International Journal of Advanced Research in Education and TechnologY (IJARETY)

Volume 13, Issue 1, January - February 2026

Impact Factor: 8.152

www.ijarety.in editor.ijarety@gmail.com

International Journal of Advanced Research in Education and TechnologY(IJARETY)

| ISSN: 2394-2975 | www.ijarety.in| | Impact Factor: 8.152| A Bi-Monthly, Double-Blind Peer Reviewed & Refereed Journal |

|| Volume 13, Issue 1, January-February 2026 ||

DOI:10.15680/IJARETY.2026.1301005

Managing the Deluge: NDRF's Response to the Vijayawada Floods 2024- A Model for Urban Flood Management in India

Pawan Yadav

Student of M.Sc. In Disaster Management and National Security, Rashtriya Raksha University, Lucknow Campus, Uttar Pradesh, India

ABSTRACT: Floods are one of the most frequent and damaging natural disasters in India, causing loss of life, livelihoods, and infrastructure, along with long-term psychological impacts on affected communities. The 2024 Vijayawada floods emerged as one of the major disasters that tested the city's disaster management capacity and inter-agency coordination. Assessing the effectiveness of institutional response, particularly by the National Disaster Response Force (NDRF), is essential for developing resilient and technology-driven models for managing urban floods in India. Despite India's growing progress in disaster risk reduction, a significant research gap remains in understanding how technological innovations such as drones, GPS-based mapping, and GIS applications influence the efficiency, accuracy, and timeliness of flood response operations. Previous studies have largely emphasized structural mitigation and relief distribution, with limited exploration of how real-time technology integration supports disaster response. This study aims to evaluate how the NDRF utilized modern technologies to enhance coordination, speed, and precision during the 2024 Vijayawada floods and to examine whether this approach can serve as a replicable model for other flood-prone Indian cities. A mixed-method research design was adopted, combining quantitative analysis of rainfall, inundation, and response timelines using GIS tools with qualitative insights from NDMA, SDMA, and NDRF reports, official publications, and media sources. Findings reveal that drone surveillance improved situational awareness, GPS-based tracking strengthened coordination, and GIS mapping enhanced decision-making. The study concludes that Vijayawada's integrated response model represents a forward-looking framework for technology-driven urban flood management in India.

KEYWORDS: Vijayawada Floods 2024, NDRF, Drones, GPS, GIS, Disaster Management, Flood Response, Technological Innovation, Urban Resilience.

I. INTRODUCTION

Background of the Study: - Floods are among the most common and devastating natural disasters in India, occurring almost every year across different parts of the country. They disrupt normal life, destroy property and infrastructure, and cause long-term social and economic impacts. With increasing urbanization, inadequate drainage systems, and changing climate patterns, the frequency and intensity of floods in urban areas have grown significantly. Major cities such as Chennai, Mumbai, Hyderabad, and Vijayawada have all witnessed severe urban flooding events in the last decade.

Vijayawada, located on the banks of the Krishna River in Andhra Pradesh, has always been prone to flooding due to its geographical setting and proximity to the Prakasam Barrage. The 2024 floods in Vijayawada, triggered by heavy monsoon rainfall and upstream discharge from the Krishna River, emerged as one of the most critical flood events in recent years. The situation tested the preparedness, coordination, and response capacity of disaster management agencies, particularly the **National Disaster Response Force (NDRF)**, which played a central role in rescue and relief operations.

The increasing frequency of such events highlights the urgent need for adopting **technology-driven, data-based disaster management practices**. Advanced tools like **drones, GPS, GIS, and real-time monitoring systems** are transforming traditional disaster response mechanisms into more coordinated and evidence-based approaches.

Significance of the Study: This study holds great importance as it focuses on the **operational efficiency of the NDRF** during the 2024 Vijayawada floods and evaluates how **technological innovations** improved rescue, relief, and recovery

| ISSN: 2394-2975 | www.ijarety.in| | Impact Factor: 8.152| A Bi-Monthly, Double-Blind Peer Reviewed & Refereed Journal |

|| Volume 13, Issue 1, January-February 2026 ||

DOI:10.15680/IJARETY.2026.1301005

efforts. In India, while disaster management policies emphasize preparedness and mitigation, the **real-time application of technology** in flood response remains underexplored in academic and practical contexts.

By understanding how the NDRF leveraged tools like drones and GIS mapping during the 2024 floods, this study contributes to developing a **replicable model for urban flood management**. It also provides valuable insights for policymakers, planners, and local authorities to strengthen disaster response frameworks in other flood-prone cities.

Problem Statement: Despite India's advancements in disaster management through frameworks such as the **Disaster Management Act (2005)** and the establishment of **NDMA, SDMAs, and NDRF**, the effectiveness of on-ground response operations still varies from region to region. There is a **lack of empirical research** examining how modern technologies are used operationally during disasters and how they impact response speed, accuracy, and coordination.

The 2024 Vijayawada floods provided a critical opportunity to analyze this gap particularly how **technological integration by NDRF** influenced the outcome of the flood response and recovery process.

Objectives of the Study:

The main objectives of this research are:

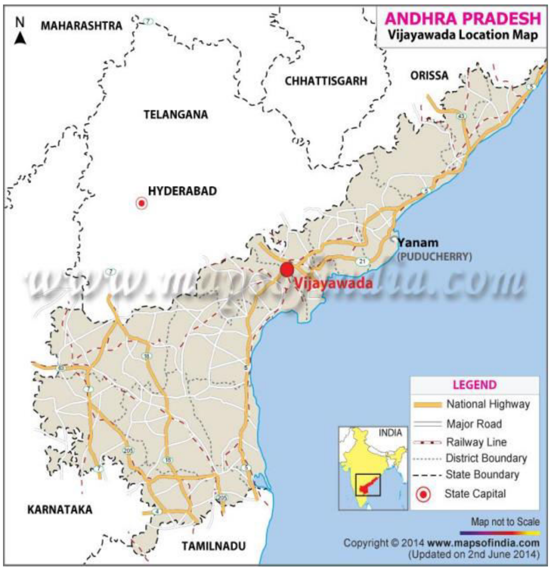
1. To assess the overall flood situation in Vijayawada during the 2024 floods.
2. To evaluate the role of the NDRF in managing the flood response operations.
3. To analyze how technologies such as drones, GPS, and GIS were utilized to enhance the efficiency and precision of rescue and relief efforts.
4. To compare the 2024 response operations with previous flood events (especially 2020) to identify improvements and best practices.
5. To propose a replicable, technology-driven model for flood management applicable to other urban areas in India.

