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From Vulnerability to Resilience: A Systematic Review of Odisha's Integrated Approach to Disaster Risk Reduction

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ABSTRACT

Odisha, a coastal state in India, has transformed its disaster management framework from a reactive model to a proactive, resilience-centred approach in response to frequent cyclones, floods, and climate-related hazards. This shift, necessitated by the need to protect lives, infrastructure, and livelihoods, gained momentum after the catastrophic 1999 Super Cyclone, which claimed over 10,000 lives and exposed critical gaps in preparedness. Over the past two decades, Odisha's reforms have significantly reduced fatalities through improved policies, infrastructure, and community engagement. This review examines Odisha's evolution in disaster governance from 1999 to 2024, analysing key initiatives such as the establishment of the Odisha State Disaster Management Authority (OSDMA), early warning systems, cyclone shelters, and evacuation plans. Using the PRISMA framework, the study evaluates 40 peer-reviewed articles, reports, and policy documents to assess the impact of these measures. Despite progress, challenges remain, including last-mile connectivity in disaster warnings—particularly for remote tribal communities—and the growing threats posed by rising sea levels and intensifying cyclones. Nature-based solutions, such as mangrove restoration, and community-driven programs like Odisha's Tsunami Ready initiative (involving 26 villages) offer scalable strategies for enhancing resilience. These experiences provide valuable lessons for other vulnerable regions, such as Indonesia and the Philippines. Moving forward, prioritising technological integration, decentralised governance, and sustainable recovery strategies will be crucial for strengthening Odisha's long-term climate resilience.

KEYWORDS

Disaster governance; Odisha; cyclone resilience; early warning systems; community participation; climate adaptation.



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1. Introduction

Odisha's extreme vulnerability to recurrent cyclones, floods, and droughts makes disaster governance a critical priority, as these hazards pose a significant threat to lives, livelihoods, and economic stability. The state's geographical location along the Bay of Bengal exposes it to severe cyclones. At the same time, erratic monsoons contribute to both floods and droughts, exacerbating food and water insecurity (National Institute of Disaster Management, 2020). Effective disaster governance—encompassing early warning systems, resilient infrastructure, community preparedness, and efficient response mechanisms—has significantly reduced fatalities, as demonstrated during Cyclone Phailin (2013) and Fani (2019) (Rahman et al., 2025). Odisha's proactive measures, including the establishment of the Odisha State Disaster Management Authority (OSDMA), cyclone shelters, and robust evacuation plans, have set a benchmark for disaster risk reduction (NIDM, 2020; OSDMA, 2008). Strengthening governance further is essential for achieving sustainable development, alleviating poverty, and adapting to climate change, thereby ensuring Odisha's resilience against escalating climate-related threats (Cvetkovic & Svrclin, 2020; Cvetković & Šišović, 2024).

In India, 84 coastal districts across 13 states and union territories are affected by tropical cyclones. Among these, five states—Andhra Pradesh, Gujarat, Tamil Nadu, West Bengal, and Odisha—along with the Union Territory of Puducherry, are considered most vulnerable to wind and cyclone disasters (NIDM, 2020). The east coast of India ranks as the sixth most cyclone-prone region in the world. Although Odisha's coastline constitutes only about 17% of India's eastern coast, it has experienced around 35% of the region's cyclonic and severe cyclonic storms, with storm surges frequently inundating coastal districts (Sahoo & Bhaskaran, 2018).

The 1999 Super Cyclone, which struck Odisha on October 29 with wind speeds exceeding 250 km/h and a 6-meter storm surge, was a catastrophic turning point in the state's disaster management history, claiming over 10,000 lives and affecting 15 million people (Fanchiotti et al., 2020a). This disaster exposed critical gaps in early warning systems, preparedness, and relief coordination, prompting the state of Odisha to overhaul its disaster response framework. The state established OSDMA in 1999, pioneered community-based preparedness programs, and invested in cyclone shelters and coastal embankments (Ray-Bennett, 2018b). These measures were successfully tested during Cyclones Phailin (2013) and Fani (2019), drastically reducing casualties and positioning Odisha as a global model in cyclone resilience (Mishra & Malakar, 2020).

A systematic review of disaster governance approaches in Odisha is essential to assess policy effectiveness, identify gaps, and adapt to evolving climate risks. Given the state's frequent exposure to cyclones, floods, and droughts, a structured evaluation can determine whether current frameworks, such as early warning systems, community preparedness, and infrastructure resilience, are keeping pace with increasing disaster intensity (UNISDR, 2015). By analysing successes (e.g., reduced mortality in Cyclone Fani) and persistent challenges (e.g., post-disaster recovery, livelihood protection), such a review can inform evidence-based policy improvements. Additionally, comparing Odisha's strategies with global best practices can enhance coordination among government agencies, NGOs, and local communities, ensuring more inclusive and adaptive governance (The World Bank, 2013). Ultimately, a systematic review would strengthen Odisha's resilience, optimize resource allocation, and provide a replicable model for other disaster-prone regions.

