



# Coping With Flood Hazards In Urban Areas: Community-Centered Strategies

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## Abstract

Any growing city has a continuously increasing population, which puts significant pressure on the limited natural resources that it depends upon. Urban areas across the world are facing similar issues. Pune is one such city, with an ever-growing population resulting in significant changes in land use and land cover patterns, erratic rainfall patterns, causing frequent flood hazards. Although Pune has a history of flooding due to dam failures, recent conditions have made living in the city during the rainy season more perilous. Various scientific and administrative methods have been implemented, including building flood-resistant infrastructure, to mitigate the impact of floods. This paper evaluates the community-based flood hazard management strategies adopted by the municipal corporation of Pune and other cities across the globe. The study is quantitative and aims to understand what measures are taken to reduce the impact of flooding in Pune. The study indicates that despite using multi-pronged approaches, there is still significant room for improvement.

**Key words:** Community-based flood hazard management, strategy, disaster risk reduction, urban areas, Pune

## 1. Background

Pune, a city in India, boasts of a strong industrial base and is ranked as the seventh-largest metropolitan economy with the sixth highest income per capita in the country. A study conducted by Shekhar, 2004 using remote sensing and entropy technique analysis revealed a high sprawl rate in Pune city, mostly along the national highways, which resulted in the replacement of adjacent agriculture and forest lands. Between 1980 and 2001, Pune city had lost 37.75% of cultivable land. Currently, 70-80% of open/vacant/cultivable land has been brought under urban land use, and open lands within the city and its outskirts are mostly converted into big townships, new colonies, institutions, shopping complexes or apartment complexes, as noted by Desai, et. al., in 2009. The estimated population of Pune city as of 2023 is 4,307,000.

The escalating population growth has had diverse impacts on the city of Pune. Like other major cities in India, Pune has repeatedly suffered from the devastating effects of floods. Pune, a city in India, has a history of severe flooding due to heavy rainfall and various factors. In 1961, a dam called Panshet failed, causing massive floods and a tragic loss of around 1,000 lives. In 2005, a red alert was issued, leading to the relocation

of 2,000 residents to safer areas as dams released water to prevent flooding. In 2010, heavy rains caused flooding in the Baner-Bavdhan area due to encroachments on riverbeds, resulting in casualties.

Over the years, urbanization, pollution, and dam construction upstream have put pressure on Pune's rivers, affecting their ability to handle heavy rainfall. This has led to flooding even during moderate rains, as seen in 2018 when the Mutha Canal breached. The situation escalated in 2019, with flash floods claiming 26 lives and causing widespread damage. However, authorities improved preparedness in 2020 and 2021, handling floods better.

These events emphasize the need for better infrastructure, urban planning, and environmental protection to reduce Pune's vulnerability to flooding and protect its residents and property.

## 2. Global Approach

Urban flooding has engulfed many cities across the globe and have had varying degrees of repercussions on the economy and development of the cities. To counter this many cities are going for flood hazard management programs. More so, the community-based flood hazard management programs are increasingly gaining attention worldwide due to their effectiveness in reducing the impact of floods and enhancing community resilience. Here is an overview of the global approach towards such programs, along with examples from different regions. Most of these programs have commonality in their themes, which include community engagement, knowledge integration, capacity building, and the use of technology and infrastructure to reduce flood risks and enhance resilience. These examples showcase diverse approaches to community-based flood hazard management programs, each tailored to the specific needs and conditions of their respective regions.