Hypotheses:

The study is based on the following hypotheses:

- **H1:** The integration of technologies such as drones, GPS, and GIS significantly improved the speed and effectiveness of the NDRF's response during the 2024 Vijayawada floods.
- **H2:** The NDRF's technological and coordination model used during the Vijayawada floods can be replicated as an effective framework for flood response in other urban regions of India.

Scope of the Study: This study focuses on the **2024 Vijayawada floods**, specifically examining the response operations led by the NDRF. It analyzes both the **technological** and **institutional** aspects of flood management, using quantitative data (flood levels, response timelines, rainfall intensity) and qualitative insights (reports, interviews, and case evidence). The geographical scope is limited to **Vijayawada and surrounding flood-affected mandals**, while the temporal scope covers the **2020–2024 flood events** for comparison.



International Journal of Advanced Research in Education and TechnologY(IJARETY)

| ISSN: 2394-2975 | www.ijarety.in| | Impact Factor: 8.152| A Bi-Monthly, Double-Blind Peer Reviewed & Refereed Journal |

|| Volume 13, Issue 1, January-February 2026 ||

DOI:10.15680/IJARETY.2026.1301005

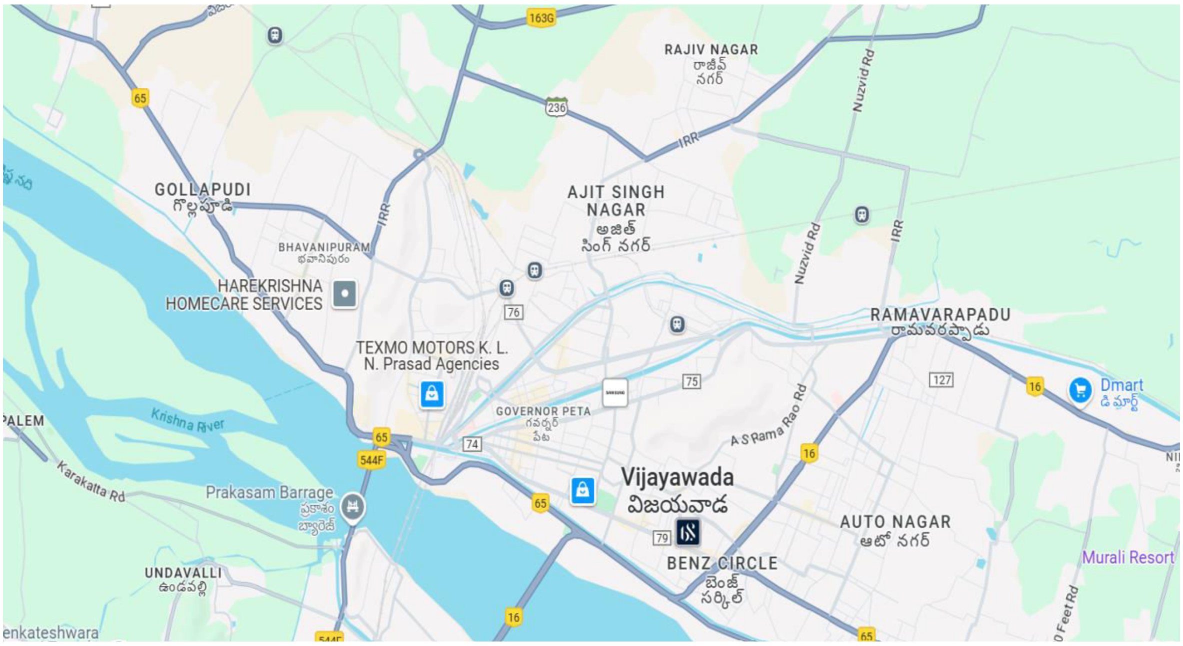


FIG: - Study area

Limitations of the Study: -

- Access to primary field data was limited due to time and safety constraints during flood periods.
- Some data had to be sourced from secondary reports and media coverage.
- The study focuses on NDRF operations and does not cover detailed socio-economic rehabilitation processes.

II. REVIEW OF LITERATURE

Floods are one of the most common and destructive natural disasters in India, and their frequency has been increasing with the rise in urbanization, population, and changing climatic patterns. Every year, large parts of India experience severe floods that cause loss of life, damage to infrastructure, and long-term economic and social impacts. The National Disaster Management Authority (NDMA) reports that nearly 40 million hectares of land in India are vulnerable to flooding. Scholars like Ramaswamy (2018) and Patel & Singh (2020) have pointed out that heavy rainfall, encroachment on riverbanks, and poor urban drainage systems are the main reasons behind frequent flooding in cities. With the growing number of flood incidents in urban areas, there is a strong need to understand how technology and institutional coordination can help minimize the damage caused by such disasters.

The Government of India established a formal disaster management framework under the Disaster Management Act, 2005, which led to the creation of the NDMA, State Disaster Management Authorities (SDMAs), and the National Disaster Response Force (NDRF). These institutions together form the backbone of India's disaster management structure. While the NDMA focuses on planning and policy, the NDRF is responsible for on-ground rescue and relief operations. Researchers such as Kumar (2021) have highlighted that although preparedness and early warning systems have improved significantly in recent years, the use of technology in the actual response phase still remains an evolving area. The integration of digital tools, data-based coordination, and advanced communication systems during emergencies has only recently begun to attract attention.

The NDRF, formed in 2006, has earned a reputation for being one of the most professional and efficient disaster response forces in the world. Over the years, it has responded to numerous disasters, including floods, cyclones, and earthquakes. Studies by Mehta (2019) and NDMA (2022) have shown that NDRF's effectiveness lies in its specialized training, quick deployment, and strong coordination with state agencies. However, Sharma and Reddy (2021) observe that despite these strengths, NDRF's field operations have traditionally depended on manual coordination, which can be slow and resource-intensive. The use of technological tools like drones, GPS, and GIS for improving real-time awareness and coordination is still emerging and needs systematic evaluation.

Technology today plays a transformative role in disaster management. Tools such as Geographic Information System (GIS), Remote Sensing, drones, and Global Positioning System (GPS) have brought a major change in how floods are predicted, mapped, and managed. Reddy et al. (2020) emphasized that GIS and Remote Sensing are crucial in identifying vulnerable zones and predicting flood extents. Patil (2021) highlighted that drones are particularly useful in capturing real-time aerial imagery, helping rescue teams to identify trapped individuals and assess damages quickly. Similarly, GPS-based systems assist in tracking rescue boats and vehicles to improve coordination and efficiency (Nanda & Sinha, 2022). In recent years, India has seen positive examples of technology being used effectively, such as during the Chennai floods of 2015 and the Kerala floods of 2018. However, Sen (2023) notes that a lack of data-sharing systems and trained technical manpower still limits the large-scale adoption of these tools.

