communities. The strategy played a significant role in bringing about a philosophical change from response to risk reduction. The Hyogo Framework for Action (HFA) 2005-2015, adopted at the 2005 World Conference on Disaster Reduction, described one of its strategic goals as a more effective incorporation of disaster risk considerations into sustainable development strategies, planning, and programming at all levels, with a focus on disaster avoidance, mitigation, and preparedness, as well as vulnerability reduction. The HFA is the first plan to clarify, identify, and detail the work that all various sectors and actors are expected to do for integrated DRR, and it outlines five action priorities:

1. Make disaster risk reduction a national and local priority with a solid structural foundation for implementation.
2. Improve early warning by identifying, assessing, and monitoring disaster threats.
3. At all levels, use expertise, creativity, and education to foster a culture of protection and resilience.
4. Reduce the risk factors that are at the root of the problem.
5. Improve disaster preparedness at all levels to ensure successful response.

Recent international debates and agreements on risk mitigation and climate commitments, together with the 2030 Goals, could provide a platform for countries like India to achieve not only a reduction in loss and harm, but also a long-term transformative growth. In March 2015, the 3rd World Conference on Disaster Risk Reduction agreed on the Sendai Framework for Disaster Risk Reduction. It is the successor to the Hyogo Framework, which began in 2005 after the Sendai Framework, was approved and ended in 2015. India is

vulnerable to natural as well as man-made disasters, making it a critical consideration for planners and policymakers.

2.3.2. The Sendai Framework for Disaster Risk Reduction

1. SFDRR aims to achieve a substantial reduction in disaster risk and disaster losses in lives, livelihoods, and health, as well as in environmental, cultural, social, physical-economic resources of individuals, communities, and businesses, over the next decade and a half.
2. A collection of principles, an all-encompassing structure with attainable goals, and an instrument with a legal basis for disaster risk reduction make up the framework.
3. The mechanism calls for stakeholders, including the private sector, the government, and other stakeholders, to share accountability.
4. It emphasizes the common concerns about human health and well-being in climate change, disaster risk reduction and sustainable development.
5. The aim of this project is to better understand disaster risk and improve disaster risk governance in order to better manage disaster risks.
6. To enhance disaster preparedness and ensure efficient response, recovery, restoration, and rehabilitation in the event of a disaster.

2.3.3. New Urban Agenda

The New Urban Agenda is a vision document for all people in all cities to live in a prosperous, egalitarian, clean, inclusive, and resilient future, but it lacks goals and clear guidance to aid implementation. The NUA is divided into six thematic fields, ten policy units, and 22 issue papers, with the policy unit on 'Urban Ecology and Resilience' highlighting the uncertain future ahead in the context of changing climate and rising urbanization, as well as the '70 percent of urban infrastructure that will occur in 2030 that does not exist yet' as a potential area of opportunity.

2.3.4. 2030 Sustainable Development Goals Agenda

Many goals exist to reduce risk and create resilience, whether through concentrating on poor people's exposure and vulnerability, ensuring stable facilities and practices, or improving understanding and adaptive capacities. Unlike climate action, there is no single target for disaster risk reduction (Goal

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13). This has its own set of benefits and drawbacks that motivate people to take action. Risk reduction can be thought of as being integrated into all aspects of sustainable development, particularly in the urban (Goal 11), where the SDGs aim for cities to be resilient. However, the unique existence and circumstances of disaster risk are not recognized or highlighted for intervention, resulting in co-occurrence.



Figure 14: Sustainable Development Goal 2015

SOURCE: United Nations Department of Economic and Social Affairs

CHAPTER 3: STUDY AREA

This section contains and addresses the site selection criteria as well as general details about the study area, including topography, slope, growing conditions, demography profile, and study transportation and communication. We understand the study area and its scenario better when we have prior knowledge of it. Thus, it is important to comprehensively know ones site of study.

3.1. City Introduction

Telangana, a southern Indian state with a 400-year history, has its capital and largest city in Hyderabad. A district that currently covers 217 square kilometres along the banks of the Musi River, which also divides the city into two portions, Musi and Easi catchment: the northern bank is at a lower level than the southern. The GHMC, on the other hand, covers a 650-square-kilometer area that includes three cities: Hyderabad, Secunderabad, and Cyberabad.

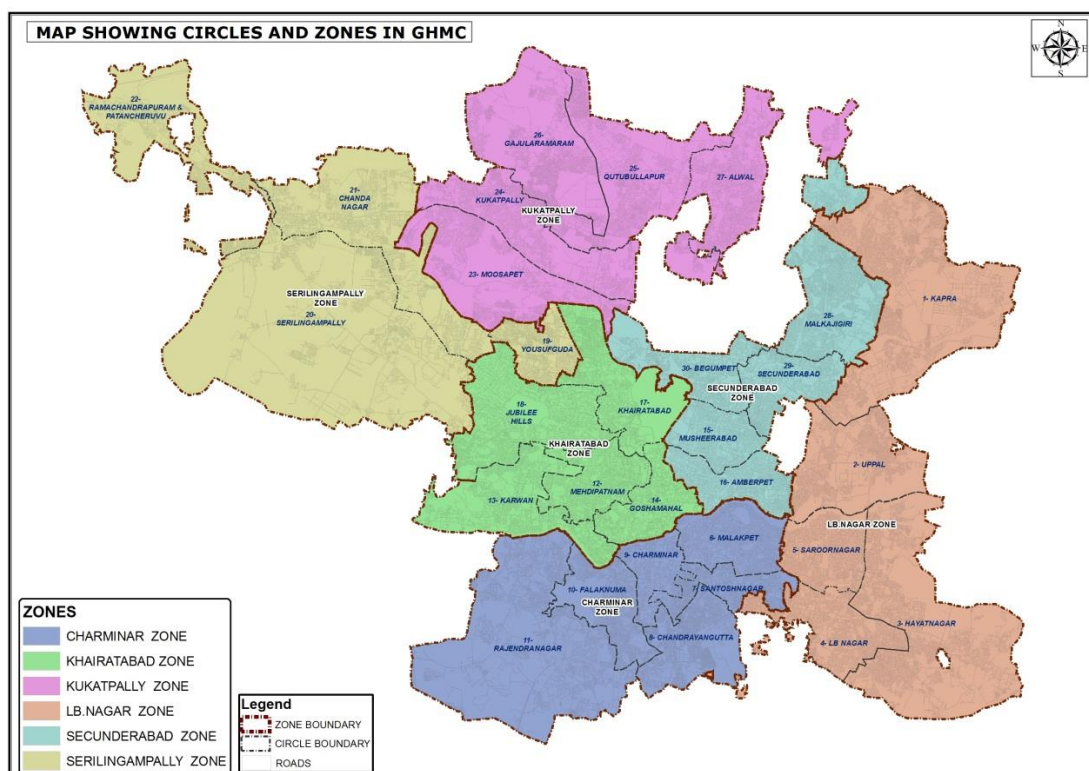


Figure 15: Hyderabad Zone and Circle Map
Source: Hyderabad HMDA Master plan 2031

According to the 2011 Census, the city has a population over 3.9 million with 100 percent of the population residing in urban areas and no one living in rural areas. This is due to the Greater Hyderabad Municipal Corporation's merger of three

CHAPTER 3: STUDY AREA

cities: Hyderabad, Secunderabad, and Cyberabad; the merger made Greater Hyderabad fully urban, and the outlying areas and rural areas became part of the Rangareddy district under GHMC jurisdiction. The city is located in the south-western part of the state, in the northern part of the Deccan Plateau, specifically a part of Telangana plateau in Southern India, and is a developed IT (Information Technology) and knowledge hub of India. Hyderabad has a unique landscape with undulating topography and stunning rock formations that are estimated to be over 2500 million years old. The city is in seismic zone 1 and is thus the least vulnerable to earthquakes.

3.2. Regional Setting

Both geographically and culturally, Hyderabad is known for its rich history, food, and multilingual community. The city of Hyderabad was built on the Musi River's banks. Charminar, Falaknuma Palace, Chowmallah Palace, and Makkah Masjid, all on the river's south side, are now known as the historic old town of Charminar, Falaknuma Palace, Chowmallah Palace, and Makkah Masjid.

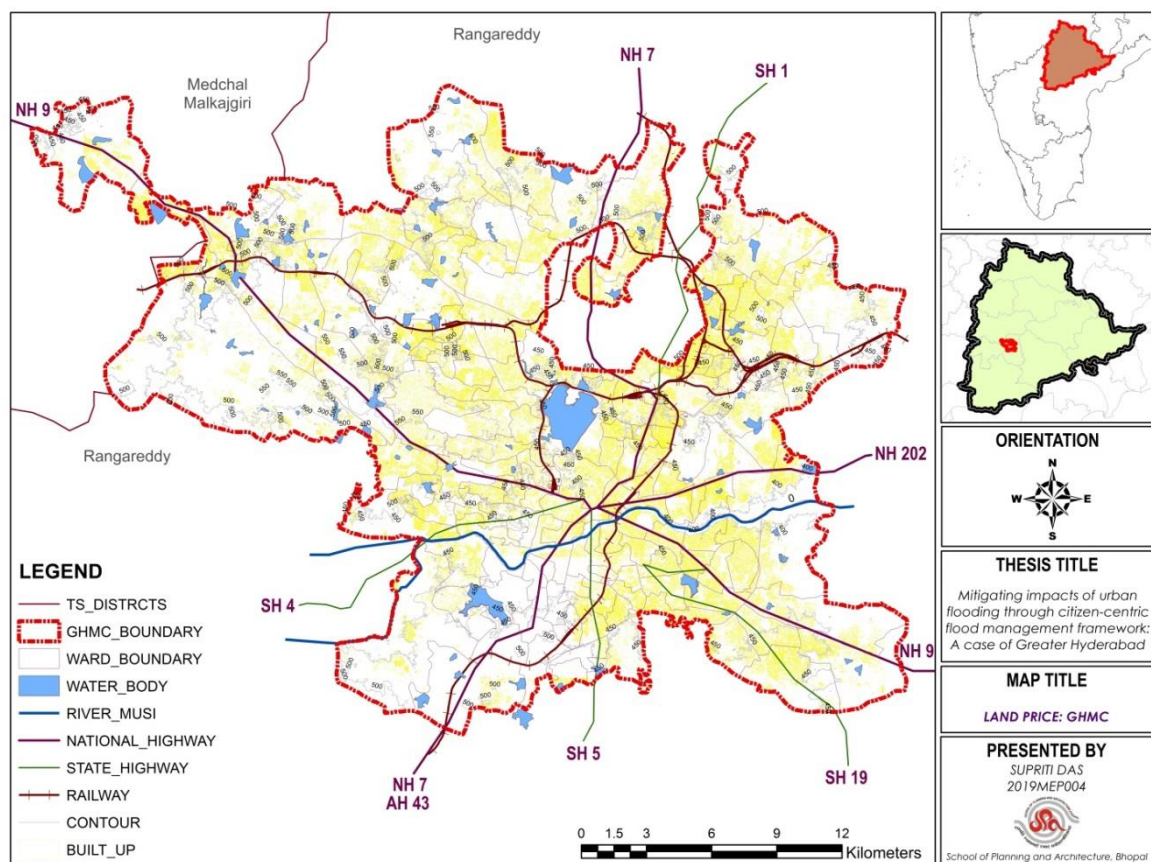


Figure 16: Base Map for the Study Area

Source: Author

CHAPTER 3: STUDY AREA

It is the twin towns of Hyderabad and Secunderabad, which are separated from Sagar Hussain by Ibrahim Qutb Shah's man-made lake in 1562 and connected by the "Tank Bund." The town is situated on the Decan Plateau, with an average elevation of 536 meters. The city is located at 17°23'2.58"N latitude and 78°27'22.9"E longitude.

3.3.1. Location

The Greater Hyderabad is a city that comprises of Hyderabad as well as parts of Rangareddy districts which lies in the south-western part of the Telangana state.

3.3.2. Connectivity

Greater Hyderabad is well connected to the adjacent cities, districts and states. The SH-1 passing through the city connects Hyderabad- Shamirpet- Karimnagar- Peddapalli- Ramagundam, SH-4 connects Hyderabad- Chevella- Parigi- Kodangal, SH-5 connects Hyderabad- Dundigal- Narsapur- Medak- Yellareddy- Banswada- Bodhan and SH-19 connects Hyderabad- Ibrahimpatnam- Peddavoora- Nagarjuna Sagar. Similarly NH-7, NH-9 and NH-202 connect the city to rest India. Since Hyderabad is well connected to other parts of the country thus, it is important to safeguard the city and its transportation system from any disruptions as it results in economic losses.

3.3. City Profile

Every city has something distinctive about it that distinguishes it from other cities, such as its demographic profile, physical characteristics, history, and other factors that contribute to the city's name and identity.

3.3.1. Demographic profile

Table 1: General city profile

Greater Hyderabad Area	650 sq. km
Population	1.02 crore
Population Density	15,385 people/ sq. km
Sex Ratio	954:1000
Literacy Rate	73.34% (77,34,000 literates)
Working Population	36% (Main and Marginal Workers)

Source: Greater Hyderabad Municipal Corporation (2020)

CHAPTER 3: STUDY AREA

The GHMC area is roughly 2.5 times the size of Hyderabad, and it stretches beyond the Hyderabad district boundary. When looking at the urban-rural population ratio, it is 100 percent urban, indicating that the city is growing even today.

The city now has a population of over 1.02 crore, up from 1 crore in 2020 and 97 lakh in 2019. Based on our calculations, the city's average annual growth rate is 2.7. The city is ancient, but in the last 15 years it has developed as an IT centre, which is another explanation for immigration and fast population growth when compared to other districts nearby.

The sex ratio is respectable and higher than the national average, giving the city and its community a positive reputation and demonstrating strong female representation in society. Since it is thought that the greater the number of women in a society, the healthier and wealthier the community becomes.

The city has a high literacy rate, which represents the status of women in society, as well as their recognition and opportunities. Greater Hyderabad has a higher literacy rate than the rest of the country. This is why the job rate, which includes both men and women, is 36 percent. It is projected that about 50% of literate people are still unemployed, and the same was reported in the primary survey, with literate yet unemployed people actively searching for jobs.

3.3.2. Flood profile

The 'Old City,' which was built on the southern banks of the Musi River by Muhammad Quli Qutub Shah, has been known as the 'Old City,' while the 'New City,' which includes the northern banks' urbanized areas,' has been known as the 'New City.' The old and new cities are linked by a number of river bridges, the oldest of which is the 'Purana Pul.' Hyderabad is twinned with Secunderabad, and the two towns are separated by the Hussain Sagar Lake. The two cities are part of a single municipal unit known as Greater Hyderabad.

According to recent historical data, Hyderabad has experienced eight major floods in the last century. It's worth remembering these floods because they each flooded about a third of the ground, and the disasters sadly hit the same old lowlands. The city's inundations have been more frequent and have caused more destruction in the last two decades as a result of the cycle of flooding. Despite the

fact that the city does not lie within any major flood zone as described by the meteorological organization and department, it has been subjected to urban and seasonal flooding with negative impacts on the public and their immediate environment in recent decades, which has always had a long-term effect on the residents of the affected areas.

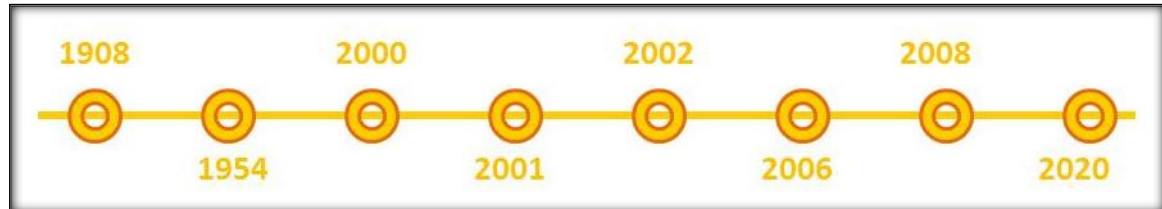


Figure 17: Hyderabad Floods: Timeline

Source: NIUA Report on Urban Flooding, 2016

City leaders, planners, and policymakers face various challenges as a result of urbanization, with urban flooding rapidly becoming a significant one. Urban flooding is caused by inadequate or insufficient storm water drain management, inappropriate planning, invasion of drains and water bodies, encroachment and filling up of low-lying areas, catchment alteration, and climate change. Certain characteristics are commonly associated with urban flooding such as:

1. Increase in flood peaks by 2-8 times
2. Increase in flood volumes by up to 6 times
3. Decrease in time required to reach flood peak
4. Excessive economic losses (loss of life, property, livelihood and productivity)

3.4. Site Selection and Justification

Over the last decade, Hyderabad has spread in all directions and has repeatedly become a hotspot for urban flooding. In the blink of an eye, land use and land cover has changed dramatically, with more impervious surfaces engulfing the green and blue cover. According to the map of India's defined flood zones, Hyderabad is not in or near any of the demarcated zones, but it has been a flood hotspot, which is reason enough for us to resolve the issue as planners and responsible citizens.