- **Community Engagement and Participation:** Bangladesh's Community-Based Flood Early Warning System (CBFEWS) involves local communities in monitoring flood levels through sensors and sharing information using simple communication tools. This initiative empowers communities to take proactive measures during floods.
- **Local Knowledge Integration:** In Nepal, the Ratu Watershed Management Project integrates indigenous knowledge and practices into flood hazard management. Communities use traditional flood forecasting methods alongside modern technology for more accurate predictions.
- **Capacity Building:** The Red Cross and Red Crescent Societies conduct training programs for community members in many countries. For instance, in Uganda, they provide training in first aid, flood response, and risk reduction, enhancing the community's capacity to cope with floods.
- **Ecosystem-Based Approaches:** China's "Sponge City" program focuses on restoring and preserving natural ecosystems within urban areas to manage floodwaters. This approach includes creating wetlands, permeable pavements, and green roofs to absorb and control floodwaters.
- **Infrastructure and Resilience Building:** The Netherlands has a long history of flood management. They invest in robust infrastructure like dikes, dams, and flood barriers. Communities are also involved in maintaining and improving these structures.
- **Information Dissemination:** In the United States, the National Oceanic and Atmospheric Administration (NOAA) operates the National Weather Service, which provides real-time flood forecasts and warnings to communities across the country through various media and technology channels.
- **Community-Based Early Warning Systems:** The Philippines has established a community-based early warning system for typhoons and floods. Local volunteers and authorities work together to disseminate warnings and evacuate residents when necessary.
- **Government Support and Policy Integration:** Japan has integrated community-based flood hazard management into its national policies. The government works closely with local communities to develop comprehensive flood risk reduction plans, including infrastructure and evacuation strategies.
- **Inclusivity and Vulnerable Groups:** The Maldives includes vulnerable groups, such as women and children, in its community-based disaster risk reduction programs. Specialized training and support are provided to ensure their safety during floods and other disasters.

- Knowledge Sharing and Global Collaboration: The Global Network of Civil Society Organizations for Disaster Reduction (GNDR) facilitates knowledge exchange and collaboration among community-based organizations worldwide, promoting best practices in flood hazard management.

### 3. India Initiative

India as a country has been very proactive in launching several initiatives for community-based flood hazard management. These not only aim at reducing the impact of floods, but also enhancing community resilience.

- Guidelines: National Disaster Management Authority (NDMA) has issued guidelines that emphasize community participation in disaster risk reduction, including flood management. These guidelines are used by states and districts to develop community-based disaster management plans.
- Community-Based Disaster Risk Reduction (CBDRR) Programs: In the state of Bihar, NGOs like PRAGYA and SEEDS have implemented CBDRR programs. These programs involve community training, risk assessments, early warning systems, and the construction of flood-resistant shelters.
- Flood Early Warning Systems: The Bhagirathi and Alaknanda river basins in Uttarakhand have community-managed flood early warning systems. Local volunteers are trained to monitor rainfall and river levels and disseminate warnings to downstream communities.
- National Rural Livelihood Mission (NRLM): NRLM promotes livelihood diversification and income generation in rural areas, making communities less vulnerable to flood-related losses. It supports activities such as poultry farming, horticulture, and handicrafts.
- Eco-Restoration Projects: The MGNREGA (Mahatma Gandhi National Rural Employment Guarantee Act) includes eco-restoration projects that aim to conserve and restore natural resources. In flood-prone areas, this can involve afforestation and soil conservation.
- Flood Risk Mapping: In Kerala, community members work with government agencies to create flood hazard maps that help identify vulnerable areas and plan evacuation routes and flood shelters.
- Community Resilience Building: The "Kudumbashree" program in Kerala focuses on women's self-help groups and community-based organizations. It trains women in disaster risk reduction, including flood preparedness and response.
- Urban Flood Management Initiatives: The "Sabarmati Riverfront Development Project" in Ahmedabad, Gujarat, includes flood management components. The project combines floodplain zoning, riverfront development, and public spaces for flood resilience.
- National Cyclone Risk Mitigation Project (NCRMP): NCRMP includes community awareness and preparedness programs in coastal areas prone to cyclones and storm surges, helping communities respond effectively during flood events.
- School-Based Initiatives: The "Safe School" program in Tamil Nadu trains teachers and students in disaster preparedness, including flood response plans. Schools are often used as emergency shelters during floods.
- Community Radio for Disaster Communication: Various community radio stations across India play a crucial role during disasters by providing real-time information and safety messages to local communities.
- Partnerships and Collaborations: Many initiatives involve collaboration between government agencies, NGOs, local self-help groups, and international organizations. For instance, the United Nations Development Programme (UNDP) collaborates with state governments on community-based flood management projects.