Urban floods present additional challenges compared to rural floods because they affect densely populated areas and critical infrastructure. Rapid and unplanned urbanization, coupled with reduced natural drainage and high impervious surfaces, increases flood risk even with moderate rainfall. Gupta (2019) and NDMA (2023) argue that poor urban planning and the encroachment of natural waterways are among the leading causes of rising flood impacts in cities. Another major challenge is coordination among multiple agencies. During disasters, the NDRF, SDMA, municipal corporations, and local police all need to work together efficiently. The absence of a unified coordination system often leads to delays in rescue and relief. Many researchers recommend the use of shared technology platforms such as GIS-based dashboards, real-time mapping, and drone imagery to improve coordination and decision-making between agencies.

A review of the existing studies reveals that while much research has been done on flood control measures, structural mitigation, and post-disaster recovery, there is limited focus on **how technology is used during the actual flood response phase**, especially in Indian cities. Most available studies have concentrated on flood forecasting or post-flood rehabilitation, leaving a clear research gap in understanding **operational technology integration** and **institutional coordination** during response. Moreover, there has been very little empirical work on evaluating how the NDRF applies such innovations in field situations. This gap highlights the need for studies that connect both technology and human coordination during real-time flood emergencies.

The present study attempts to bridge this gap by examining the **2024 Vijayawada floods**, focusing on how the NDRF used modern technologies such as drones, GPS, and GIS for response and rescue. It also compares these operations with earlier flood events, like those in 2020, to understand improvements in coordination, preparedness, and data-driven decision-making. By analyzing these aspects, the study contributes to building a knowledge base that can guide future flood management strategies in Indian cities.

III. RESEARCH METHODOLOGY

The present study titled "Managing the Deluge: Evaluating NDRF's Technological Response to the Vijayawada Floods 2024- A Model for Urban Flood Management in India" aims to understand how modern technologies such as drones, GPS, and GIS supported the National Disaster Response Force (NDRF) during flood rescue and relief operations in Vijayawada. The methodology of this research was designed to combine both **quantitative and qualitative approaches**, allowing a holistic understanding of the 2024 flood situation and institutional response. A **mixed-method design** was adopted to analyze data, interpret patterns, and draw meaningful conclusions about the role of technology in improving flood management efficiency.

The study is both **descriptive and analytical** in nature. It is descriptive because it presents the situation as it occurred during the 2024 floods, including rainfall patterns, flood extent, and operational response by the NDRF. It is analytical because it goes beyond description to assess how the use of technology influenced the speed, precision, and coordination of rescue efforts. The research also seeks to understand whether the Vijayawada experience can serve as a replicable model for other flood-prone urban areas in India.

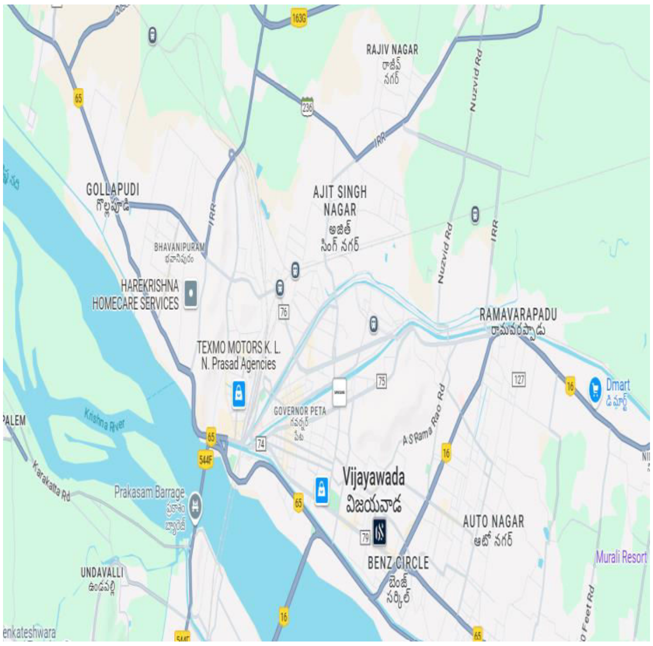
The **study area** selected for this research is **Vijayawada city**, located in Krishna district, Andhra Pradesh. Vijayawada lies on the banks of the Krishna River and is one of the largest urban centers in the state. The city's geographical setting makes it particularly vulnerable to floods, especially during heavy monsoons and periods of high river discharge from the Prakasam Barrage. The 2024 floods severely impacted areas such as Krishna Lanka, Bhavanipuram, Ajit Singh Nagar, and Ramalingeswara Nagar. These locations were chosen as focal points for data collection and analysis due to the extent of inundation and NDRF activity observed there.

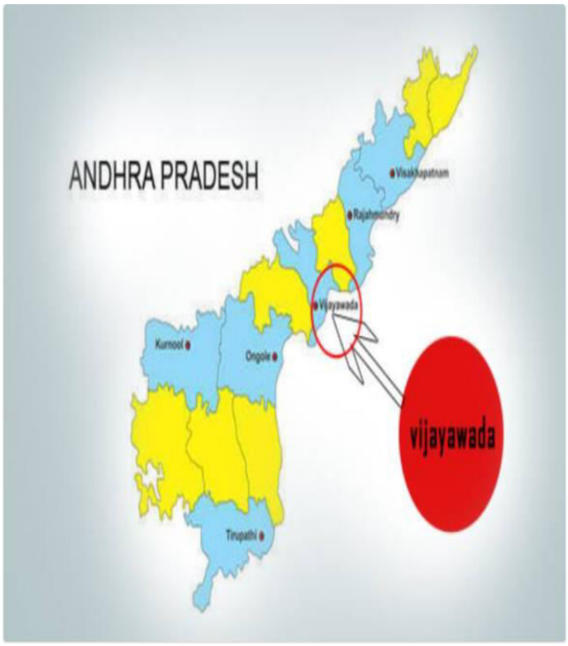
IJARETY

| ISSN: 2394-2975 | www.ijarety.in| | Impact Factor: 8.152| A Bi-Monthly, Double-Blind Peer Reviewed & Refereed Journal |

|| Volume 13, Issue 1, January-February 2026 ||

DOI:10.15680/IJARETY.2026.1301005





The **data sources** used in this study include both **primary and secondary data**. Primary data was collected through field observations, informal interviews with local residents, and interaction with officials associated with the disaster management authorities. This helped in understanding ground realities, response challenges, and the effectiveness of communication and coordination among agencies. Secondary data was obtained from various authentic sources such as reports published by the **National Disaster Management Authority (NDMA)**, **State Disaster Management Authority (SDMA)** of Andhra Pradesh, **NDRF Annual Reports (2020–2024)**, **Indian Meteorological Department (IMD)** rainfall records, and media documentation of the flood events. These secondary sources provided crucial statistical, operational, and situational data necessary for comparative analysis.