CHAPTER 3: STUDY AREA

There are three major reasons why, out of all the metropolitan cities, only Hyderabad is chosen, and they are as follows:

1. Cities multi-directional expansion has been a trend and that extends even beyond Hyderabad district boundary
2. Land cover transformation along with increasing impervious surfaces and this is evident even through various analysis
3. The city and its location despite being far away from all of the demarcated flood prone areas, it still has been a flood hotspot

CHAPTER 4: DATA COLLECTION

The most important purpose of data collection is to obtain information-rich and accurate data from a variety of sources, both primary and secondary, for statistical analysis so that data-driven research decisions can be made. We can retain and analyse important information about the study area, its current and potential inhabitants, by collecting data. The data's reliability is also improved by greater sample sizes and effective research techniques.

4.1. Method of Data Collection

Perception study is the method that has been adopted to understand the situation experienced by the people who are annually affected due to flooding and also to identify the gaps in what government claims to have done and what people have received on grounds till date.

4.2. Primary Data Collection

Primary survey is an important step in all kinds of study, research and other similar processes. It not just gives a picture of ground but also helps knowing about the unknown. Primary data could be collected through various sources such as household surveys and investigations, talking or surveying different NGO's that work in line with similar events like floods or other disaster, surveying officials from various responsible authorities like GHMC or DDMA amongst others and this can also be done by referring to old documents that are available with various agencies, organizations and institutions.

Table 2: Primary data and its relevance

	Target	Data Collected	Analysis	Relevance
Objective 1	To identify gaps and problem (focus) area	Literature on available framework		Basic understanding of the topic and theme. Knowing the global scenario and status with respect to floods. (how they cope, what they do and how can we recover from such events at the earliest)
		Global and national status on flooding		
		Status and causes of urban flooding in India		

CHAPTER 4: DATA COLLECTION

Objective 2	Analysing status of city's drainage network and water accumulation points to identify the flood catalyst	Flood occurrence: History, affected areas, identification of vulnerable wards	<p>Qualitative and Quantitative analysis Along with mapping for spatial understanding.</p> <p>Socio-economic analysis Drainage Density analysis LULC (Temporal) NDVI (Temporal) Land Pricing Watershed analysis Slope Analysis Flow Accumulation Stream Order Analysis Flood Vulnerability (Weighted Overlay)</p>	Finalizing the study area within the selected city for further analysis
		Factors responsible for flooding: Infrastructure coverage (% of area and population catered) and maintenance status		Understanding the study area through peoples lens along with basic analysis based on data collected during primary survey
		Impacts of flooding on people and authorities responsible		
		Losses incurred		
		Mitigation, reversal and recovery strategies adopted		
Objective 3	To quantify how equipped communities and other stakeholders are to cope with flood events	Condition and situation during floods	To assess all the flood prone areas, intensity of impacts, variation in vulnerabilities from one location to other, people's behaviour in flood events and their capacities to recover by Capturing people's perception on vulnerability as well as intensity of impacts and how equipped (capacity) were the vulnerable communities to cope with the disaster. This will	
		Capturing people's perspective on vulnerability as well as the severity of impacts		
		Range of losses to various communities		

CHAPTER 4: DATA COLLECTION

		Role of various stakeholders in recovery process	help me in identifying the gaps that exist in the policies, strategies and governance level.
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Source: Author

4.2.1. Sample Size

Initially some offices were targeted in order to identify the areas and groups that were most affected followed by groups that were moderately affected by the recent flood. After getting information on the affected areas, certain wards and colonies were identified where most of the residents were affected by flood. Due to paucity of time and not to forget the pandemic situation, only 1% samples were collected from each area (48 families out of 4800 affected families).

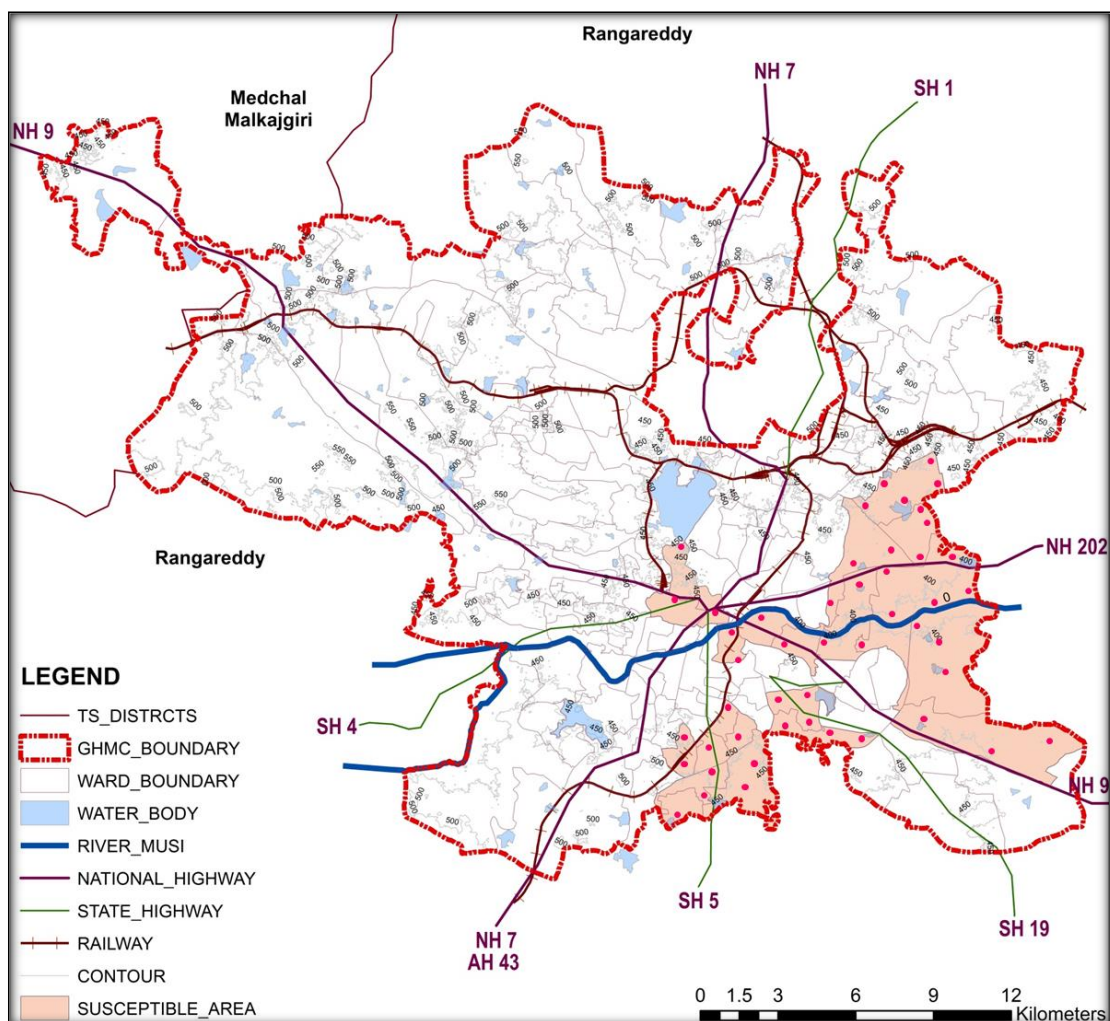


Figure 18: Points of data collection

Source: Primary Survey

4.2.2. Survey Type and Technique

The survey conducted was random but targeted a certain group. To be specific, such areas and people were surveyed those who either live in flood affected wards or were flood victims. The method followed is perception survey and the sample collection was based on snowball technique where one responder leads to another and the process continues. This method was adopted because this helped in reaching out to the target group with convenience.

Snowball sampling

It is a technique in which research participants recruit other people to take part in a test, sample and survey. It's used when finding prospective participants is difficult. Snowball sampling is named for the fact that once the ball starts rolling, it picks up more "snow" anywhere along its way and grows bigger and better. A non-probability sampling approach is snowball sampling. It doesn't have the same level of probability as, say, plain random sampling (where the odds are the same for any particular participant being chosen). Rather, the researchers chose participants based on their own judgment.

This method is especially useful when people don't want to be identified. For instance, if a study was looking at exam cheating, pickpocketing, substance abuse, facing something unpleasant, or some other "unacceptable" social activity, potential participants would be hesitant to participate due to the potential consequences. Other research participants, on the other hand, are likely to know someone in similar situations and may tell them about the study's benefits while assuring them of anonymity and confidentiality.

There are two stages to snowball sampling:

1. Determine if there are any possible subjects (initially) in the population. Sometimes, only one or two subjects are discovered at first.
2. Request that those individuals select others (and then request that those individuals recruit others). Participants should be informed that they are not required to have any additional names.

4.2.3. Nature of Questions

1. General details/ profile (to know the socio-economic status)

2. Situation then (during flood) and now (recovery phase).
3. Level of inundation?
4. Level and type of loss?
5. How have you dealt with the event?
6. When did secondary stakeholders reach?
7. Steps taken by responsible authorities?
8. Positive (Right) step
9. Negative (Wrong) step
10. Role of affected and unaffected communities in the vicinity?
11. Dis public participate in the flood management process. If so, how and to what extent?

4.3. Secondary Data Collection

A wide range of data and information has been provided by various agencies and organizations which further added to advanced analysis. Some authentic data on plans, policies as well as infrastructure has been provided by the GHMC (SNDP section) that has helped in analysis of drainage availability, drainage density and also flood vulnerability.

CHAPTER 5: DATA ANALYSIS

All data collected is analysed in this chapter, and loopholes in the current scenario are discovered so that the ground reality can be understood and corrected or addressed with relevant suggestions in the next chapter. As a result, residents and the city will be more prone to floods, as well as changes in the economy, health care, and other critical areas. The process of ordering, structuring, and giving value to the collected data is known as data interpretation and analysis. It plays an important role in spatial planning because it aids in the decision-making process for the area's growth and development. The research conducted in this section can help in a small way. The set of analyses performed in this section would help to meet the objectives two and three goals in part.

5.1. Socio-Economic Profile

The socio-economic profile has been evaluated on the basis of age, educational qualification, occupational engagement, source of income, household size and income, along with land holding size and all these data were collected during the field visit from 26 February 2021 to 6 March 2021. The data gives a rough idea about the ways in which the flood affected people and such flood events are almost an annual event for them. The relation between their social and economic lives tells a lot about their adaptive capacity along with coping mechanism.

5.1.1. Age and Gender profile

Age defines every community and its capacity to deal with a certain event or in this case disaster. Thus a comprehensive analysis is a must to understand and identify what role the predominant age group could possibly play in any similar event in future. Thus, this analysis will guide in formulating appropriate strategies that the existing community structure could readily adapt and be ready to fight similar event and bounce back better in future.

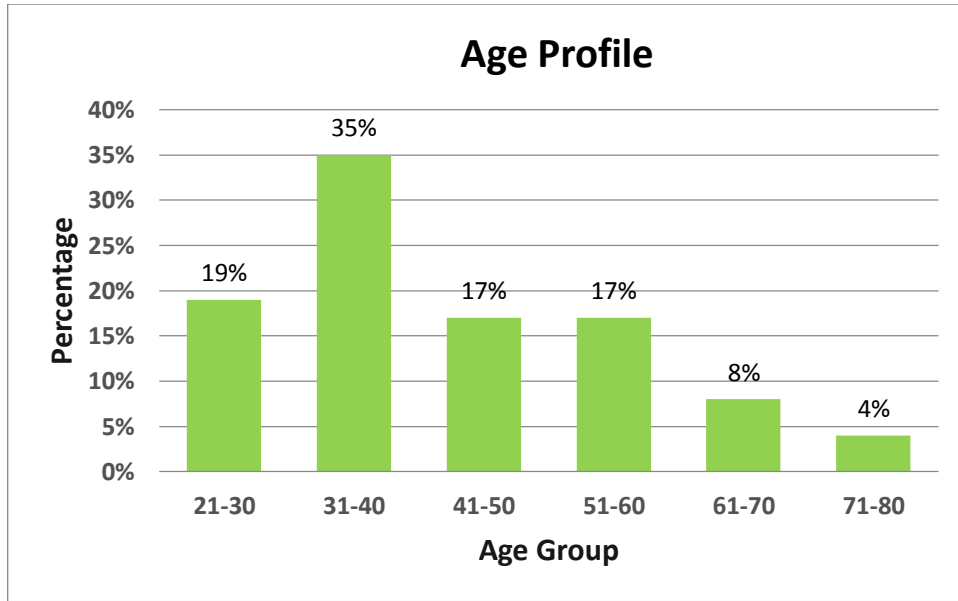


Figure 19: Age profile of the responders
Source: Primary Survey

The Figure above shows distribution of responders based on their ages. The age factor plays a major in the process of policy making as the implementation and success of the policies, schemes and various other initiates are defined by the acceptance of it among various people. If we as planner and policy makers go for designing policies and schemes as per the predominant age of the citizens, there will be higher chances of proper implementation and success of the same.

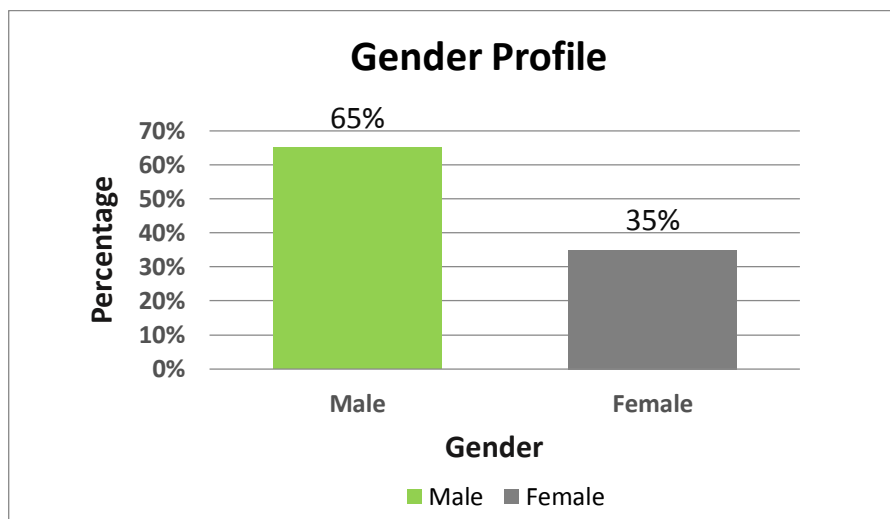


Figure 20: Gender profile of the responders
Source: Primary Survey

Out of the total responders, 65% were male whereas 35% were female. Though the affected areas had a good mix of male and female just like the state’s sex

ratio but while conducting survey, the responders to could spare time were male. Just like age, gender too has a role to play in determining the speed of recovery. A community with high number of male has lesser challenge in overcoming the disastrous situation as they can help other in recovering and rehabilitating. Also they also extend a psychological strength to their family members too.

5.1.2. Educational Profile

As known to all, our activities reflect our mind and thus it can be stated that education has a key role to play when it comes to the acts and action of an individual or a community. A well trained mind will show a well-trained body. Education will lead to better wellbeing and awareness and hence one who has basic understanding of good and bad, dos and don'ts, he would never go wrong with his basic activities. Then may it be acting in a certain way or doing a certain thing, especially in times of a disaster. The figure above shows a picture of well-educated society who could easily be taught about or imparted with flood based knowledge in order to enhance their resilience.