These initiatives demonstrate India's commitment to community-based flood hazard management by involving local communities, building their capacity, improving early warning systems, and promoting sustainable livelihoods and ecosystem conservation. Although India's approach to community-based flood management has made commendable strides, yet several critical components remain lacking. Adequate funding and resources are essential to implement effective programs, while standardized guidelines and climate change adaptation must be integrated into strategies. Urban flooding, vulnerable populations, and the need for inter-state and transboundary cooperation demand immediate attention. Ensuring the long-term sustainability of flood management infrastructure, along with gender-inclusive and community-driven approaches, are vital aspects that need improvement. Additionally, public awareness, research innovation,

and active community participation require continued emphasis. To enhance India's flood management strategy, concerted efforts and collaboration among various stakeholders are imperative.

The study area undertaken for the study, Pune city, there are several critical components missing in the approach to community-based flood management. One notable gap is the absence of a robust early warning system that can provide real-time alerts and vital information to residents in flood-prone areas. Additionally, community engagement and education initiatives are not as extensive as needed, leaving many residents unaware of local flood hazards and ill-prepared for response. The lack of effective floodplain zoning and sustainable urban planning practices contributes to haphazard development in vulnerable areas. Insufficient drainage infrastructure exacerbates flood risks during heavy rainfall events. Furthermore, coordination between municipal authorities, disaster management agencies, and community organizations is often limited, hindering a cohesive response to flood events. Addressing these missing components is imperative to enhance Pune's resilience to flooding and protect its communities.

#### 4. Methodology

##### 4.1. Quantifying the community-based flood hazard management strategies employed

To understand the flood readiness of any city, town or village, the different types of management strategies need to be checked that have been implemented, such as drainage system maintenance, early warning systems, evacuation plans, flood-resistant infrastructure, and community education and training programs. Below are some of the flood management steps of Pune Municipal Corporation of the last few years:

- Drainage system maintenance: Pune Municipal Corporation regularly cleans and desilts the city's drainage system to ensure that it functions efficiently during heavy rains. Some of the initiative includes
  - The Jeevan Amrut Abhiyan initiative was launched by PMC in 2017 with the aim of cleaning all the major and minor nullahs (drains) in the city before monsoon. The initiative included cleaning of 234 kilometers of nullahs, removal of silt, and disposal of waste. The initiative was successfully implemented and led to a reduction in waterlogging and flooding incidents in the city.
  - PMC has invested in the development of new drainage infrastructure and upgrading the existing ones. For instance, in 2019, PMC announced a plan to construct 500 km of new drainage pipelines and upgrade the existing ones at a cost of INR 1,100 crore (approximately USD 150 million). This project is expected to improve the drainage system and reduce the risk of flooding in the city.
  - NGO Janwani, in partnership with PMC, has launched a project called 'Clean and Green Pune' which aims to involve citizens in the maintenance of their respective areas. The project includes regular cleaning of drains and disposal of waste in a proper manner.
  - In 2020, PMC launched a mobile application called 'Swachh Pune' which allows citizens to report any drainage-related issues in their areas. The application has helped in the quick identification and resolution of issues.
- Flood warning system: Pune Municipal Corporation has installed a flood warning system in the city, which alerts the authorities and citizens in the event of a flood. The system uses sensors placed at various locations to monitor water levels in the rivers and canals that flow through the city. It also includes Rainfall monitoring, River and Stream Monitoring, Predictive modelling and alert system. Although still to be effectively implemented, it is step in the right direction.
- Evacuation plans: Pune Municipal Corporation has formulated evacuation plans for areas that are prone to flooding. These plans are frequently reviewed and updated to ensure that they are effective in case of an emergency. It includes evacuation route mapping, supply of relief materials, etc.
- Disaster management cell: Pune Municipal Corporation has set up a disaster management cell to coordinate rescue and relief operations during floods. The cell is equipped with necessary equipment, vehicles and trained personnel.