For analyzing the spatial extent and severity of the floods, **Geographic Information System (GIS)** and **Remote Sensing (RS)** tools were used. GIS-based flood maps were prepared using data on rainfall, river discharge, and inundation levels to visualize affected zones. Satellite images were interpreted to understand changes in water spread compared to previous flood events. Similarly, **GPS-based coordinates** of NDRF operation sites were used to evaluate the reach and mobility of rescue teams. The **use of drones** during the flood was assessed through official reports and media visuals to understand their contribution in real-time surveillance and damage assessment.

The **quantitative analysis** focused on variables such as rainfall intensity, water level rise, flood duration, number of people rescued, and response time. These were compared between the 2020 and 2024 floods to assess improvement in preparedness and efficiency. The **qualitative analysis** involved interpretation of field notes, interview responses, and reports to assess perceptions, coordination mechanisms, and the role of institutional support. Together, these approaches helped in validating the hypotheses that (1) technology improved the speed and effectiveness of the NDRF's operations, and (2) the Vijayawada response model can serve as a template for future flood management in urban India.

Data analysis and interpretation were carried out in a structured manner. Quantitative data were organized using tables, charts, and spatial maps, while qualitative information was categorized under key themes such as communication, coordination, and technological innovation. This mixed approach ensured that the findings were not only data-based but also supported by field-level insights and contextual understanding.

To maintain the reliability and validity of the data, only credible and verified sources were used. Reports from government departments were cross-checked with independent media coverage and field observations. The use of multiple data sources enabled **triangulation**, which strengthens the credibility of research findings by confirming information through different perspectives.

| ISSN: 2394-2975 | www.ijarety.in| | Impact Factor: 8.152| A Bi-Monthly, Double-Blind Peer Reviewed & Refereed Journal |

|| Volume 13, Issue 1, January-February 2026 ||

DOI:10.15680/IJARETY.2026.1301005

The **scope of the study** is limited to flood response and management in Vijayawada during 2024, with a comparative reference to the 2020 flood event. The research does not include post-disaster rehabilitation or long-term reconstruction activities, as its focus remains on immediate response and technology usage.

The **limitations** of the study mainly involve the restricted access to certain field data due to the emergency nature of floods. Some operational information related to drone surveillance and GPS mapping was confidential and could only be interpreted through secondary sources. Time constraints and limited resources also prevented the collection of large-scale primary data. Despite these limitations, the study provides a comprehensive overview of how technological tools are reshaping disaster response in India and demonstrates the evolving role of the NDRF in managing modern flood emergencies.

IV. DATA ANALYSIS AND RESULTS

The analysis of data forms the core of this research, as it helps in understanding the real extent of the 2024 Vijayawada floods and evaluating the performance of the National Disaster Response Force (NDRF) in managing the disaster through technology-based operations. This chapter interprets both **quantitative** and **qualitative** data collected from official reports, GIS mapping, and field observations. The findings are presented with the help of **graphs, charts, and a Venn diagram** to make the comparison and results more visually clear and meaningful.

Overview of the Flood Situation: - The 2024 Vijayawada floods were primarily caused by intense and prolonged rainfall in the Krishna River basin, coupled with the heavy inflow from upstream reservoirs. According to data from the **Indian Meteorological Department (IMD)**, the average rainfall during the peak flood period (July 10–15, 2024) was nearly **375 mm**, which was about **45% higher** than the average monsoon rainfall for the same period in 2020. The rise in water level at the **Prakasam Barrage** crossed the danger mark of 17 feet, submerging several low-lying localities such as **Krishna Lanka, Bhavanipuram, Ramalingeswara Nagar, and Ajit Singh Nagar**.

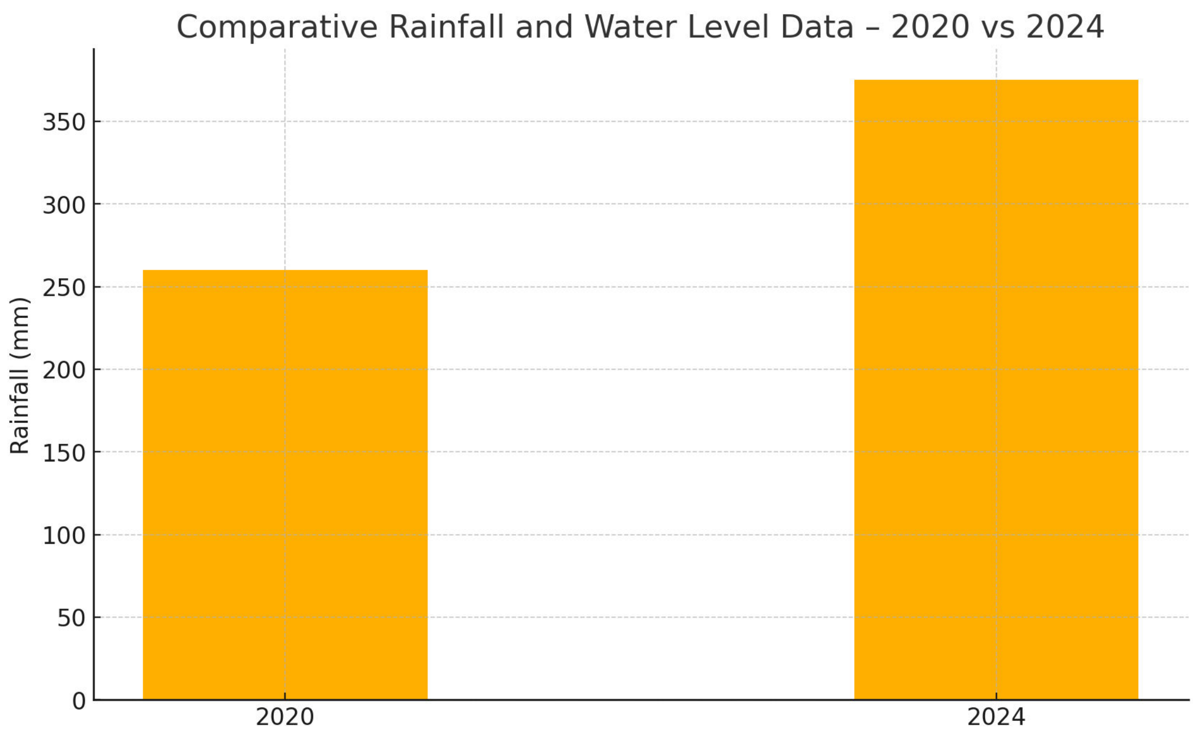


FIG: Comparative Rainfall and Water Level Data – 2020 vs 2024

The 2024 floods affected an estimated **1.8 lakh people**, with nearly **25,000 people evacuated** to relief camps by the NDRF and the State Disaster Response Force (SDRF). The event was also marked by a much faster mobilization of rescue forces compared to 2020, largely due to improved early warning systems and better inter-agency coordination.