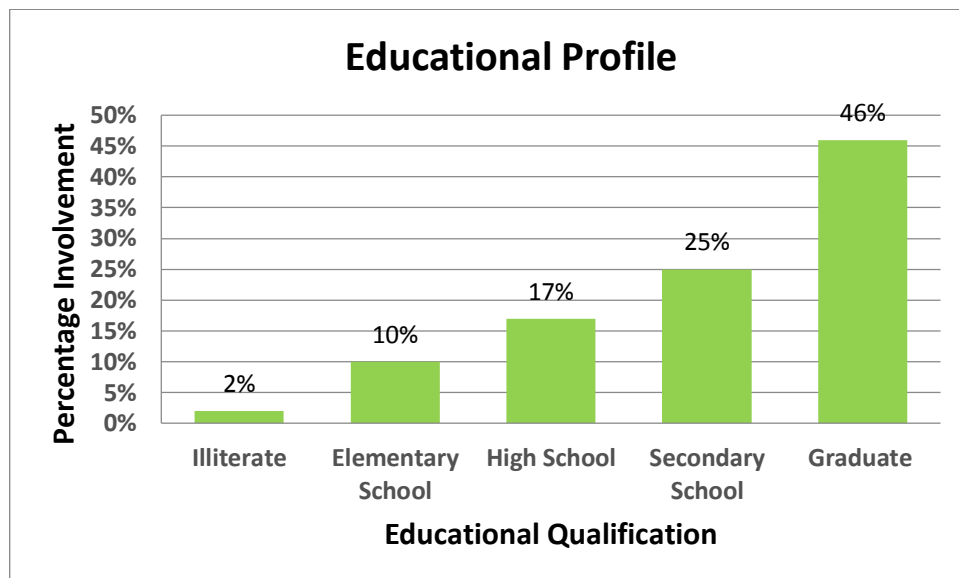


Figure 21: Educational profile of the responders
Source: Primary Survey

5.1.3. Occupational profile

The figure above demonstrates that most of the affected families either belong to EWS, LIG or MIG (few families). Majority of the responders are in private jobs or business. This also indicates towards lack of employment opportunities which

could possibly help in improving their lifestyle as well as their resilience as resilience is direct and positively associated with the income.

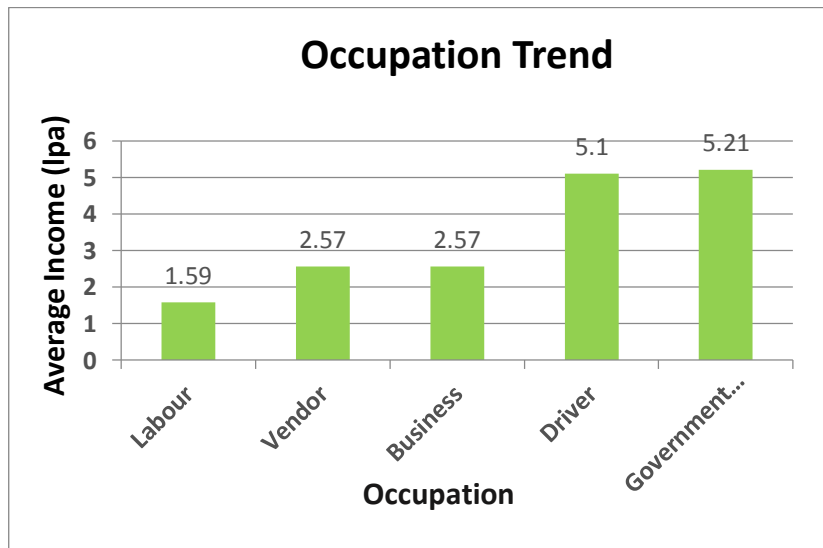


Figure 22: Occupational profile of the responders
Source: Primary Survey

5.1.4. Source of Income

The graph below shows how people have self-employed themselves as an outcome of unemployment. Based on the responders' narrative on how they landed up taking this profession, most of them had the same answer to the question. Where they revealed their interest or inclination toward government or public sector jobs but since they couldn't find one for them hence they landed up doing what they are doing now.

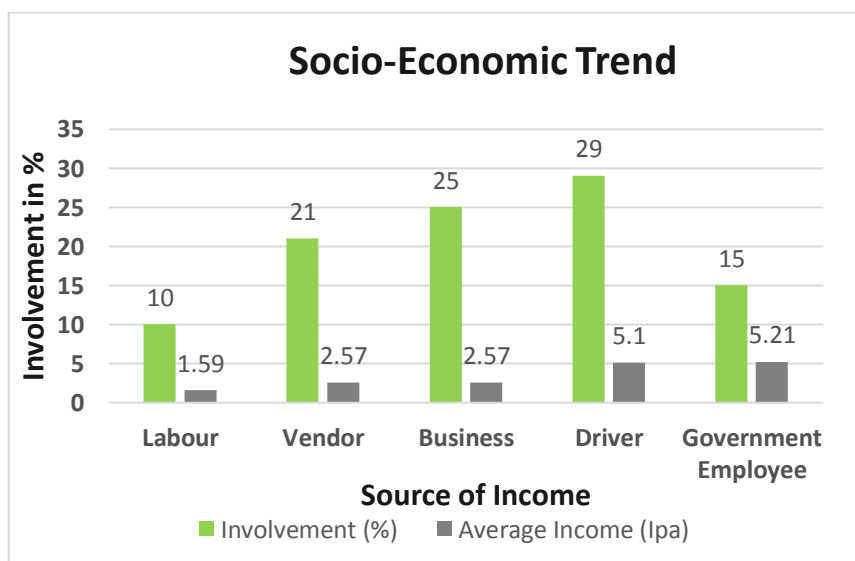


Figure 23: Income sources and distribution
Source: Primary Survey

5.1.5. Household size

The family size gives a picture of the ethnicity as well as culture of the place, the community and the society. Large family size indicates joint families and it has been seen that families that have more member in it has to adjust and sacrifice a lot in their day to day life.

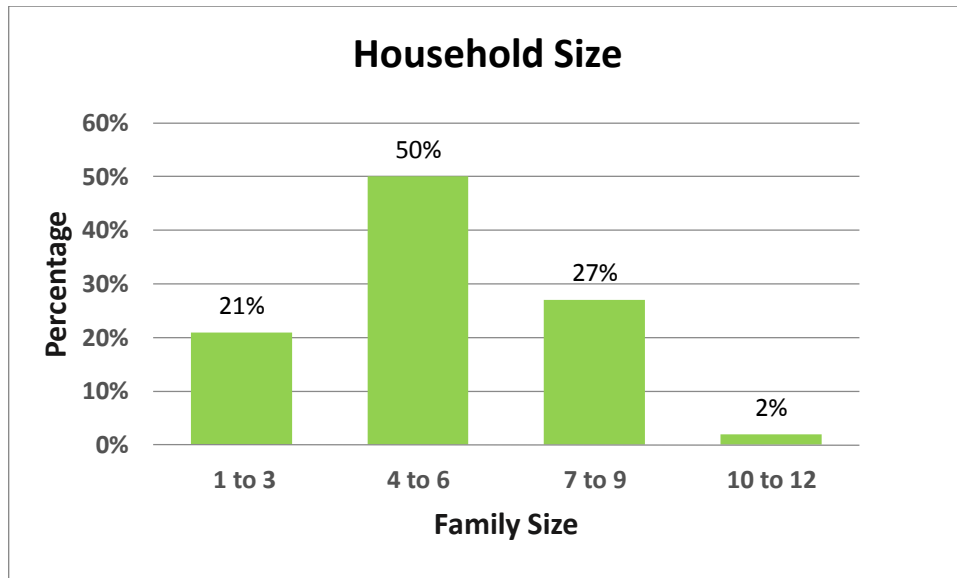


Figure 24: Household size
Source: Primary Survey

5.1.6. Household income

Income is one of the factors that determines as well as affect one’s ability to deal and cope with the disaster. But it is unfortunate to see how people living in the vulnerable areas are highly prone to the impacts of flood not just because of their geographical location but also because of their financial condition which is hardly about four to five lakhs per annum. One who is earning to somehow fulfil his day to day needs will for sure fall prey to floods. To control or mitigate the impacts of flood on these residents we need to either train them or make them aware of what is to be done before, during and after the disaster hits.

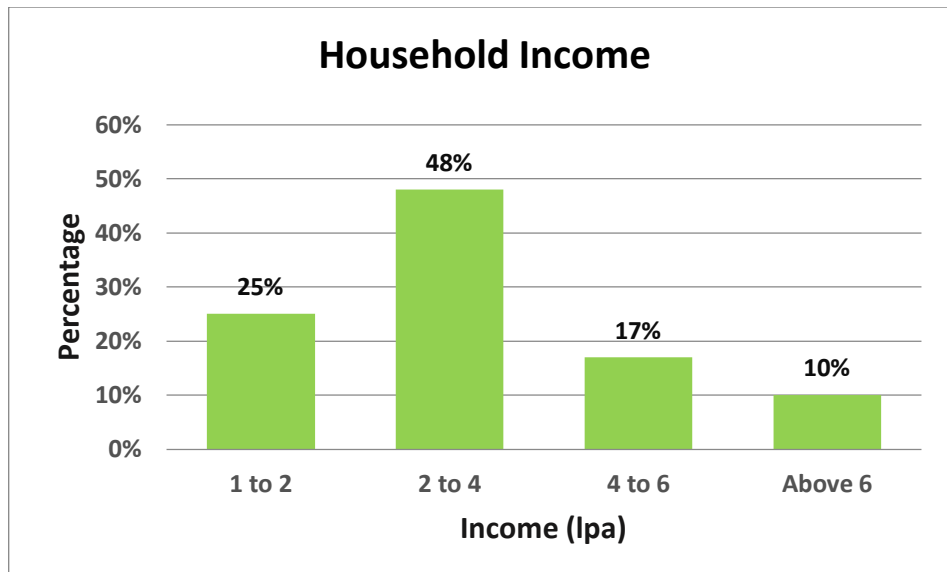


Figure 25: Household Income
Source: Primary Survey

5.1.7. Land Holding size

The land holding size along with family size describes the condition of living. Land holding size should ideally be directly related to family size but in case of Hyderabad city, it is just the contrary. Land holding size is small and family sizes are large and this indicates a situation where people live in congested or poorly serviced condition. Such conditions could further increase the risk of being affected by floods because in areas that are congested, it is difficult to manage any event or disaster that is sudden in nature.

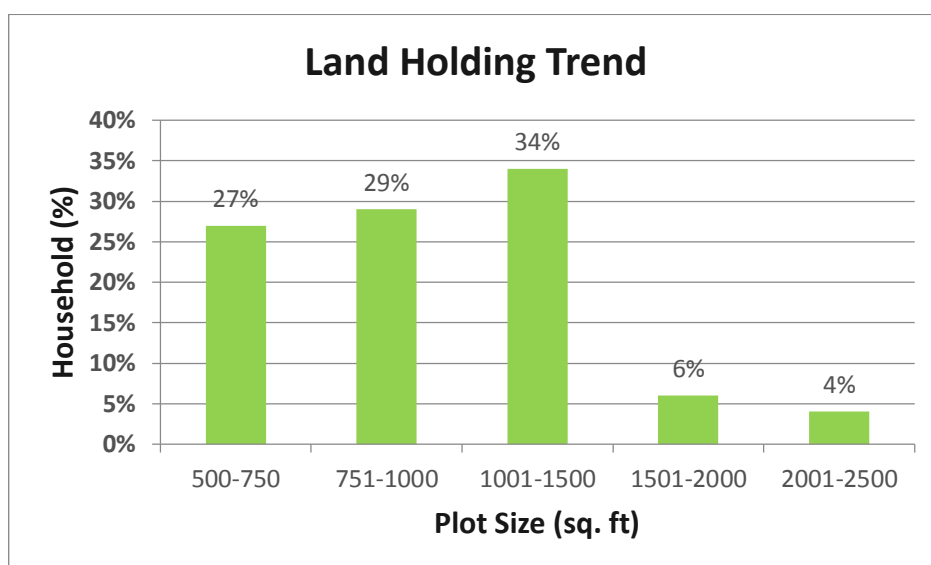


Figure 26: Land holding pattern
Source: Primary Survey

5.1.8. Adaptive Capacity

Adaptive capacity is one such factor for which the analysis is completely based on the narrative during the site visit. As per the responders awareness is concerned, just few of them were aware of the fact pertaining to loss and damage. It is surprising to learn how people living in present day modern era of technology and yet are deprived of the facts that are a must know for certain group of individuals. This in itself is enough to prove that we need to work towards betterment of the society in a way where people are taught about their surroundings which would include all the risk and benefits that they are or could be exposed to in future. People residing in the wards that are most vulnerable, has hardly any knowledge about mitigation and adaptation strategies.

5.1.9. Level of Satisfaction

Majority of the responders were dissatisfied by the initiatives taken by responsible authorities because that made the condition even worse. The only help that were extended to the affected families are Relief/ Recovery initiatives by GHMC: Food packets and 10,000 per family in all the affected wards. People are dissatisfied by the approach adopted by the GHMC's that has focused only on equality but in such situations, equity proves to be a better option for recovery.

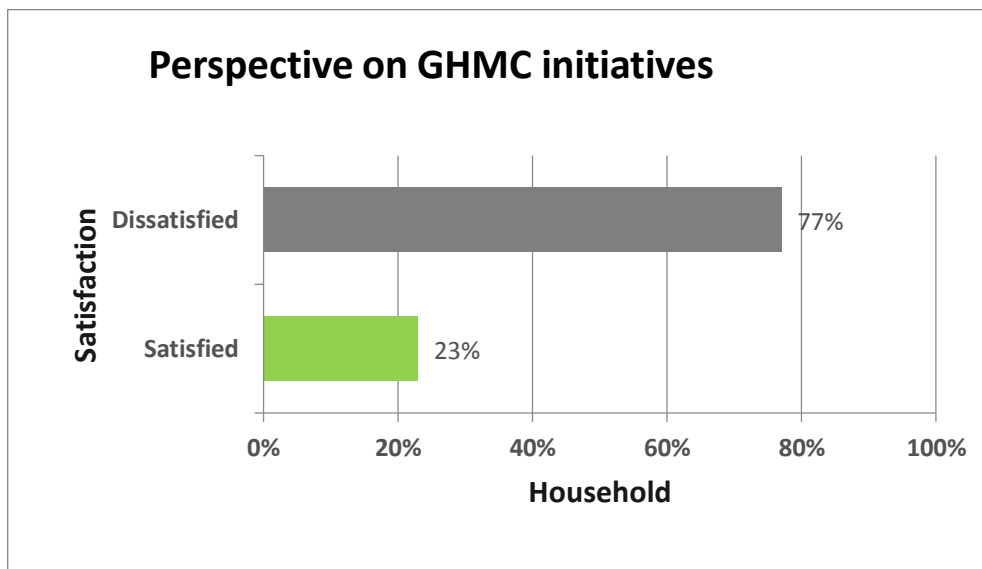


Figure 27: Initiatives by local government
Source: Primary Survey

5.2. Physical Profile

The city of Hyderabad is renowned both geographically and culturally for its rich history, food and its multi-lingual culture. Hyderabad was originally built on the banks of the Musi River. It now stands on the south bank of the river and is now known as the historic old town of Charminar, Falaknuma Palace, Chowmallah Palace and Makkah Masjid. It is the twin towns Hyderabad and Secunderabad separated from the Sagar Hussain by the man made a lake of Ibrahim Qutb Shah in 1562, and bound by the "Tank Bund." The town is located on the Decan Plateau and reaches an average altitude of 536 m. The city is at the latitude of 17.366 degrees N and 78.476 degree E.