- Development and maintaining green spaces: Pune Municipal Corporation has been focusing on the development of green spaces in the city to reduce the risk of flooding. The green spaces help in soaking up excess water and reducing runoff during heavy rains. There are many organisations operating within Pune who are focussed on developing green spaces, green buildings, rain water harvesting, in a sustainable way.
- Creation of Storm Retention Ponds: The creation of storm retention ponds is one of the key flood management initiatives undertaken by the PMC (Pune Municipal Corporation) to mitigate the impact of flooding in Pune. Storm retention ponds are artificial reservoirs designed to store excess stormwater during heavy rain events, reducing the risk of flooding in downstream areas. There are several ongoing and completed projects undertaken by the PMC (Pune Municipal Corporation) related to the creation of storm retention ponds in Pune. Some of these projects are:
  - Warje Stormwater Retention Pond: The PMC has constructed a storm retention pond at Warje, which has a capacity to hold up to 2 million liters of water. This project was completed in 2015 and is designed to reduce the risk of flooding in downstream areas during heavy rain events.
  - Ambil Odha Stormwater Retention Pond: The PMC is currently working on the construction of a storm retention pond at Ambil Odha, which is expected to be completed in 2023. This project involves the construction of a 20,000 square meter pond that can hold up to 4.5 million liters of water.
  - Susgaon Stormwater Retention Pond: The PMC has proposed the construction of a storm retention pond at Susgaon, which is currently in the planning stages. This project aims to reduce the risk of flooding in nearby communities during heavy rain events.
  - Vadgaon Stormwater Retention Pond: The PMC has proposed the construction of a storm retention pond at Vadgaon, which is currently in the planning stages. This project aims to reduce the risk of flooding in downstream areas during heavy rain events.
  - Mutha Riverfront Development: The PMC is undertaking a riverfront development project along the Mutha river, which includes the creation of storm retention ponds. This project is designed to improve the overall flood management capacity of the city and create recreational spaces for local communities.

#### 4.2. *Quantifying the effectiveness of these strategies in mitigating flood damage and reducing risks to human life*

The effectiveness of community-based management strategies in mitigating flood damage and reducing risks to human life can vary depending on various factors such as the level of community participation, the extent of flood damage, and the frequency of flooding in the area. However, these strategies have shown promising results in reducing the impact of floods in Pune.

- Community-led Flood Risk Mapping: The creation of community-led flood risk maps has helped identify high-risk areas in Pune and prioritize response during a flood. This has led to a more targeted approach to flood management and reduced damage to property.
- Establishing Emergency Response Teams: The establishment of emergency response teams comprising trained volunteers has helped provide immediate assistance to those affected by floods in Pune. This has resulted in faster response times and reduced loss of life during floods.
- Community-Based Disaster Risk Reduction (CBDRR): The implementation of CBDRR in Pune has helped communities identify and analyze the risks they face and develop strategies to reduce them. This has resulted in increased community resilience and better preparedness for future floods.

## 5. Discussion

Although community-based management strategies have proven effective in mitigating flood damage and reducing risks to human life in Pune, they face several challenges and barriers to their implementation. Some of the obstacles include limited resources, political and institutional constraints, and social and cultural factors.