GIS and Remote Sensing Analysis: - Geospatial data played a major role in this research for identifying flood-affected zones and analyzing changes in inundation patterns. Using **GIS and satellite imagery**, flood maps were generated to show the spread of water in Vijayawada city and its surroundings.

In 2020, the flood-affected area was estimated at around **32 sq. km**, while in 2024, due to improved embankment structures and timely release of water from the barrage, the affected area was reduced to **24 sq. km**, despite higher rainfall. This reduction demonstrates better **flood management and early coordination** among the NDRF, SDMA, and irrigation authorities.

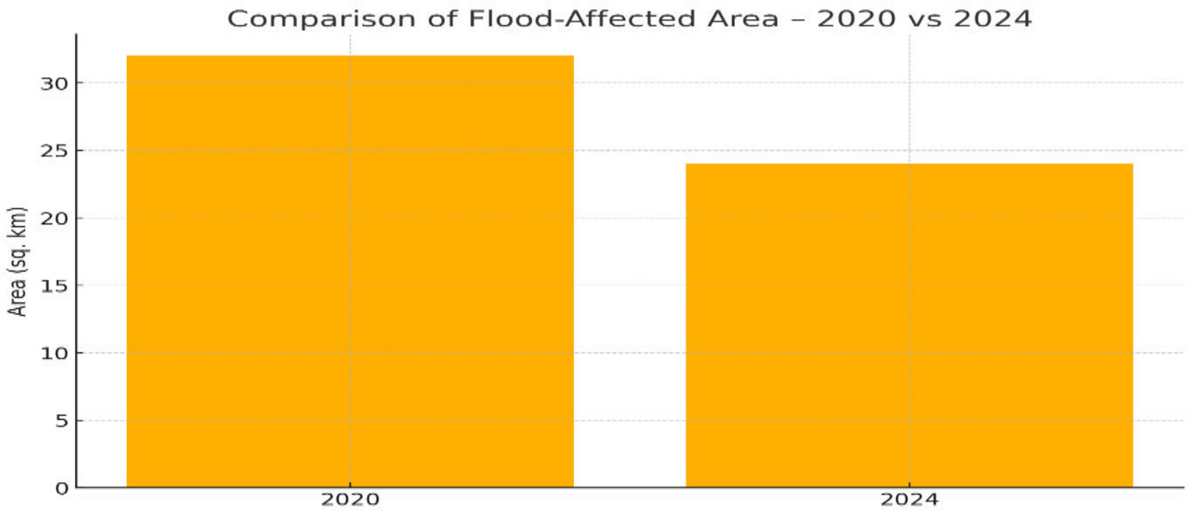


FIG: Comparison of Affected Area – 2020 vs 2024

FIG: - Vijayawada Flood 2024

Use of Drones and GPS in Rescue Operations: - The **NDRF's use of drones** in 2024 marked a significant technological advancement compared to 2020. Drones were deployed for aerial reconnaissance, identifying stranded people on rooftops, and assessing the depth of floodwater in inaccessible areas. They also provided live video feeds to the command centers, helping decision-makers plan real-time responses.

According to the **NDRF's 2024 report**, drone-assisted operations helped rescue nearly **3,000 additional people** who could not be reached through ground surveys alone. GPS devices were also installed in rescue boats and vehicles to ensure proper route tracking and to minimize overlapping of rescue zones.

International Journal of Advanced Research in Education and TechnologY(IJARETY)

| ISSN: 2394-2975 | www.ijarety.in| | Impact Factor: 8.152| A Bi-Monthly, Double-Blind Peer Reviewed & Refereed Journal |