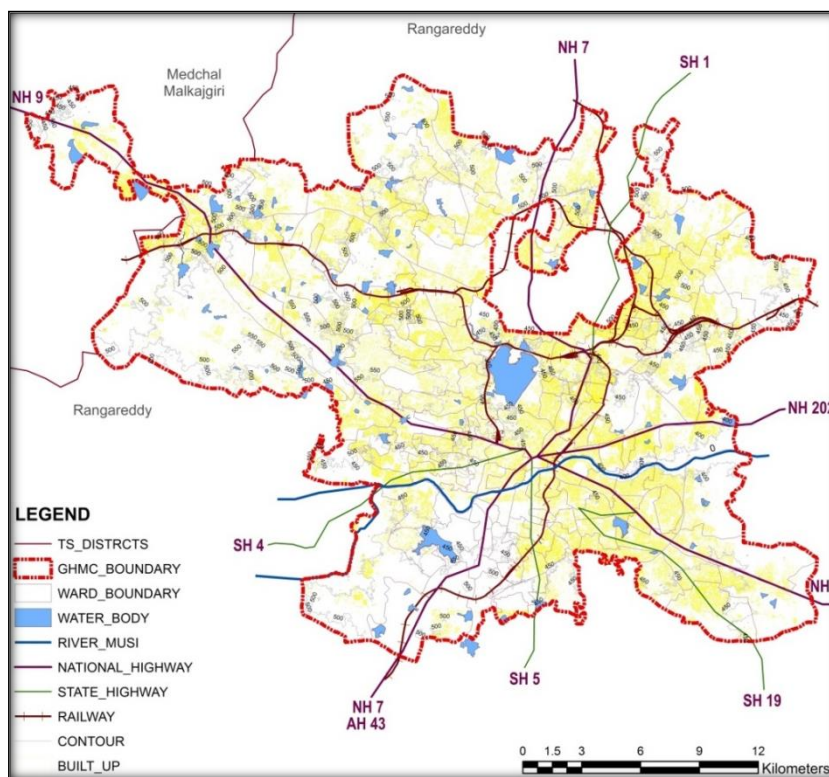


Figure 28: Base map - Hyderabad city

Source: Author

The map above shows the regional setting of the Greater Hyderabad city. Through the map it is evident that river Musi divides the city into two halves, northern and the southern. The general profile of the city is such that the lower/southern part is densely populated because of two reasons. The first reason being, the core city part or the old city area comprises of wards on the southern bank of Musi. The second reason being comparatively lower land prices that makes this area affordable for even the immigrants.

5.2.1. Land Value

It is well known that land is of the most precious and essential resources which is limited. Thus it is vital to value such a natural resource and to do so; we must evaluate its holistic value (social, economic, agricultural) and co-relate it to present monetary value (Manganelli, 2013). Such co-relation helps in understanding the urban morphology. For an architect, developer or planner it is highly important to understand the land prices as such studies and analysis helps in successful planning and physical development (Rodas, 2018). Land, apart from being a limited natural resource, it also faces great pressure as a result of increasing population and their activities such as agriculture, over irrigation and ground water exploitation (Zheng, 2003). Thus, land is one of the matters of concern when it comes to planning and development.

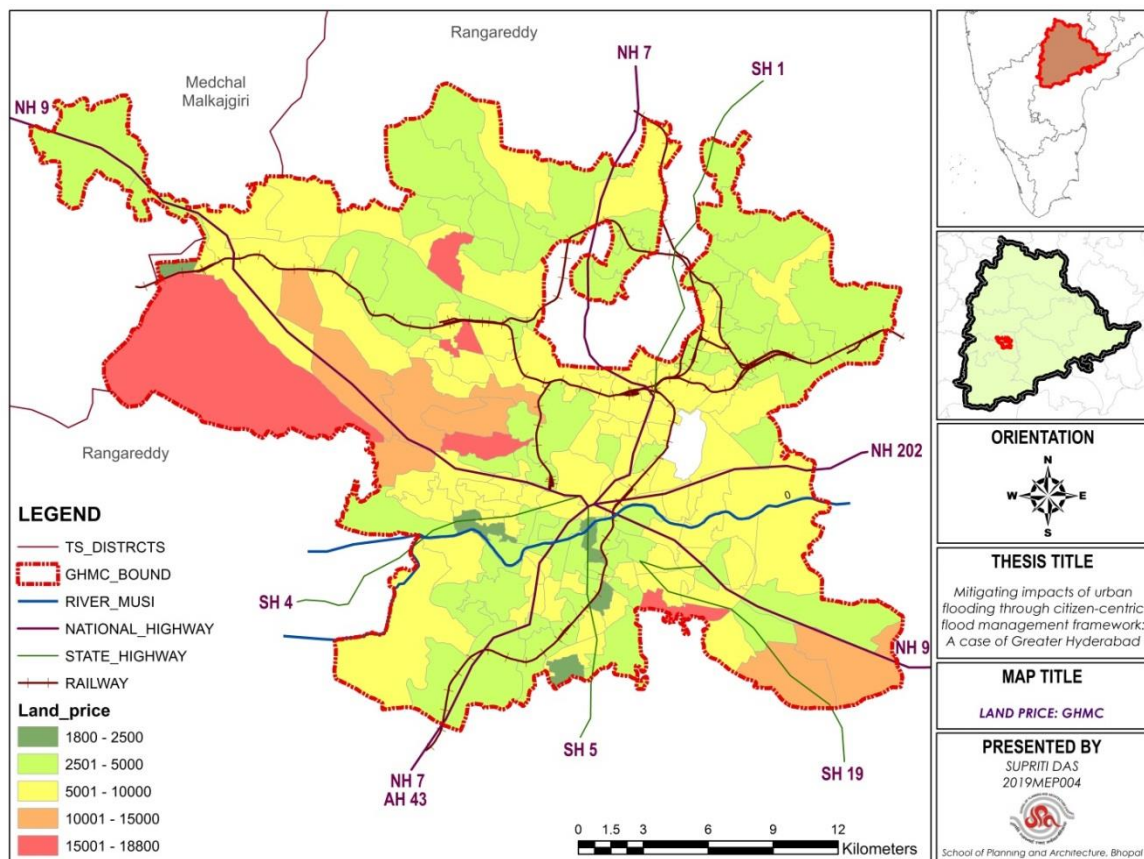


Figure 29: Land value - Hyderabad city

Source: Author

The land-value map demonstrates variation in land prices (given rates are at Rs. /sq. ft.) within the GHMC boundary. These values could be related to population as well as population density as we know that areas having low land prices

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attract immigrants as well as people who are looking for property/ shelter at comparatively lower price. The city area (Central part in the map) is low to medium prices and the reason behind this is congested condition in which people manage to live and anybody who could afford to pay for a safer and better place won't come to the core areas. In Hyderabad, Banjara and Jubilee Hills are the most expensive (residential cum mixed land-use) wards whereas Gachibowli (part of Cyberabad) is the most expensive commercial ward as it houses most of the MNC's and other corporate offices.

5.2.2. Population Density

Population density is yet another factor to be considered in planning and developmental processes as it throws light on how future would be (Tang, 2019). A place associated with low density for a long illustrates peoples dislike to accept that place as their habitat or place of work and on the other hand, any place with higher density demonstrates public's liking and priority to be that area.

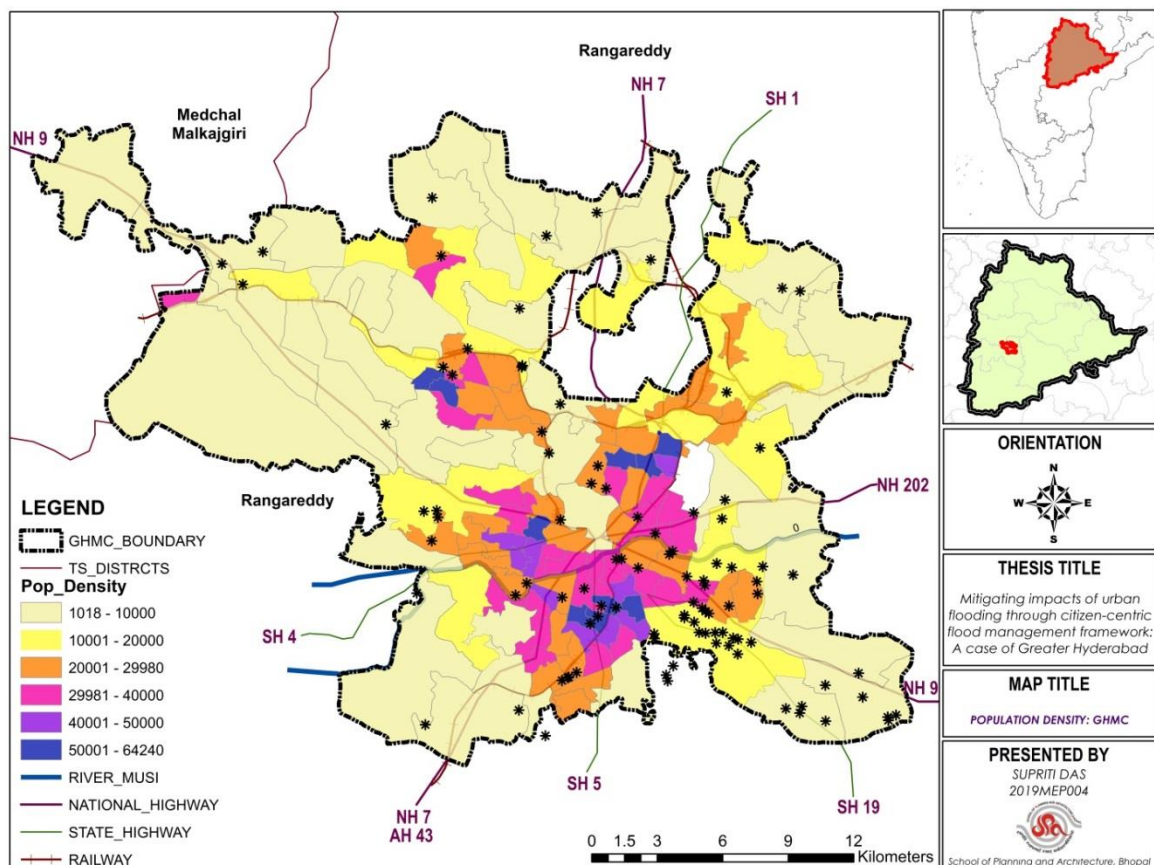


Figure 30: Population density - Hyderabad city

Source: Author

Population density could be a result of various factors such as access to basic services, connectivity, distance from work place, safety and security and a lot more (D.Debarma, 2019). Thus the southern part of the city that is old as well as core of the city is densely populated and this has been represented in the map. The map represents range of population density and on comparing land value and population density map it can be stated that areas having low land prices are highly populated. The points in the population density map represents water accumulation points and from this it can be inferred that mostly water accumulated within wards with higher density and thus the flood impacts affects substantial number of residents. Thus, this research aims to mitigate these impacts and this will eventually decrease the loss to life and property as well.

5.2.3. Wards exposed to flood risk

While studying an issue like flood, it is important to identify the areas that are most likely to be hit or are vulnerable to flooding as such mapping helps in understanding the flood situation, risks, impacts and target groups for the study.

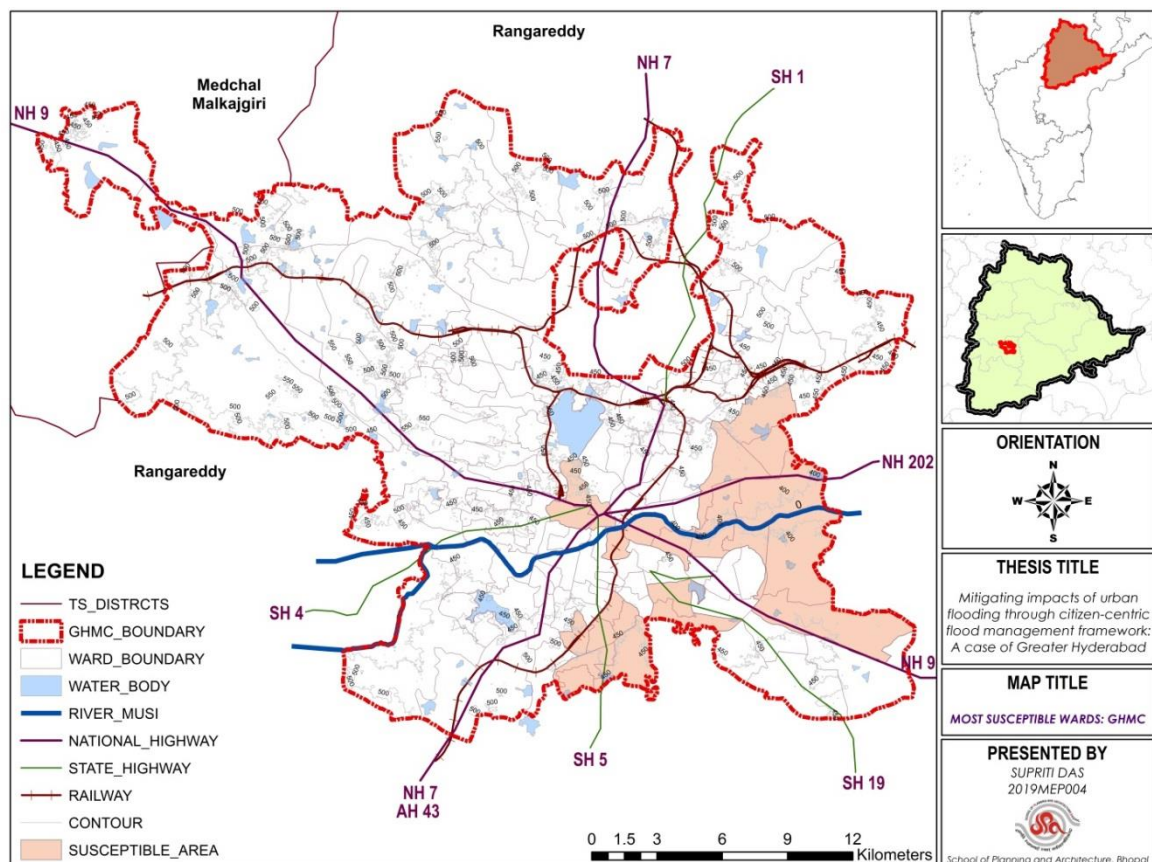


Figure 31: Most susceptible wards - Hyderabad city

Source: Author

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The reason behind this (Flood situation) could be many such as general elevation, topography, physical infrastructure, and maintenance factor or construction pattern. But once the root cause of a disaster is identified along with the areas that are being exposed to it, then conducting a compressive analysis becomes easier because one could easily acquire data regarding the same.

The wards that have been highlighted in the map above are the wards that get flooded every monsoon season as they have poor drainage network system and moreover the increasing population particularly in these wards are making them even more prone to flood events by imposing pressure on poor infrastructure that is in place.

5.2.4. Watershed

Watershed mapping and analysis helps in natural resource (water) studies. It also guides in resource centric planning and developmental approach which further results in a nature-centric development (Shukla, 2011) (Montgomery, 1995).