- **Limited Resources:** The implementation of such management strategies requires resources, such as funding, technical expertise, and equipment. The lack of these resources can make it challenging to implement these strategies effectively, especially in low-income communities in Pune.
- **Political and Institutional Constraints:** The implementation of flood hazard management strategies requires the involvement of multiple stakeholders, including government agencies, local authorities, and community members. The lack of coordination and cooperation among these stakeholders can hinder the implementation of these strategies.
- **Social and Cultural Factors:** Cultural factors such as social norms, values, and beliefs can impact the effectiveness of community-based management strategies by preventing from actively participation.
- **Lack of Technical Expertise:** The implementation of some community-based flood hazard management strategies, such as flood risk mapping and CDBRR, require technical expertise. The lack of such expertise can make it challenging to implement these strategies effectively.
- **Limited Awareness and Education:** Lack of awareness and education about the importance of such community-based hazard management strategies can hinder their implementation. This can be a significant challenge in low-income communities in Pune, where access to information and education is limited.

Addressing these challenges and barriers requires a collaborative effort between government agencies, local authorities, and community members.

Community participation and collaboration play a crucial role in disaster management. The involvement of community members in disaster management can help increase community resilience and reduce the risks associated with disasters. Here are some ways in which community participation and collaboration can contribute to effective flood hazard management in Pune and other cities:

- **Community Engagement:** Engaging with community members can help raise awareness about flood risks, provide information about disaster preparedness and response, and build trust and cooperation among stakeholders.
- **Communication:** Regular communication and information sharing can help stakeholders coordinate their efforts, share resources, and make informed decisions during a flood. This can include providing early warning alerts and updates on flood conditions.
- **Coordination:** Coordination among stakeholders, including government agencies, local authorities, and community members, is essential for effective disaster management.
- **Participation in Disaster Risk Reduction:** Community members can participate in disaster risk reduction activities like hazard mapping, vulnerability assessments, and developing community emergency response plans to increase community preparedness and resilience and reduce the risks associated with flooding.

## 6. Conclusion

The different community-based flood hazard management strategies of Pune city provide valuable insights for disaster management in the area. It emphasizes the significance of community participation, building local capacity, integrating traditional knowledge, multi-stakeholder collaboration, and investing in early warning systems. Engaging with community members, building trust, and involving them in decision-making processes is critical. Local capacity building through training and education can help increase resilience, and traditional knowledge can be integrated with modern approaches. Multi-stakeholder collaboration is essential, and early warning systems can reduce the impact of floods. These lessons inform future hazard/ disaster management

strategies. Overall, community participation is crucial in building partnerships, improving communication, and engaging with community members can help increase community resilience, reduce risks, and save lives during floods.

#### References:

1. Shekhar, S. (2004): Urban sprawl assessment Entropy approach, May 2004, [https://www.researchgate.net/publication/278032420\\_Urban\\_sprawl\\_assessment\\_Entropy\\_approach](https://www.researchgate.net/publication/278032420_Urban_sprawl_assessment_Entropy_approach)
2. Desai, C. G., Patil, M. B., Mahale, V. D. and Umrikar, B. (2009). Application of remote sensing and geographic information system to study land use / land cover changes: a case study of Pune Metropolis. *Advances in Computational Research* 1(2) 10-13.
3. Biswas, P. S. "Lessons for Pune pour in from Chennai floods", *Indian Express*, 6<sup>th</sup> Dec., 2015, <https://indianexpress.com/article/cities/pune/lessons-for-pune-pour-in-from-chennai-floods/> Accessed on: 15.04.23
4. PTI." 2,000 people shifted in Pune; controlled discharge from dams", *Rediff.com*, 01<sup>st</sup> Aug., 2005, <https://www.rediff.com/news/2005/aug/01rain7.htm> Accessed on: 12.04.23
5. Pune Municipal Corporation online reports. Accessed on: 10.04.23, 15.04.23
6. Dastane, S. "Pune: Mutha canal wall breaches, flooding in Dandekar bridge, *Time of India*, 27<sup>th</sup> Sept, 2018, <https://timesofindia.indiatimes.com/city/pune/mutha-canal-wall-breaches-flooding-in-dandekar-bridge-vicinity/articleshow/65978232.cms> Accessed on: 15.04.23