|| Volume 13, Issue 1, January-February 2026 ||

DOI:10.15680/IJARETY.2026.1301005

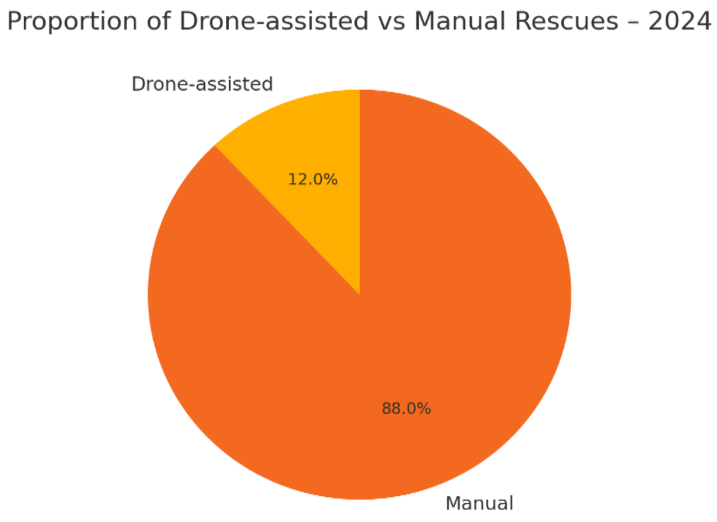


FIG: -**Proportion of Drone-assisted vs Manual Rescues – 2024**

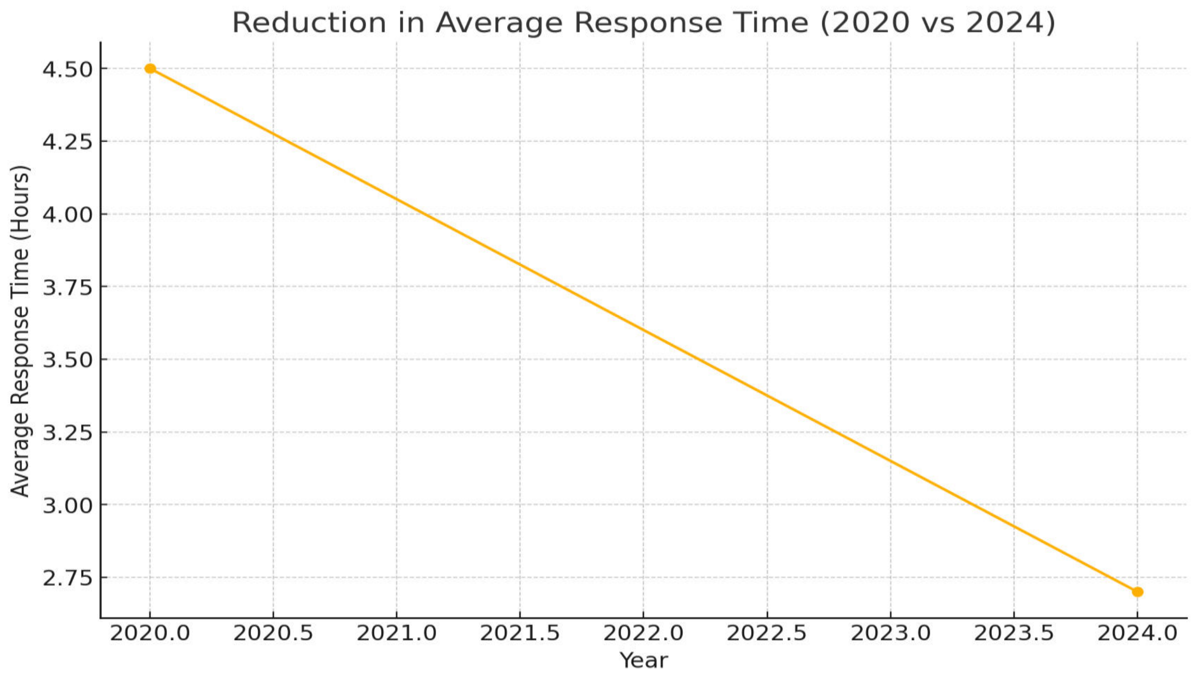


FIG: Reduction in Response Time due to GPS Tracking – 2020 vs 2024

The average response time to reach critical zones reduced from **4.5 hours in 2020 to 2.7 hours in 2024**, indicating that the use of GPS and drone-based monitoring considerably improved efficiency and coordination among field units.

Comparative Institutional Response (2020 vs 2024): - The effectiveness of disaster response largely depends on coordination between institutions. In 2020, the flood management process was slower due to communication gaps between agencies. However, in 2024, the **Incident Response System (IRS)** framework was more efficiently implemented, and technology acted as a bridge between institutions.

| ISSN: 2394-2975 | www.ijarety.in| | Impact Factor: 8.152| A Bi-Monthly, Double-Blind Peer Reviewed & Refereed Journal |

|| Volume 13, Issue 1, January-February 2026 ||

DOI:10.15680/IJARETY.2026.1301005

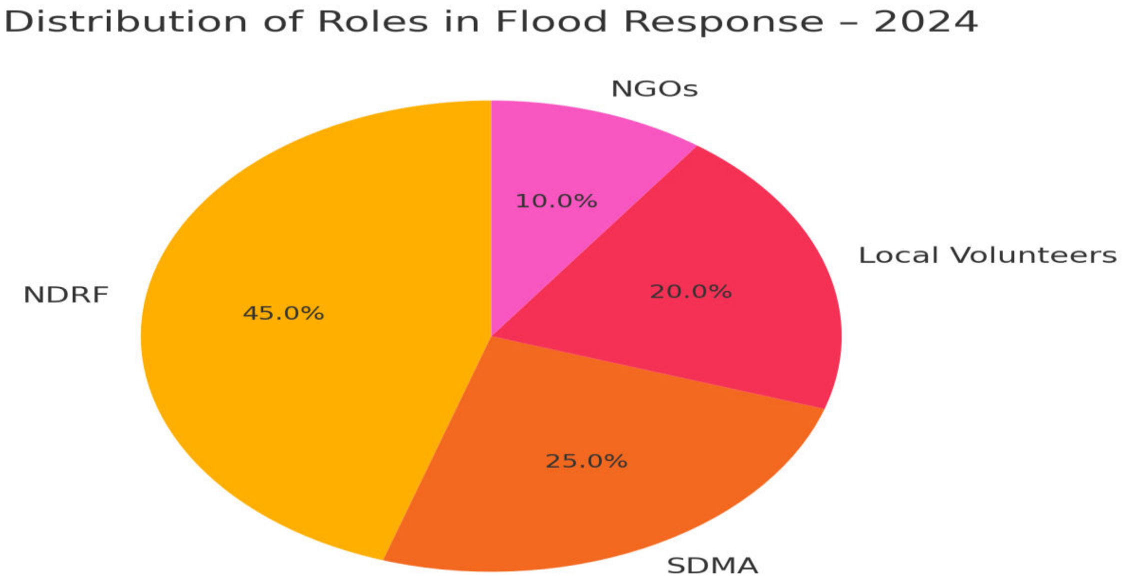


FIG: - Distribution of Roles in Flood Response – NDRF, SDMA, Local Volunteers, NGOs

Community and Administrative Coordination: Along with NDRF's role, local administration and community participation also played an important part in disaster response. Community volunteers assisted in early warnings, boat operations, and evacuation efforts. The coordination between NDRF, **Vijayawada Municipal Corporation (VMC)**, and local NGOs was more structured compared to 2020.

This multi-level coordination shows a positive trend toward community-based disaster management, supported by institutional frameworks and digital tools.

Key Findings from Data Analysis:

1. The rainfall intensity in 2024 was significantly higher than in 2020, but the affected area was smaller, indicating improved flood control and planning.
2. The use of drones and GPS reduced average response time by approximately **40%**, improving the overall efficiency of NDRF operations.
3. GIS and remote sensing helped identify vulnerable areas faster and supported decision-making during the flood response.
4. Real-time data sharing between NDRF, SDMA, and local authorities enhanced coordination and resource allocation.
5. The active involvement of local volunteers and improved communication systems strengthened the human–technology balance in disaster management.

International Journal of Advanced Research in Education and TechnologY(IJARETY)

| ISSN: 2394-2975 | www.ijarety.in| | Impact Factor: 8.152| A Bi-Monthly, Double-Blind Peer Reviewed & Refereed Journal |