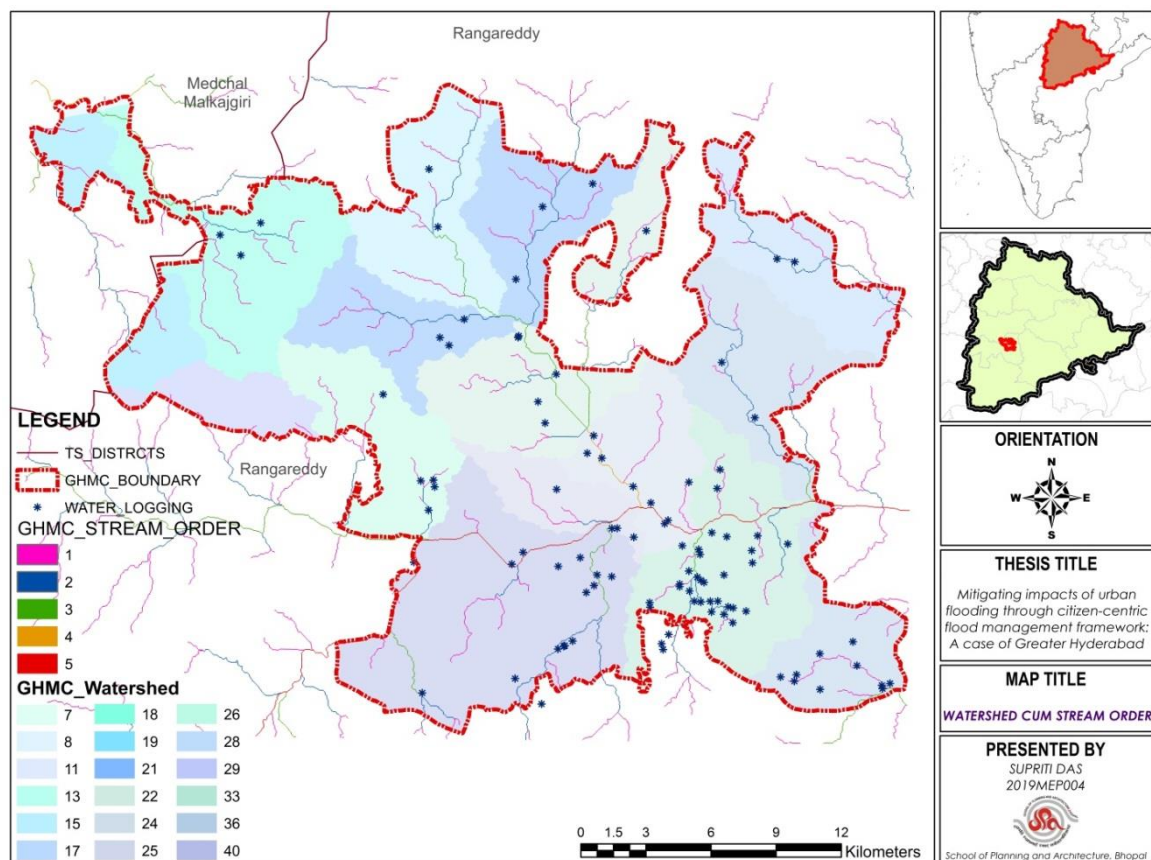


Figure 32: Watersheds - Hyderabad city

Source: Author

Also the city comprises of 18 watersheds out of which 13 watersheds have water accumulation points which indicates toward organic development and poor land use planning. Such conditions on ground are outcome of illegal encroachment or even could be a result of unplanned development. The wards that are either completely or part of watersheds being poorly managed will be exposed to flood risks until they are provided with proper infrastructure to cater the issue. Thus, addressing water logging along with flooding should be one of the priorities.

5.2.5. Drainage density

Drainage density analysis helps in identifying the impervious and concreted areas along the channels and these further guides in demarcating location where water percolation and infiltration capacity is low (Tucker, 2000). Usually, area with high drainage density has low percolation capacity. Thus, in areas with high drainage density, water either accumulates or flows at high rate through a narrow or smaller area causing flood like situation (Fenta, 2017).

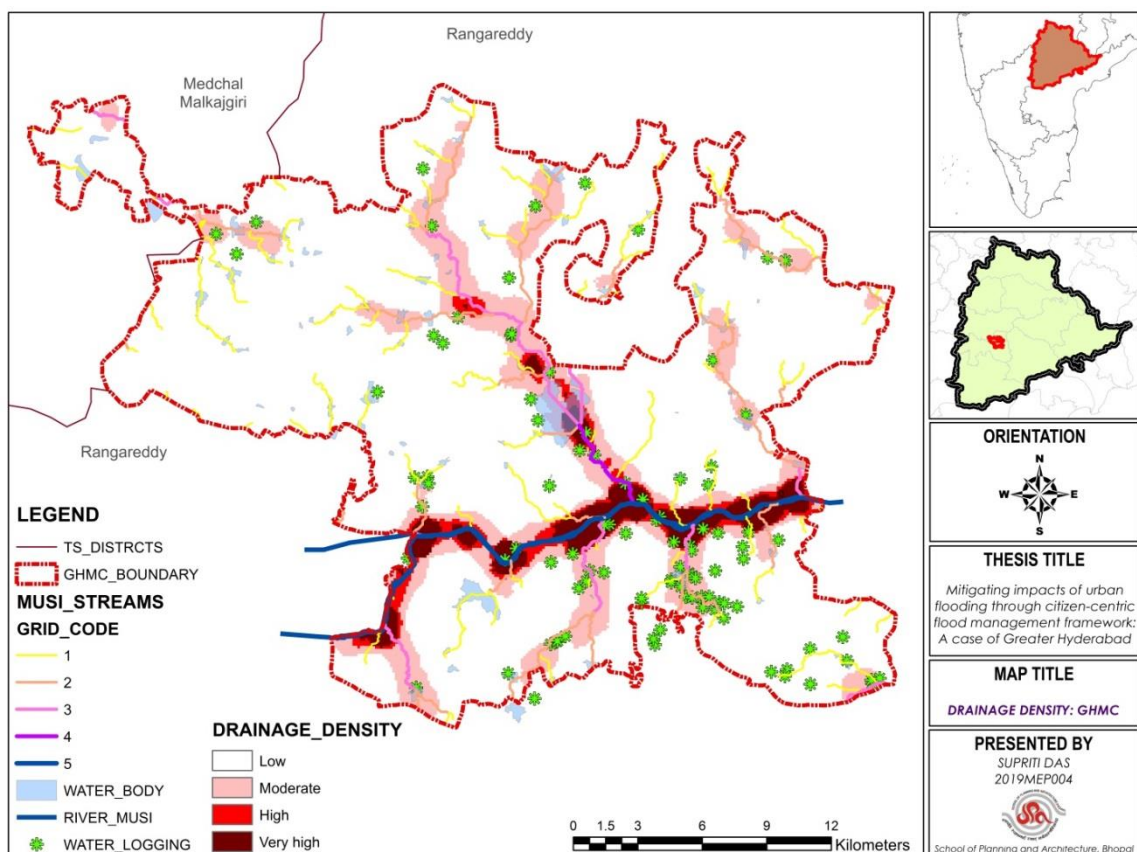


Figure 33: Drainage density - Hyderabad city
Source: Author

The map above represents the drainage density within the study area. From the map it is evident that fifth and fourth order streams are either river Musi or a stream emerging from it therefore the drainage density is high along these two classes of streams. But on ground the water gets accumulated in areas having presence of third order stream. Even the moderate level drainage density causes such furious conditions hence we must take a step in line with the same so as to arrest the flood severity at the earliest and to the greatest extent possible.

5.2.6. Slope

Contour is an important factor to be considered for higher efficiency in settlement planning. It helps in studying the slope of the given area and thereafter plans could be made as per the slope because it is well known that there is no alternative for nature and natural forms (Vartanian, 2013). Following the contour or nature slope will not just help in controlling urban issues but it will also help in making cities most-efficient in terms of basic services.

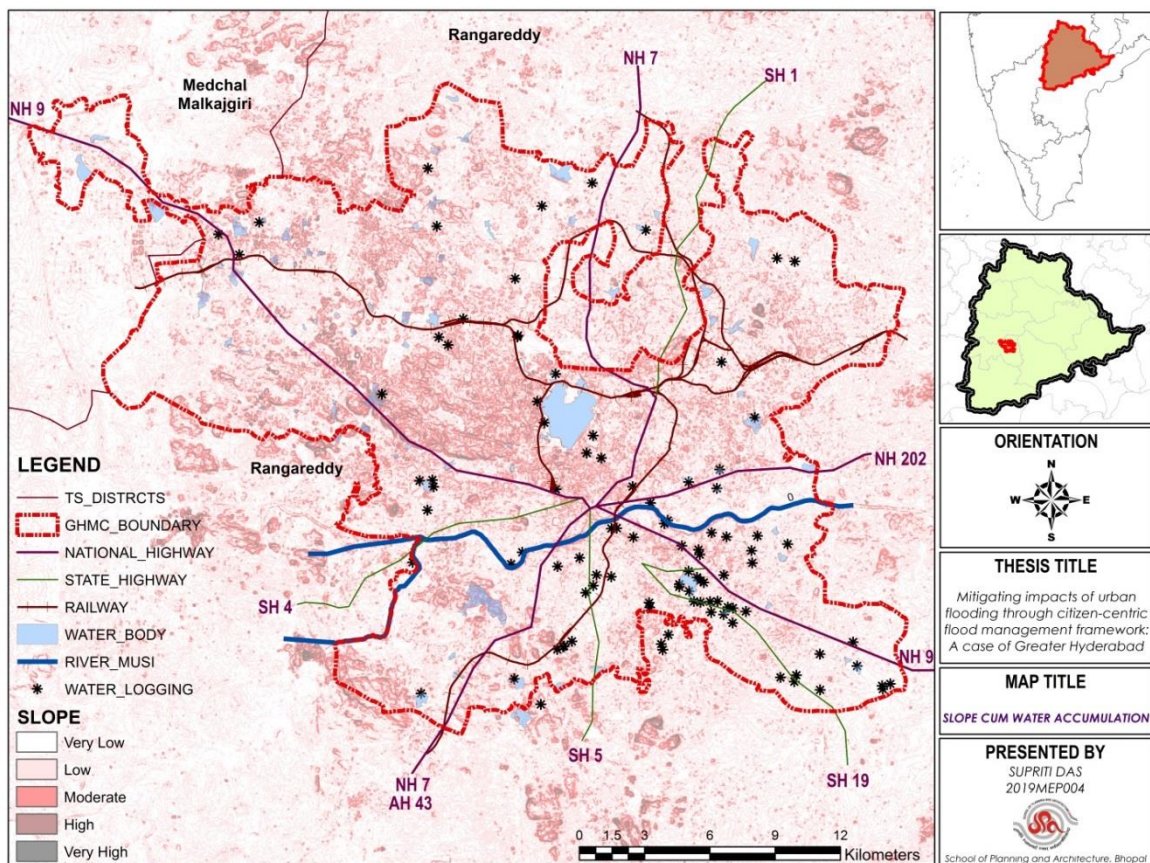


Figure 34: Slope - Hyderabad city

Source: Author

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The map above represents slope of the study area. As it has already been established that slope plays a major role in determining water flow within any given region. May it be associated with drainage or storm water or even domestic water supply, natural topography has a lot to do with all of the above mentioned services. It is evident through the map that most of the accumulation points are located at low-lying areas of the city. So we can infer that it is the planning that is faulty and this needs to be rectified in order to prevent and control flood occurrences.

5.2.7. Normalized Difference Vegetation Index

Normalized Difference Vegetation Index is a technique that is popularly known for its ability to monitor vegetation of any given area (from macro to micro scale). NDVI as a technique is of great significance to planners as it helps in differentiating between various land cover such as water, vacant/barren land, constructed patches, shrubs and healthy/ dense vegetation on ground (Albarakat, 2019) (Zaitunah, 2018).

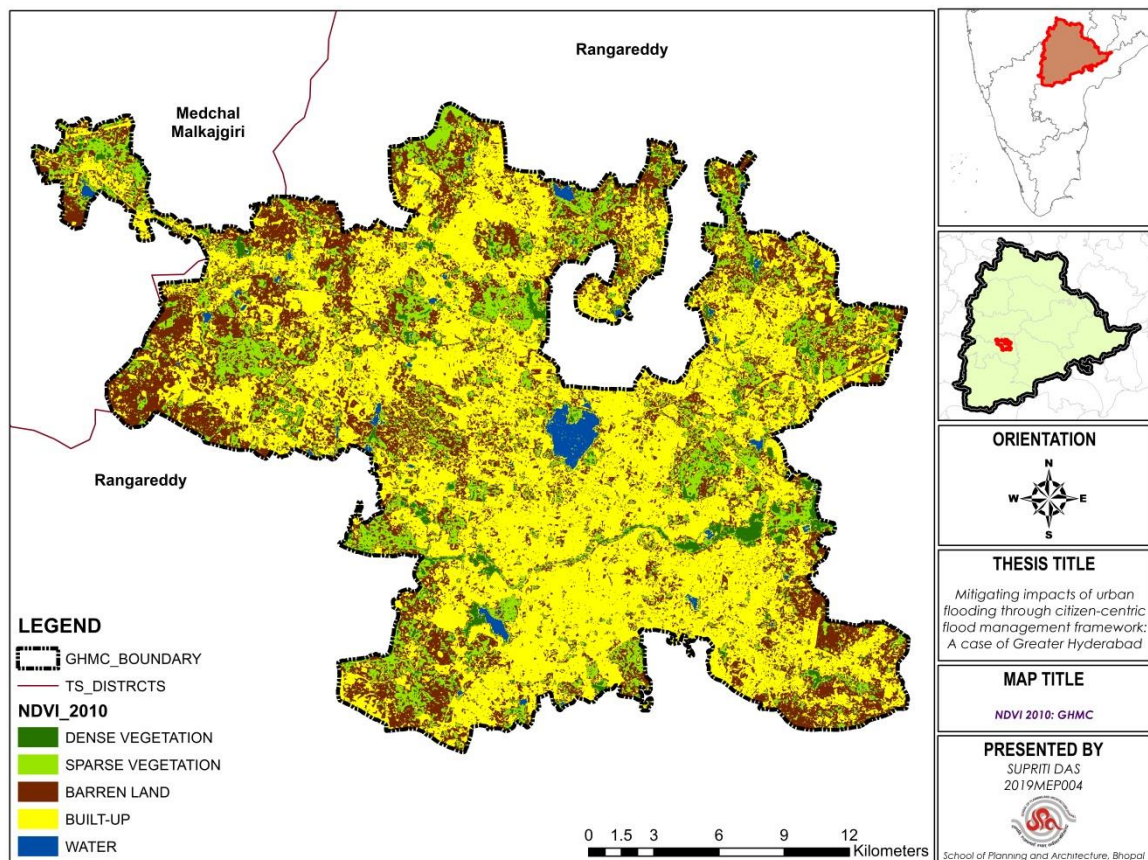


Figure 35: NDVI for 2010 - Hyderabad City

Source: Author

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On comparing NDVI of varying years, one can study the changes and differences brought in or that has been introduced in a span of designated years. Such analysis shows area and percentage change in land cover under various types (ones mentioned above). NDVI analysis for the year 2010 and 2020 has been done for this research and those maps have been attached below.

The map above represents the Normalized Difference Vegetation Index for the year 2020. NDVI helps in identifying the areas having vegetation as all the vegetated parts reflect the green rays and those rays are used to determine the level and health of vegetation. In the map above, green patches demonstrate vegetation health in such a way that darker the colour, higher is the vegetation density and better is its health. IN 2020, the city had green patches that are good healthy vegetation scattered throughout the city along with built-up and also barren land. The most healthy vegetation patch is found along the river Musi because of the water flowing through the river supported vegetation.

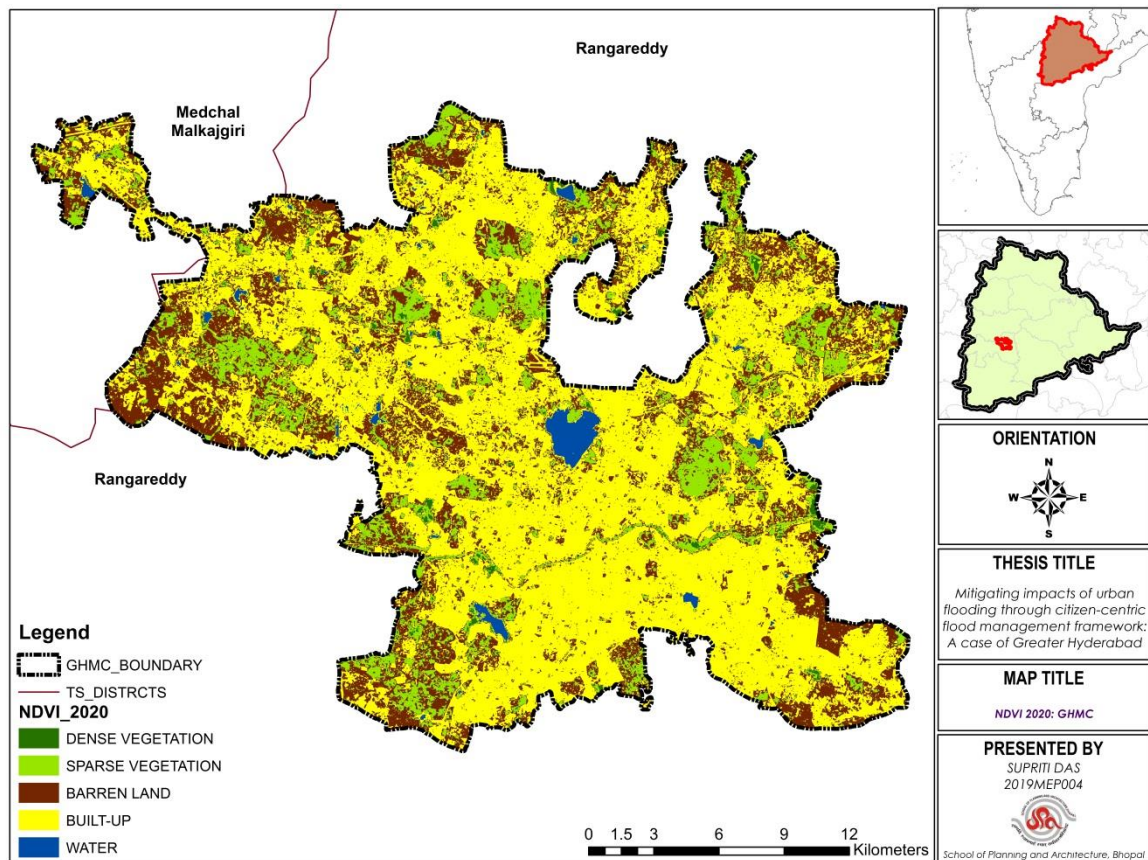


Figure 36: NDVI for 2020 - Hyderabad City

Source: Author

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The map above represents the Normalized Difference Vegetation Index for the year 2020. Since NDVI maps are used to identify the health of vegetation, where dark green colour shows healthiest vegetation. But in NDVI for 2020, it is evident that the healthy vegetation that existed along river Musi in 2010 is now absent and has been replaced by the barren land. The reason behind this change is stagnant water in the Musi and also reduction in quantity of water flowing through Musi over a span of ten years. Thus the green patches turned into shrubs and further into barren lands. Also it is worth noting that most parts of vegetation have either transformed into barren land or has been encroached for construction purpose.

Table 3: Comparative analysis of NDVI between 2010 and 2020

Normalized Difference Vegetation Index				
Land Use	Area_2010	%_2010	Area_2020	%_2020
Water	9.8	1.5%	8.2	1.25%
Built-up	331.5	51%	383.5	59%
Barren Land	195	30%	169	26%
Sparse Vegetation	97.5	15%	84.5	13%
Dense Vegetation	16.2	2.5%	4.8	0.75%
TOTAL	650 sq. km	100%	650 sq. km	100%

Source: Author

5.2.8. Land Use Land Cover

Land use land cover is a technique that is known to monitor the change in our surrounding, especially on the land. It demonstrates change over a period of time for which the analysis has been done. Today, rapid urbanization is one of the major matters of concerns as we have limited resources and unlimited needs to be fulfilled (Twisa, 2019). In such tough times it is the LULC that will help us to keep a check on the pattern of change around us and for a sustainable future; we must all take responsible steps towards it (Kafi, 2014).

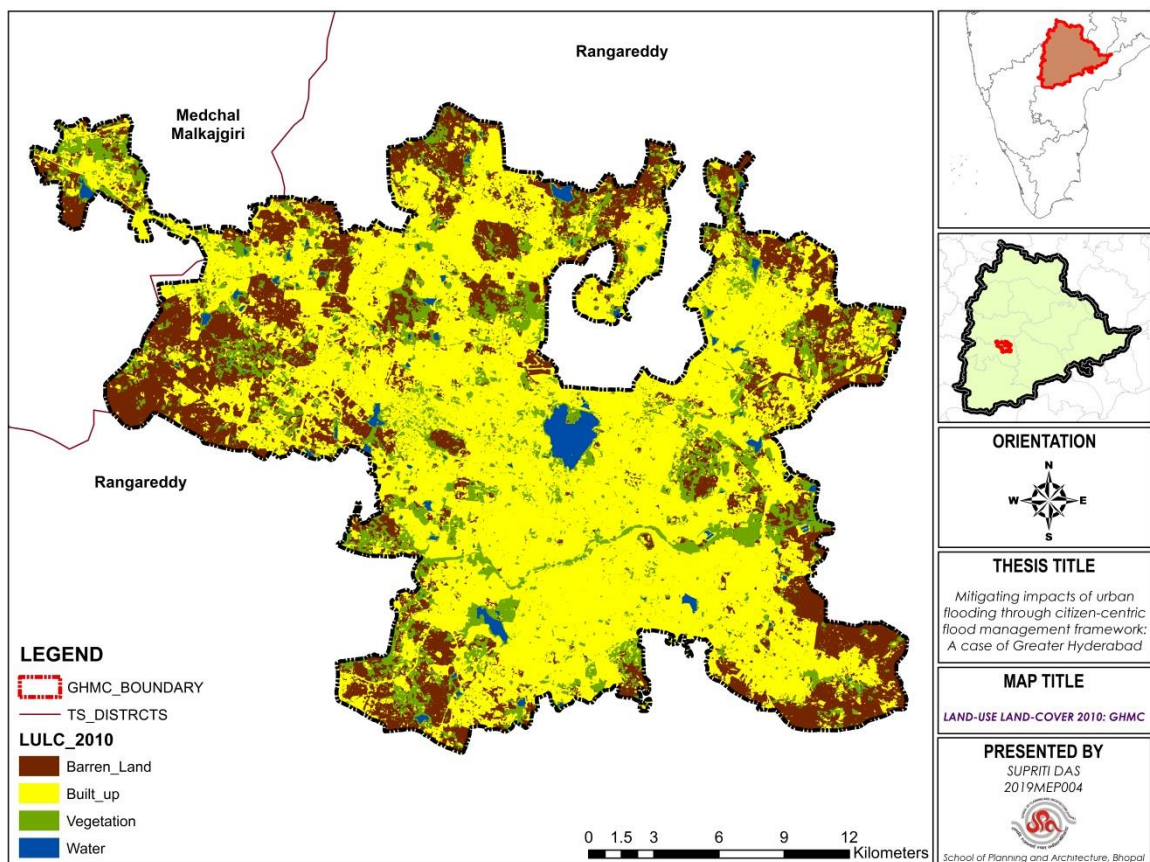


Figure 37: LULC for 2010 - Hyderabad City
Source: Author

The map above represents the LULC for the year 2010. The LULC mapping helps in identifying the land cover pattern of a given area on ground and in analysing temporal change in case it is required. From the map, it can be inferred that the maximum land is covered by built-up (including residence, industries and commercial structures), followed by barren land and green patches. Similarly, it can also be said that there are vacant or barren land left at the periphery of the city limit which has high potential of growth in years to come.

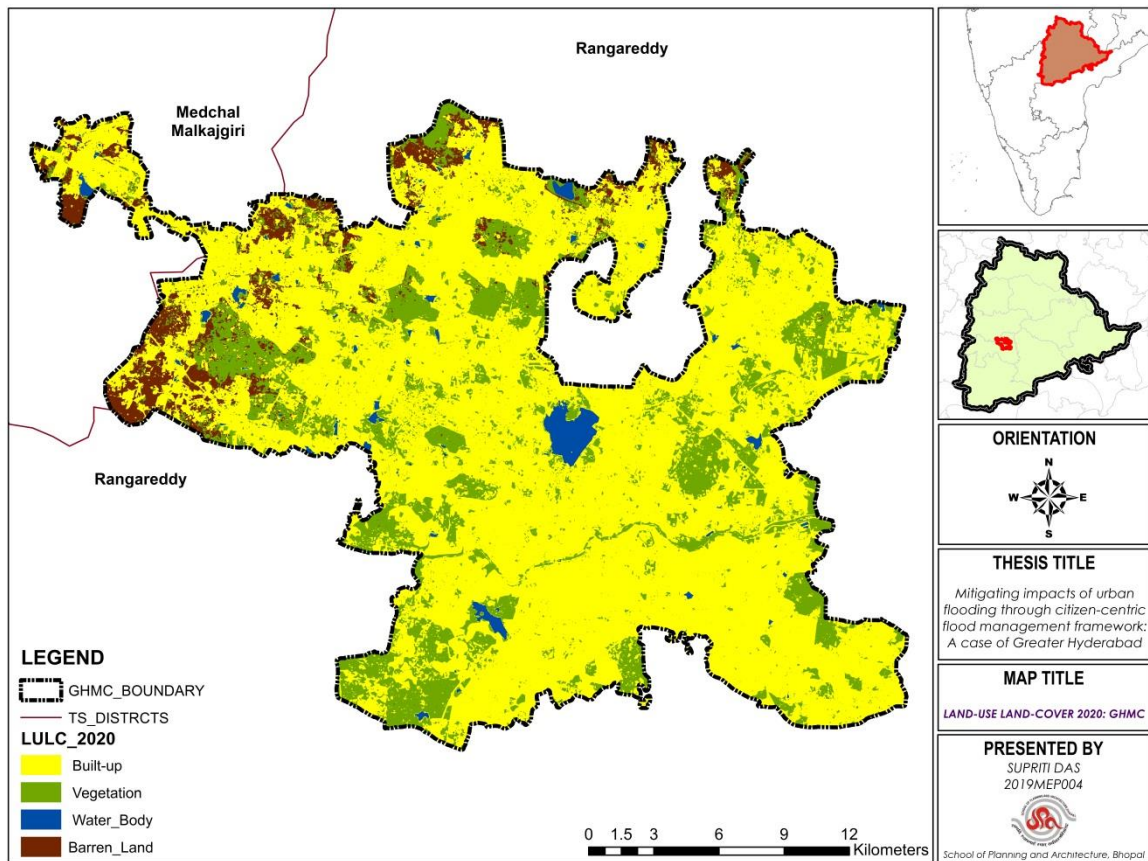


Figure 38: LULC for 2020 - Hyderabad City

Source: Author

The map above represents the LULC for the year 2020. The map clearly demonstrates that majority of the city’s land has been covered by the built form. It also reflects how the peripheral areas have been developed over a period of ten years which has left no land vacant unlike it was back in 2010. Only few areas in the Cyberabad remains vacant and the reason is the area being commercial which only allows just few activities and also there are restrictions to what could be built. Thus from the map it can be inferred that the south-eastern part of the city has transformed the most in terms of land cover change (from vacant and green spaces to build forms, especially residences).

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Table 4: Comparative analysis of LULC between 2010 and 2020

Land Use and Land Cover				
Land Use	Area_2010	%_2010	Area_2020	%_2020
Water	11.1	1.7%	10.4	1.6%
Vegetation	97.5	15%	128	19.7%
Barren Land	156	24%	33.8	5.2%
Built-up	385.4	59%	477.8	73.5%
TOTAL	650 sq. km	100%	650 sq. km	100%

Source: Author

5.2.9. Flood Vulnerability

Flood vulnerability is defines as an individuals or a group’s capacity to withstand, cope and recover from flood (Nasiri, 2016). In areas that have been suffering from flood like disasters should be addressed at the earliest. For addressing such an issue one must first conduct a vulnerability analysis in order to identify and demarcate the areas that are most vulnerable followed by areas with moderate and low vulnerability respectively (Munyai, 2019). In a metropolitan city like Greater Hyderabad, there is an urgent need to address the flood related issues as it is associated with physical, social as well as economic losses. As a planner one must try to design spaces in a way that they are safe to reside.

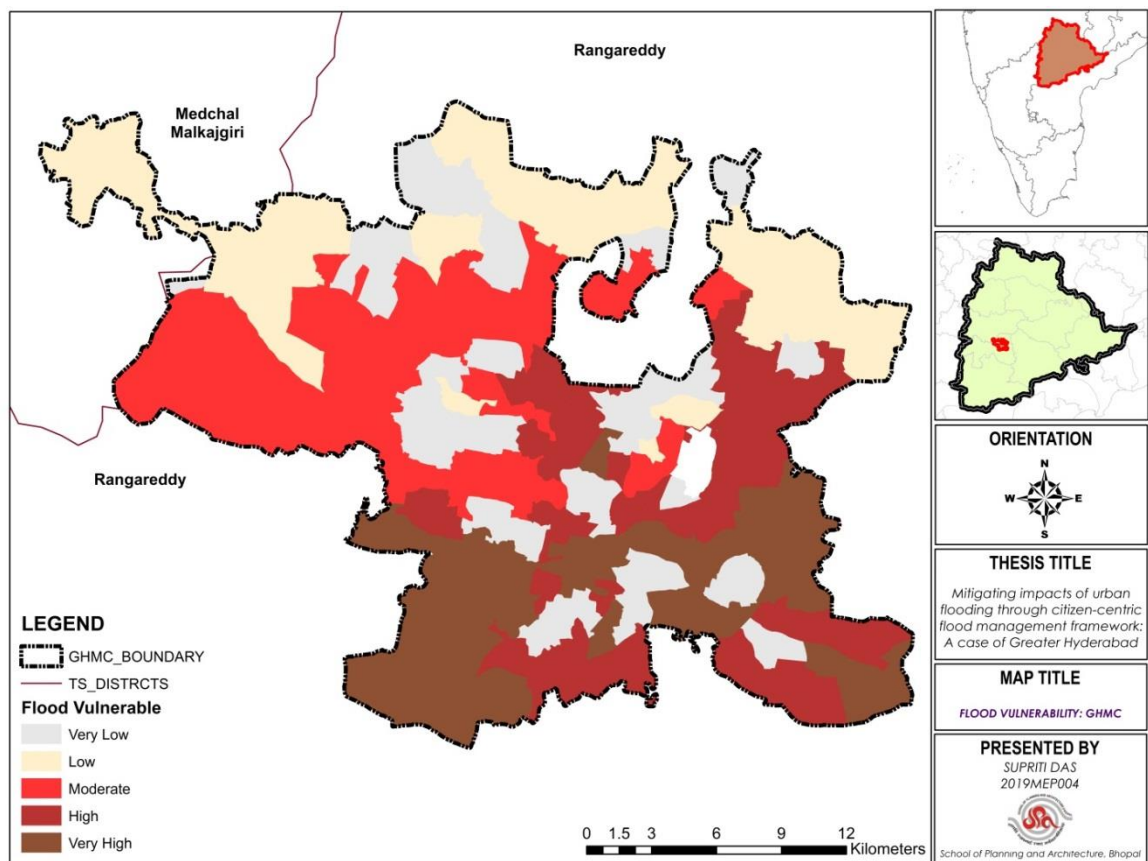


Figure 39: Flood Vulnerability - Hyderabad city
Source: Author

The map above represents the range of vulnerability for the Hyderabad city and this has been done using a technique called “weighted Overlay’ which has been performed using ArcGIS as a tool.

From the map it is prominent that the southern part of the city is most prone to the risk of floods because of large low-lying patches that exists, higher population

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density; mostly water accumulates in the wards lying in the southern part and higher drainage density that persists which means the high density of concrete structures have clogged the surfaces and thus floods are prominent in these areas.

The weights have been taken based on several research papers and those are as follow: 10% to LULC, 15% to Watershed and Stream Order each, and 20% to Slope, Flow Accumulation and Drainage Density each.

CHAPTER 6: KEY FINDINGS AND PROPOSAL

The chapter will include some of the possible spatial as well as policy level recommendations that would minimize the risk of flooding, make communities better informed and resilient to floods in future by altering the micro-climate to some extent. This will not only make people more adaptive but will also help in making the city flood proof for the future.

6.1. Key Findings

1. Most parts of the city are well connected to the municipal drainage network except for some parts in Cyberabad (recently developed part). But the infrastructure network in place are old, poorly maintained and are inefficient to withstand heavy/ excess water.
2. Most of the affected families belong to EWS, LIG or MIG (few cases/ families) which makes the situation even worse as people from EWS or LIG do not have appropriate means or strategies to cope with the disaster and also to recover.
3. South-eastern part of the city was most affected and the major reason behind this is natural topography. This part of the city is comparatively low lying and thus all the excess water came down and gets accumulated.
4. Period of Inundation: 30-45 days
5. Unreported deaths and missing cases have been file, this show the lack of institutional efficiency. Responsible agencies do not have any records or documentation of such cases.
6. Initially (for two days) only communities help each other.
7. Areas that were affected have land prices (constructed) ranging 1800-10000 per square feet.
8. Integrating technology with the existing system becomes important in order to enhance community's resilience.
9. Extension of drainage network is the need of an hour, keeping in mind the population growth rate.
10. Plantation drives are needed to compensate for the increase in impervious surface.