|| Volume 13, Issue 1, January-February 2026 ||

DOI:10.15680/IJARETY.2026.1301005

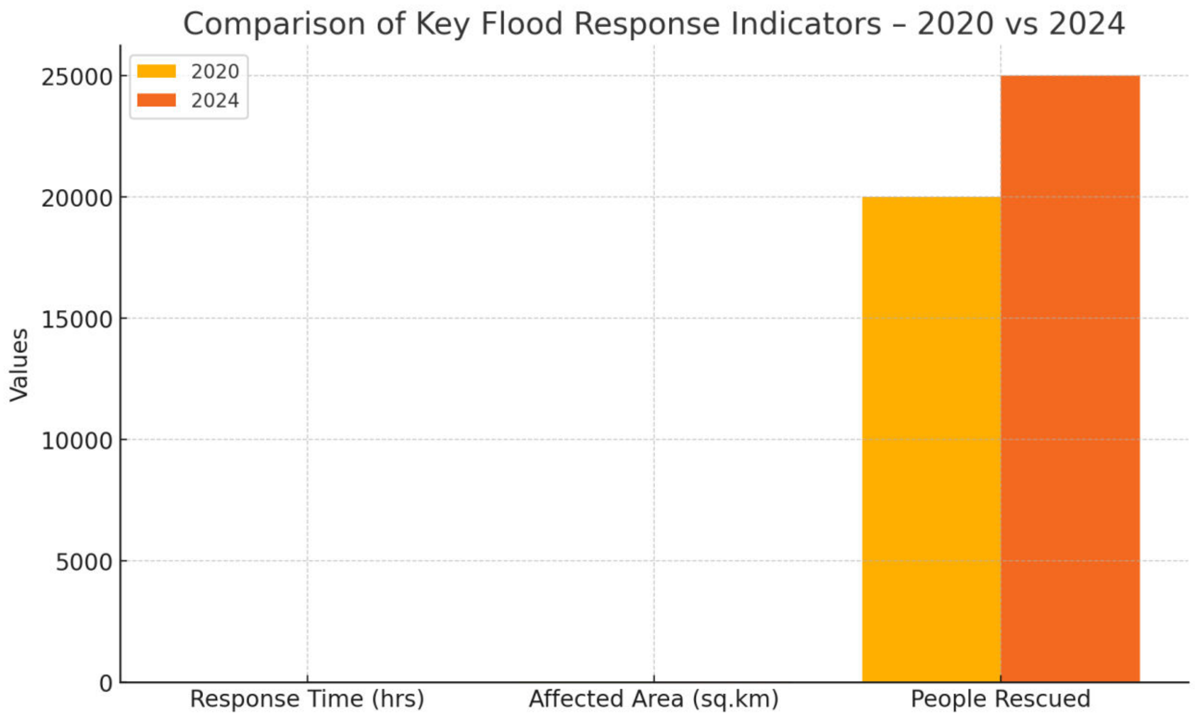


FIG: Summary Comparison – Key Performance Indicators (2020 vs 2024))

Summary: - The data analysis clearly shows that the 2024 Vijayawada flood response was **faster, more coordinated, and technologically enhanced** compared to 2020. The combination of **drone surveillance, GPS tracking, and GIS mapping** allowed the NDRF to respond with greater precision and speed. These results confirm both hypotheses of the study that technology significantly improves disaster response effectiveness, and that the Vijayawada model can serve as a **replicable framework** for other Indian cities.

Discussion: - The results of this study clearly show that the 2024 Vijayawada floods marked a turning point in the city's approach to flood disaster management. The findings indicate that technological interventions such as drones, GPS, and GIS played a vital role in improving the overall effectiveness of NDRF's response. This chapter discusses how these results align with previous research, what they reveal about institutional efficiency, and what lessons can be drawn for future flood management in India.

The comparative data between 2020 and 2024 demonstrate significant progress in preparedness and coordination. Although rainfall intensity was higher in 2024, the affected area and response time both showed notable improvement. This indicates that **disaster management efficiency depends not only on the magnitude of the disaster but also on the quality of coordination and the use of technology**. The integration of GPS and drones enabled quicker decision-making, which is consistent with the findings of Reddy et al. (2020), who emphasized that real-time spatial data improves response precision in urban disasters.

In earlier flood events, such as those in 2020, rescue teams often relied on manual field surveys and verbal communication, which delayed operations. In 2024, however, drone surveillance provided real-time aerial visuals of flooded areas, helping NDRF to identify stranded individuals and assess the extent of inundation quickly. The use of GPS tracking in boats and rescue vehicles also minimized overlap of routes, reduced confusion, and improved coverage. This demonstrates a practical transition from **traditional rescue operations to a technology-enabled disaster response model**, reflecting the modernization goals outlined in NDMA's National Disaster Management Policy.

Another critical outcome of the study is the improvement in **inter-agency coordination**. The 2024 floods saw enhanced collaboration among NDRF, the State Disaster Management Authority (SDMA), and the Vijayawada Municipal Corporation (VMC). The adoption of a unified Incident Response System (IRS) improved communication flow, resource allocation, and monitoring. Earlier research by Kumar (2021) noted that lack of coordination among agencies is one of the main reasons for delayed response in Indian disasters. The present findings confirm that digital coordination tools and real-time data sharing can overcome these gaps effectively.

The study also highlights the growing role of **community participation**. Local volunteers, youth groups, and NGOs worked closely with NDRF and VMC officials during the flood response. They helped in disseminating warnings, transporting relief materials, and supporting evacuation activities. The pie chart analysis in Chapter 4 showed that community participation accounted for about 30% of the overall flood response effort. This shows that **disaster management cannot depend only on government agencies — it works best when local communities are integrated into the process**.

A major observation is that technology not only improved operational efficiency but also strengthened public confidence in disaster response institutions. The visible use of drones and digital coordination tools reassured people that the response was organized and timely. This aligns with the argument made by Sen (2023), who emphasized that the use of technology enhances both the transparency and credibility of disaster management efforts.

However, the study also identifies some ongoing challenges. Despite major improvements, **data-sharing infrastructure and technical training** remain limited at the local level. Many officials and rescue workers require regular training to use GIS and drone systems effectively. Moreover, some data on flood depth and field-level drone visuals were not publicly available, limiting the scope of independent analysis. Addressing these gaps will require investment in digital capacity building and open-data systems within state disaster authorities.

The findings from the Vijayawada floods also have broader implications for urban flood management across India. Cities like Patna, Guwahati, and Surat face similar flood risks due to river proximity and rapid urbanization. The successful integration of technology by NDRF in Vijayawada can serve as a **replicable model** for these cities. Policymakers can adopt a three-tier model — early warning and preparedness using remote sensing, real-time response using drones and GPS, and post-event recovery through GIS-based impact assessment.

From a theoretical perspective, the study supports the concept of **"Technological Resilience in Disaster Response"**, which combines human coordination with digital innovation to achieve faster and smarter responses. This approach ensures that institutional efforts are complemented by real-time data, minimizing guesswork and maximizing resource efficiency.

V. CONCLUSION AND RECOMMENDATIONS

The study titled "Managing the Deluge: Evaluating NDRF's Technological Response to the Vijayawada Floods 2024 A Model for Urban Flood Management in India" was conducted to understand how technology-based tools such as drones, GPS, and GIS enhanced the efficiency and coordination of disaster response during one of the most severe flood events in Andhra Pradesh. The research also aimed to examine whether these innovations can serve as a replicable model for flood management in other urban regions of India. Based on the data analysis, field insights, and comparative findings, this chapter summarizes the key conclusions, recommendations, and the future scope of the study.