6.2. People's perspective on their adaptive capacity

On surveying people, especially who were flood victims had poor or no coping mechanisms as such. Although floods are quite frequent in Hyderabad but they have never been this wild and intense for a long time. Thus, people have poor awareness, preparedness and mechanism to fight the flood situation. Also it has been observed that people belonging to lower-income groups are mostly marginalized as they do not have any representation the any of the processes thus they are unheard and all their needs too get ignored. This is a vicious cycle of excluding the marginalized and talking about gaps in integrated approach for addressing urban issues.

People are interested to know issues that surround them; they are looking forward to learn and educate themselves with how to deal with issues around them at micro level, individual and community level. Since people are aware of the fact that they have low to no capacity when it comes to dealing with unexpected and uncertain events like flood. The reason being, they have never been given any lesson or have never been exposed to any such event before which had causes damages anything like 2020 floods.

To overcome all such lacunas, especially within urban limit; we must come up with strategic plans for flood management, urban renewal that could reverse the effect of development to some extent, and most importantly involve people from the civil society in the processes.

6.3. Impacts of flood on people

Flooding has a wide range of consequences for people. People are stressed on several levels, not just when flooding happens, but also in the lead-up to a flood, as well as during the clean-up and recovery process. Flooding can cause property loss, residential destruction, financial hardship, and emotional distress. As a result, dealing with flooding will bring people together, cultivating community spirit and goodwill.



Figure 40: Impacts of flood on the society
Source: Author

Loss of life and property: Flooding has immediate effects, including loss of life, property damage, crop destruction, livestock loss, infrastructure failure, and health problems caused by waterborne diseases. Flash floods that occur suddenly with little to no notice kill more people than slow-moving riverine floods. Floods can cause harm to personal property, such as cars and houses, as well as unsafe living conditions if the water is not removed quickly.

Loss of livelihood: When communication links and services such as power plants, highways, and bridges are lost or damaged, economic activities come to a halt, resulting in dislocation and the dysfunction of everyday life for a time well beyond the duration of the flooding. Similarly, direct effects on output assets, whether in agriculture or manufacturing, can stifle routine operation and result in

job losses. Also in non-flooded areas, the impact of the loss of life can be felt in industry and economic activities.

Resource shortage: During major flood events, ineffective planning, management, and response can result in public dissatisfaction, resource shortages, havoc, or a lack of confidence in authorities, particularly state and Central government. Lack of growth in flood-prone areas can lead to socioeconomic inequity, which can lead to social instability, posing a threat to regional peace and stability.

Health and psychological effect: Flood is one such event that can cause strong and negative impacts on human health as it is mostly associated with epidemic or water borne diseases post-flood. It can also impact people psychologically because many of the flood victims have to lose their near and dear ones to floods and some of them might even lose all of their savings while fighting the floods and it all depends upon the flood intensity and ones range of exposure as well as vulnerability.

Anxiety, fear, rage, frustration, sorrow, and grief are some of the emotions that flood victims may feel. It's normal for people who have been through traumatic events like floods to have trouble sleeping, lose their appetite, have depressed or angry moods, and have heightened feelings of anxiety. Organizations coordinating emergency response, such as municipal corporations and non-governmental organizations, often make mental health practitioners available that is very much needed.

Disrupts activities: When major floods occur, such as the floods in Chennai, Kerala, Mumbai, and Hyderabad, day-to-day operations come to a halt because communication and transportation networks are flooded; causing transportation and other transport-dependent or related services to get affected.

Migration: Flooding that occurs on a regular basis, resulting in the loss of livelihoods, production, and other long-term effects on the economy and forms of suffering, can result in mass migration or population relocation. Migration to established urban areas exacerbates city overcrowding. These refugees increase the ranks of the urban poor, and many of them end up living in low-lying parts of

cities that are usually prone to flooding and other natural disasters. Selective labour outmigration can often result in complex social issues.

Economic losses: The high cost of recovery and rehabilitation may have a negative effect on services and other development activities in the country, and in some cases, may weaken the region's already fragile economy. Flooding in a region on a regular basis can deter long-term investments by both the government and the private sector. A lack of livelihoods, as well as the displacement of skilled labour and inflation, can hinder a region's economic growth. As a result of the loss of money, product and service costs will rise, delaying development plans.

6.4. Impacts of flood on environment

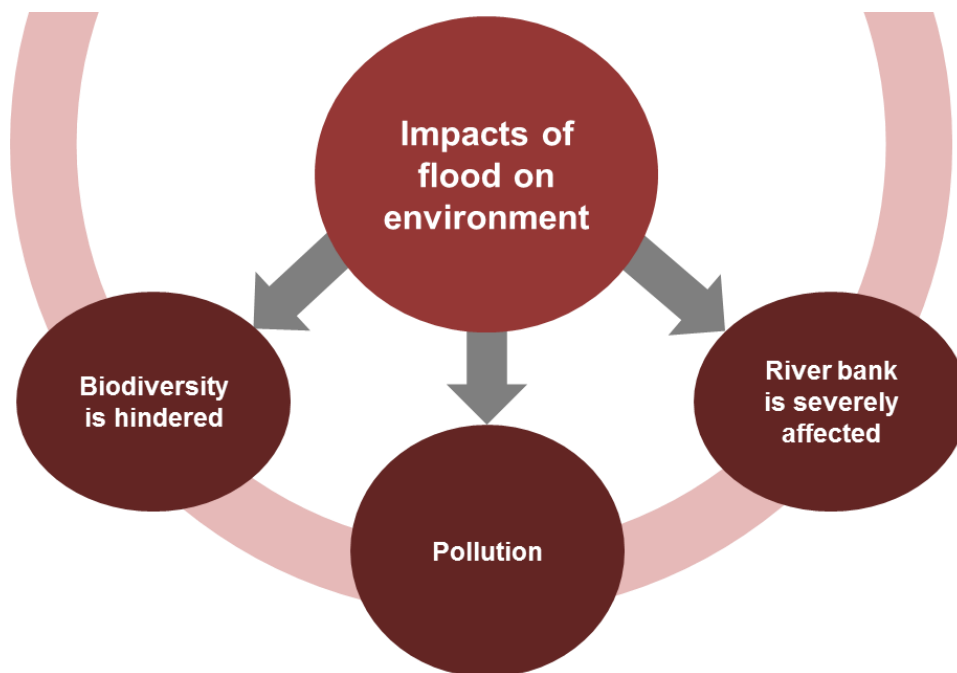


Figure 41: Impacts of flood on the environment

Source: Author

There are a wide range of impacts that the floods have on the environment and some of them have been discussed below:

1. Biodiversity is hindered by floods because of the force that water exerts on the trees and other vegetation and once the vegetation is gone, it takes along birds, animals and other organisms that might otherwise regulate micro-climate.

2. Floods are known for causing pollution by stirring all the land areas and its components. Post-flood, all we see is waste and other unwanted items every here and there and this needs to be tackled through a long-term and a strategic plan.
3. River banks and areas along the rivers are mostly affected because when water flows at its peak, takes away all that it can. Thus we need to strengthen the areas along rivers and this could be done by planting trees along the river Musi, in case of Hyderabad.

6.5. Recommendations

Recommendations call for explicit steps to be taken in strategy, practice, concept, or future studies. There are several gaps in the literature that should be addressed in order to contribute to the field of planning. Recommendations are based on the findings of the study which show what actions or directions should be taken.

6.5.1. Riparian Buffer to control and prevent flood occurrences

A riparian buffer, by definition, is a vegetated “buffer-strip” near a stream that helps to cover and largely shield the stream from the effects of nearby urban, commercial, or agricultural land use. Riparian areas provide food, shelter, and water to a wide range of species, and they also act as migration routes and rest stops for a variety of wildlife. Riparian buffers are the lands and plant communities that line rivers, streams, bays, and other bodies of water. Buffers have high soil moisture, are prone to floods, and are home to biodiversity that has evolved to live alongside water. Stream banks are stabilized and floodwater velocity is limited by trees and grasses in riparian areas, resulting in lower downstream flood peaks.

Riparian buffers are one of the most effective techniques for reducing non-point emissions and improving water quality along with decreasing flood frequency. The trees, shrubs, forbs, grasses, grass-like plants and other vegetation that grow along streams are known as riparian buffers. These plants help to prevent erosion by filtering and cleaning the water.

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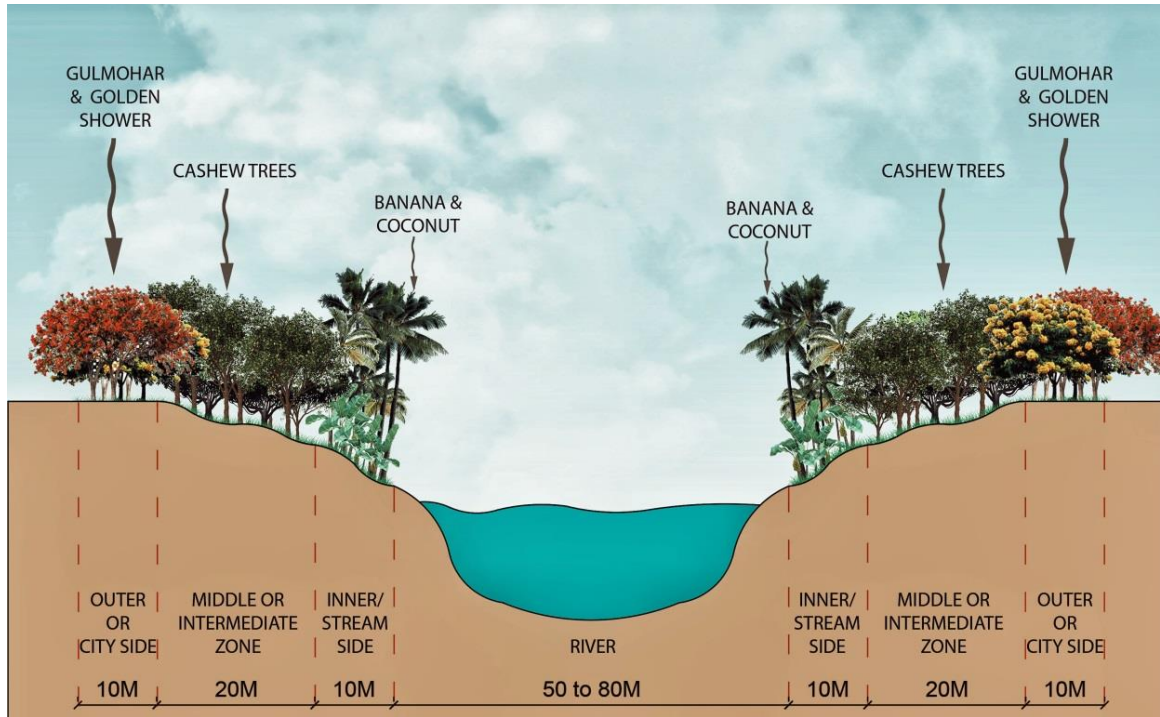


Figure 42: Riparian Buffer along Musi River (Sectional Elevation)
Source: Author

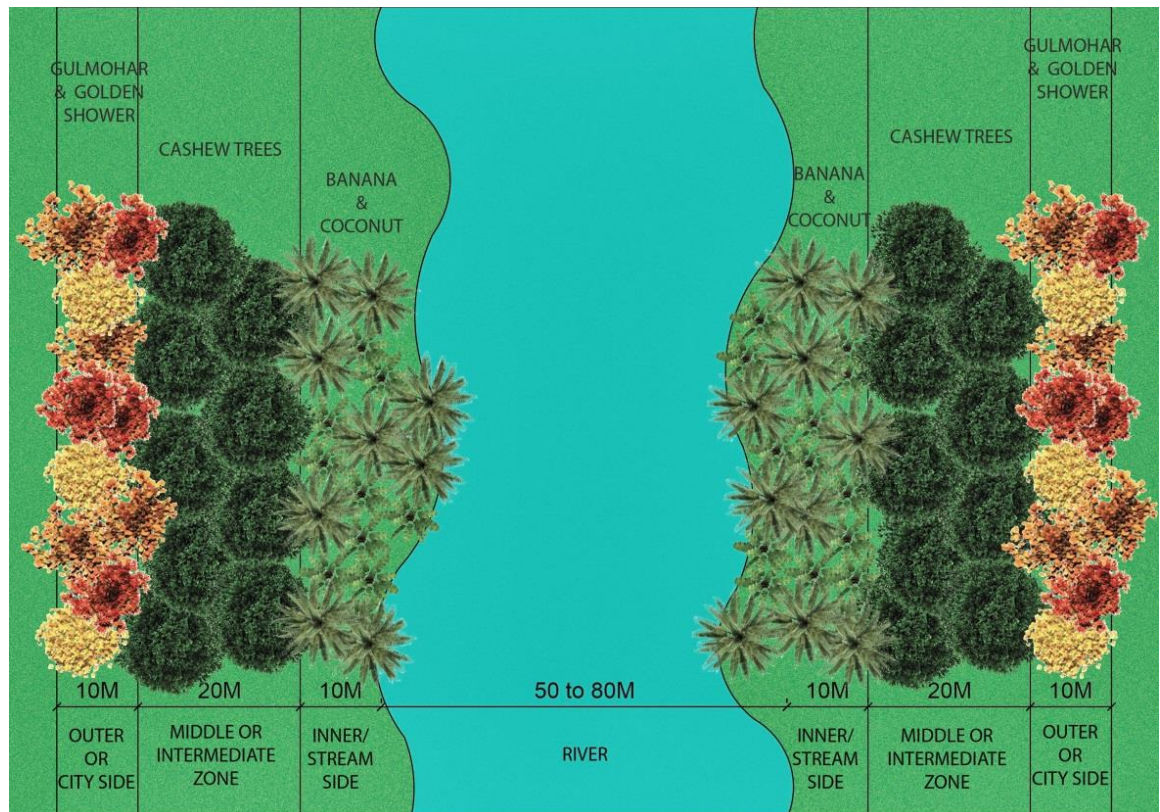


Figure 43: Riparian Buffer along Musi River (Plan)
Source: Author

It has numerous benefits associated:

1. Improves quality of water
2. Removes excess pollutants from water bodies
3. Minimizes erosion
4. Decreases flood frequency and intensity
5. Improves and balances micro-climate
6. Provides food and shelter
7. Replenish ground water

This initiative will be carried out as part of a national mission called the **National Mission on Sustainable Habitat**. It will promote integrated water management and address water scarcity issues. Also it will assist in reversing land use transition to some degree for a stretch of around 20 km and possibly further in the future.

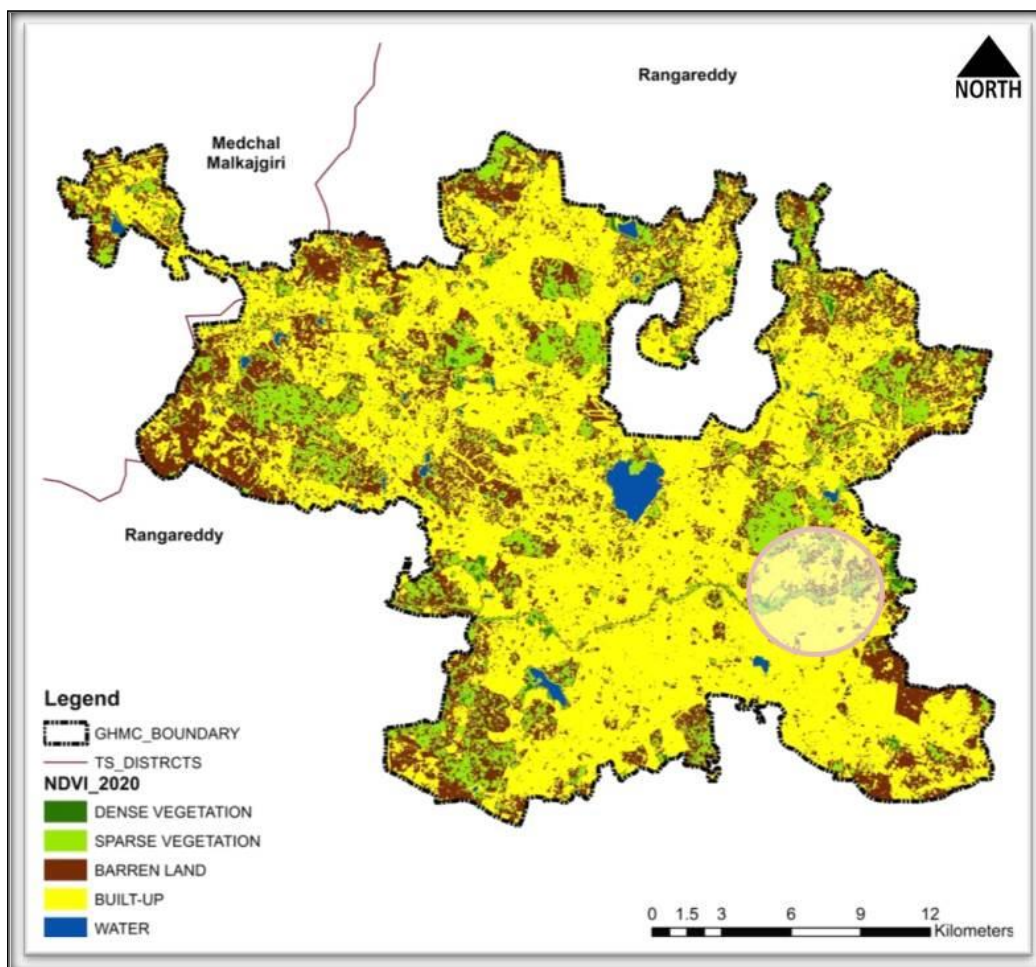


Figure 44: Location to initiate project 'Riparian Buffer'

Source: Author

Plants will be provided by the public under the **Plant for Permit scheme**, in which citizens will be required to gift or pay for one plant before birth and death certificates are issued. This way, public involvement would be assured while the corporation's financial burden would be reduced. Such initiatives will boost awareness among people and also make them informed and responsible citizen.

6.5.2. Integrating grey and green infrastructure

Since urbanization has caused siltation of streams and nallas, as well as clogging them to the point where streams overflow even before monsoon peak, Hyderabad has been constantly exposed to flood risk and associated losses. To fix these risks, the government, in collaboration with NGOs and civil society, must adopt an approach that is inclusive, effective, and complements nature and natural features, rather than harming or altering them as is currently done (BROWDER, 2019).

There are many examples around the world of how governments and communities can work together to leverage nature's natural capacity to replace or improve infrastructure structures, and design development projects to resolve both development challenges as well as ecosystem degradation. These methods are referred to as "nature-based solutions," whereas "green infrastructure" refers to solutions that are specifically designed to provide a service.

Green infrastructure

These are a form of infrastructure that intentionally and strategically preserves, enhances, or restores natural systems such as forests, agricultural land, floodplains, riparian areas, and coastal forests (urban greens patches, mangroves and urban forests) while combining them with grey infrastructure to produce more resilient and lower-cost services. Such practices are also known as engineering with nature or natural infrastructure.

Grey infrastructure

Reservoirs, pipes, pumps, embankments, water treatment systems, and canals are examples of constructed structures and mechanical equipment. These built solutions are located in river basins, watersheds, wetlands or coastal

ecosystems, and their hydrological and environmental characteristics have a significant impact on the grey infrastructure's efficiency.

Nature-based solutions

It's an umbrella term for 'actions to preserve, restore, manage sustainably, and revive natural or changed ecosystems that efficiently and adaptively resolve societal problems while also benefiting human well-being and ecosystems'. Due to ecosystems' typically robust buffering capacity and ability to help offset rainfall or drought extremes, green infrastructure may help increase climate and urban resilience and resiliency. Natural system components such as estuaries mangroves, and sea grass beds, on the other hand, can help with mitigation efforts owing to its high carbon sequestering capacities.

In the case of Hyderabad, Nature-based solutions (NBS) can be applied successfully to maintain and for extension of existing infrastructure.

1. As it has been identified above how the existing infrastructure, specially the drainage network within the city limit needs to be cleaned and maintained regularly along with a plan to extend the same in areas that are either highly or very highly vulnerable to floods.
2. It will help in controlling flood severity as well as frequency to great extent.
3. Along with the above, blue-green infrastructure must be adopted for better, eco-friendly and sustainable solutions such as Bio-swales, roof gardens, pervious pavements and community level rain water harvesting.
4. Regular cleaning of drains and de-silting the drains/ channels to avoid water overflow.
5. Using mesh/ jalis to cover the drains will disable the drain blocking process.
6. Riparian buffers to be provided along the river Musi, where native species would be planted in order to enhance water.

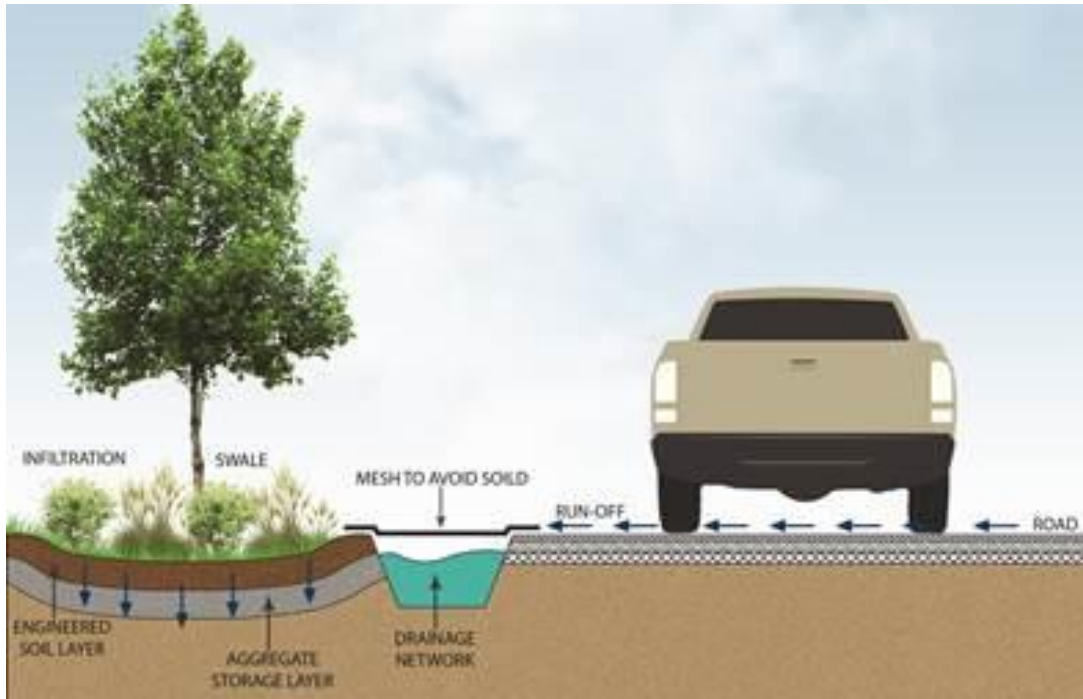


Figure 45: Swales to replace median along all major roads (Sectional Elevation)
Source: Author

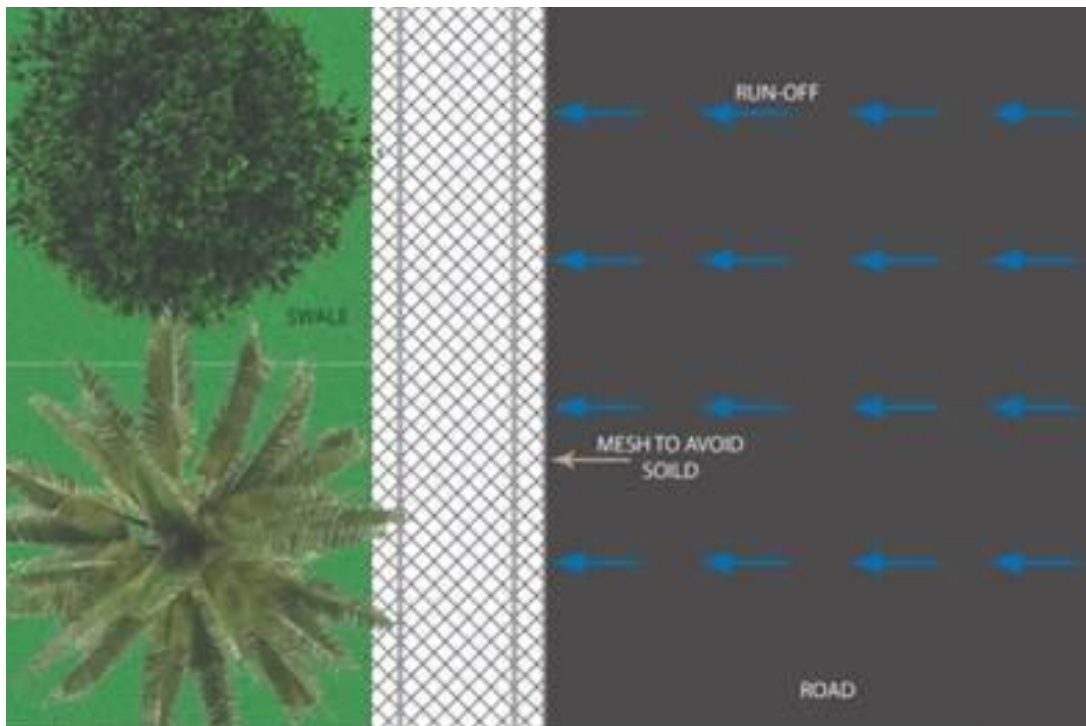


Figure 46: Swales to replace median along all major roads (Plan)
Source: Author

CHAPTER 6: KEY FINDINGS AND PROPOSAL



Figure 47: Ways of addressing and mitigating flood events
Source: Author (Compiled)

Increased onsite storm water absorption is possible with NBS for urban flooding. They are most efficient when implemented into systematic urban planning plans and can be extended from the house or building level to the landscape or even regional scale. They are often used in conjunction with multiple NBS and grey infrastructure components and are most effective when used in combination with multiple NBS and grey infrastructure components.

Green roofs minimize storm water runoff by allowing rainwater to infiltrate through the roofs of structures. Green roofs will hold 50 to 100% of the storm water that falls on them. Conventional roofs are more than two to five times more expensive to set up. Green roofs, on the other hand, are equivalent in terms of expense over their lifetime, as they usually last twice as long as conventional roofs and insulate houses, lowering heating and cooling bills.

Pervious concrete, asphalt, or interlocking pavements allow rainwater to penetrate where it falls, reducing storm water runoff. These have installation costs that are about two to three times those of standard asphalt or concrete. Some applications, on the other hand, have shown a 90% reduction in runoff volumes.

Rain gardens and bio-swales are examples of **bio-retention areas**, which are vegetated trenches built to collect runoff in a particular location and help reduce storm water. Bio-retention areas can filter contaminants and have been shown to remove up to 90% of heavy metals from storm water, in addition to controlling peak flows.

Parks and greenways, for example, may be purposefully built or secured in strategic places to catch water from upstream basins and surrounding areas. The price of open space varies widely and is primarily determined by land prices and design layout. As seen in the case of Beijing, China, the benefits can be substantial, approximately corresponding to the annual water needs of the city's urban ecological landscape.

Storm water can be captured and retained in **constructed wetlands**, allowing for even more water infiltration. Constructed wetlands cost less than built (grey) solutions for the same purpose, but these costs are often highly variable depending on land costs. An acre of wetland can hold between 3.8 and 5.7 million litres of floodwater, minimizing peak loads on wastewater and storm water systems.

6.5.3. Improving adaptive capacity

1. Adaptive capacity could be enhanced through flood mitigation skill development programme.
2. Sharing traditional techniques and knowledge to cope with flood.
3. People living in vulnerable areas must have hazard insurance, one who falls under MIG/HIG could buy and for people falling under EWS/ LIG should be given subsidy for the same.
4. Preparing evacuation and rehabilitation plans in order to be ready for any similar situation in future.

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5. Incorporating disaster programs/ education at schools or even in public areas to sensitize the general public.
6. Addressing social inequality through appropriate policies, schemes and subsidy.

6.5.4. Framework for an inclusive planning process

1. Responsible agencies/ authorities should prepare a flood mitigation plan along with citizens.
2. Localizing building codes and zoning regulations as per the need.
3. Plantation drives must be taken up to either compensate or reverse the consequence of development in which the green spots are disappearing.

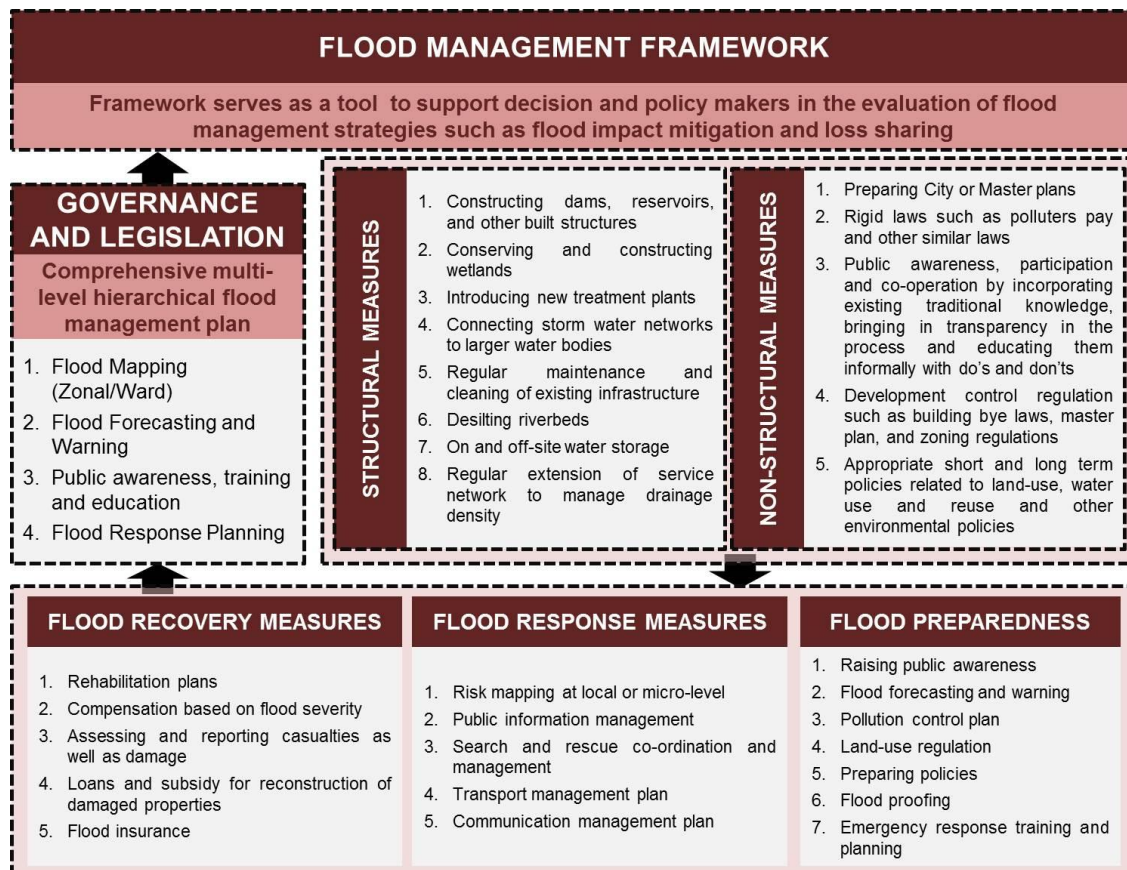


Figure 48: Flood management framework

Source: Author

6.5.5. Integrating technology with the system

1. Early warning system X SMS or Other alert system. This would help to minimize loss of life and property.
2. Decentralizing (Zonal) forecasting and alerting centers for higher efficiency.

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