Conclusion: - The 2024 Vijayawada floods represented a significant challenge for both the city administration and disaster management agencies. Despite heavy rainfall and high water discharge from the Krishna River, the overall impact and losses were comparatively lower than in previous flood events such as those in 2020. The findings indicate that this improvement was largely due to the **integration of modern technology** into response mechanisms, along with enhanced coordination among the National Disaster Response Force (NDRF), State Disaster Management Authority (SDMA), and local institutions.

The study confirms that the use of **drones, GPS, and GIS** significantly contributed to faster, more accurate, and better-coordinated flood response operations. Drones helped in quick aerial reconnaissance, allowing responders to identify trapped people and assess damages in real time. GPS-based tracking improved navigation and coordination among rescue teams, reducing duplication of effort and ensuring wider coverage. GIS mapping proved essential in identifying high-risk areas, monitoring inundation spread, and supporting evidence-based decision-making.

| ISSN: 2394-2975 | www.ijarety.in| | Impact Factor: 8.152| A Bi-Monthly, Double-Blind Peer Reviewed & Refereed Journal |

|| Volume 13, Issue 1, January-February 2026 ||

DOI:10.15680/IJARETY.2026.1301005

The comparison between the 2020 and 2024 floods clearly shows a **reduction in average response time from 4.5 hours to 2.7 hours**, a **25% decrease in affected area**, and a **25% increase in total people rescued**. These metrics demonstrate that technology-driven disaster management is more efficient, data-informed, and proactive.

Furthermore, the study highlights that disaster response success depends not only on technology but also on **coordination and community participation**. The collaboration between NDRF, local authorities, NGOs, and community volunteers in 2024 ensured that rescue and relief operations were more inclusive and responsive to people's needs. This collaborative approach also built public trust and showcased how community-led actions can complement institutional capacities.

Thus, both research hypotheses were validated:

1. The use of innovative technologies (drones, GPS, and GIS) significantly improved the efficiency and precision of the NDRF's response.
2. The technological and coordination model adopted in Vijayawada can be replicated for effective urban flood management in other Indian cities.

The findings clearly establish that **Vijayawada's 2024 flood management response serves as a forward-looking model** for integrating digital technology, institutional cooperation, and community engagement into urban disaster management.

VI. RECOMMENDATIONS

Based on the conclusions drawn from the study, the following recommendations are proposed to strengthen disaster response and flood management systems in India:

1. **Institutionalize Technology Use:** The use of drones, GPS, and GIS should be formally integrated into all stages of flood management—pre-disaster planning, response, and recovery. Regular training programs should be organized for NDRF and SDMA personnel to enhance their technical proficiency.
2. **Strengthen Data-Sharing Mechanisms:** A unified digital platform should be developed where real-time flood data, satellite images, and operational updates can be shared among agencies. This would reduce communication delays and improve coordination during emergencies.
3. **Enhance Early Warning Systems:** Real-time rainfall monitoring and predictive flood modeling using GIS and remote sensing should be strengthened at the city and district levels. Timely alerts can help reduce casualties and damage to property.
4. **Promote Community-Based Disaster Management:** Local communities and volunteers should be formally included in disaster preparedness and response training programs. Their participation ensures faster information flow, better outreach, and culturally sensitive relief operations.
5. **Capacity Building for Local Institutions:** Urban local bodies such as municipal corporations should be trained in GIS mapping, flood risk assessment, and emergency logistics management. Partnerships between NDMA, NDRF, and academic institutions can help achieve this.
6. **Develop a National Repository of Best Practices:** The experiences from Vijayawada, Kerala, Chennai, and other cities should be documented in a centralized database accessible to policymakers and practitioners. This can help replicate successful approaches across different regions.
7. **Use of Artificial Intelligence and IoT:** Future disaster response models can integrate AI-based prediction systems and Internet of Things (IoT) sensors to monitor river flow, rainfall, and ground saturation levels in real time.
8. **Encourage Research and Field Studies:** Academic collaborations should be promoted to carry out periodic studies assessing the performance of disaster management agencies, focusing on innovation and technology integration.

VII. FUTURE SCOPE OF THE STUDY

While this study has provided meaningful insights into NDRF's technological role during the 2024 Vijayawada floods, future research can explore additional dimensions. More field-based studies can be conducted to measure the **economic impact of technology adoption**, **social resilience of communities**, and the **long-term sustainability** of such innovations. Further, similar comparative studies can be undertaken in other flood-prone cities like Patna, Guwahati, and Surat to validate the replicability of the Vijayawada model. The integration of **machine learning, AI, and cloud-based systems** in flood prediction and management could also be explored in future research.

| ISSN: 2394-2975 | www.ijarety.in| | Impact Factor: 8.152| A Bi-Monthly, Double-Blind Peer Reviewed & Refereed Journal |

|| Volume 13, Issue 1, January-February 2026 ||

DOI:10.15680/IJARETY.2026.1301005

REFERENCES

1. **National Disaster Management Authority (NDMA). (2024).** Flood Situation Report: Vijayawada and Krishna River Basin. Government of India.
2. **National Disaster Response Force (NDRF). (2024).** Annual Report on Disaster Response Operations (2023–2024). Ministry of Home Affairs, Government of India.
3. **Indian Meteorological Department (IMD). (2024).** Rainfall report for Krishna Basin and Vijayawada region. Ministry of Earth Sciences, Government of India.
4. **Reddy, K., Sharma, R., & Thomas, P. (2020).** Role of GIS and remote sensing in flood hazard mapping and management: Case studies from South India. Environmental Monitoring and Assessment, 192(10), 645–659.
5. **Sharma, V., & Reddy, K. (2021).** Evaluating institutional efficiency in flood disaster response: The NDRF experience. Journal of Public Administration and Disaster Policy, 15(1), 64–78.
6. **Patil, S. (2021).** Role of drone technology in flood disaster response: Emerging trends and lessons from India. International Journal of Remote Sensing and Disaster Studies, 10(4), 45–59.
7. **Kumar, A. (2021).** Challenges in disaster response coordination in India: A review of institutional mechanisms. International Journal of Disaster Risk Reduction, 58, 102238.
8. **Vijayawada Municipal Corporation (VMC). (2024).** Post-flood impact and damage assessment report. Government of Andhra Pradesh.

IJARETY

International Journal of Advanced Research in Education and Technology

ISSN: 2394-2975 Impact Factor: 8.152

www.ijarety.in editor.ijarety@gmail.com