2. Methodology

This study employs a systematic approach to examine Odisha's disaster governance framework, scrutinising its policies, government systems, and community-based programs. The methodology is designed to be transparent, accurate, and reliable in showing how Odisha changed from being vulnerable to disasters to becoming more resilient. The research follows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework, which provides a clear, step-by-step process for reviewing studies. This helps ensure the findings are trustworthy and can be verified by others. The systematic review is particularly useful for this study, as it enables re-

searchers to gather evidence from diverse sources, compare findings, and identify gaps in disaster management strategies.

The study began by searching for relevant research papers, reports, and policy documents. Researchers first identified 250 studies from academic databases, such as Scopus, Web of Science, and Google Scholar, as well as government and international organisation reports (NIDM, 2020, 2021; OSDMA, 2008). After removing duplicate studies, 180 remained. The next step was to review the abstracts of these studies to determine if they met the inclusion criteria. This process narrowed the list down to 95 articles. Finally, the most relevant 60 studies were selected for a full review. The inclusion criteria required that studies be peer-reviewed articles, official government reports, or policy documents published between 1999 and 2024. They also had to focus on Odisha's disaster governance, including policies, institutions, and community participation. Case studies of major disasters, such as the 1999 Super Cyclone, Cyclone Phailin (2013), and Cyclone Fani (2019), were included to understand how the state of Odisha prepared for and responded to these events. Studies that were not peer-reviewed, such as opinion pieces or general reports not specific to Odisha's disaster governance, were excluded (Fanchiotti et al., 2020b; Ray-Bennett, 2018b).

The research used a combination of methods to analyze the selected studies. First, a descriptive analysis was done to trace the changes in Odisha's disaster policies over time, from before the 1999 Super Cyclone to the present day. Then, a thematic analysis was used to identify key topics in disaster governance, such as early warning systems, evacuation plans, and community training programs (Mishra & Malakar, 2020). The study also compared Odisha's disaster management strategies with those of other Indian states like Andhra Pradesh and Gujarat, as well as with global standards like the Sendai Framework (Pal et al., 2017). Finally, a SWOT analysis (Strengths, Weaknesses, Opportunities, and Threats) was conducted to evaluate what Odisha is doing well in disaster management and where improvements are needed (Dash & Walia, 2020). This mixed-method approach helped provide a complete picture of Odisha's progress in disaster resilience.

While this review offers a broad assessment of Odisha's disaster governance, several limitations should be acknowledged. Methodologically, its reliance on published literature and qualitative case studies may exclude undocumented grassroots experiences and lack quantitative validation (Pal et al., 2017; Ray-Bennett, 2018b). The focus on post-1999 reforms limits historical comparisons and may miss recent policy shifts like SDG alignment (Chhotray & Few, 2012; Dash & Akhter, 2023). Geographically, a coastal focus overlooks inland hazards and urban-rural implementation gaps (Sahu, & Mishra, 2023; Shukla et al., 2025). Data-wise, few longitudinal studies track long-term recovery, while overreliance on official reports may introduce bias (Maly et al., 2022; Syal et al., 2021). Thematic gaps include limited analysis of gender and caste, and isolated treatment of technologies like AI without addressing digital divides (Gupta et al., 2022; Sharan & Gaillard, 2025). Future research should adopt mixed-methods approaches, expand the temporal lens to pre-1999, and consider cross-regional comparisons with states like Gujarat and Tamil Nadu (Kumar & Pradhan, 2022).

3. Evolution of Disaster Management Mechanism

Odisha's disaster governance has undergone significant evolution, transitioning from a relief-oriented approach to a resilience-driven framework. This transformation follows the Adaptive Governance (AG) model proposed by Djalante et al. (2011), which emphasises polycentric and multilayered institutions to enhance resilience against natural hazards. Before India's independence, disaster governance was largely reactive, focusing on post-disaster relief measures. However, in the 21st century, disaster risk reduction (DRR) has gained prominence, with Odisha emerging as a leader in disaster preparedness (Djalante et al., 2011). Following the catastrophic 1999 Super Cyclone, Odisha established the Odisha State Disaster Management Authority (OSDMA) on December 28, 1999, making it the first state-level disaster management body in India. OSDMA coordinates efforts among the State Disaster Management Authority, Revenue and Disaster Management Department, and the Office of the Special Relief Commissioner to ensure effective disaster preparedness and response. The Odisha Disaster Rapid Action Force (ODRAF) was formed in 2001, equipped with modern technology to provide immediate disaster response (Chhotray & Few, 2012; A. Mohanty et al., 2022).

3.1 Evolution of Disaster Governance in Odisha

Odisha’s disaster governance can be categorized into three distinct phases:

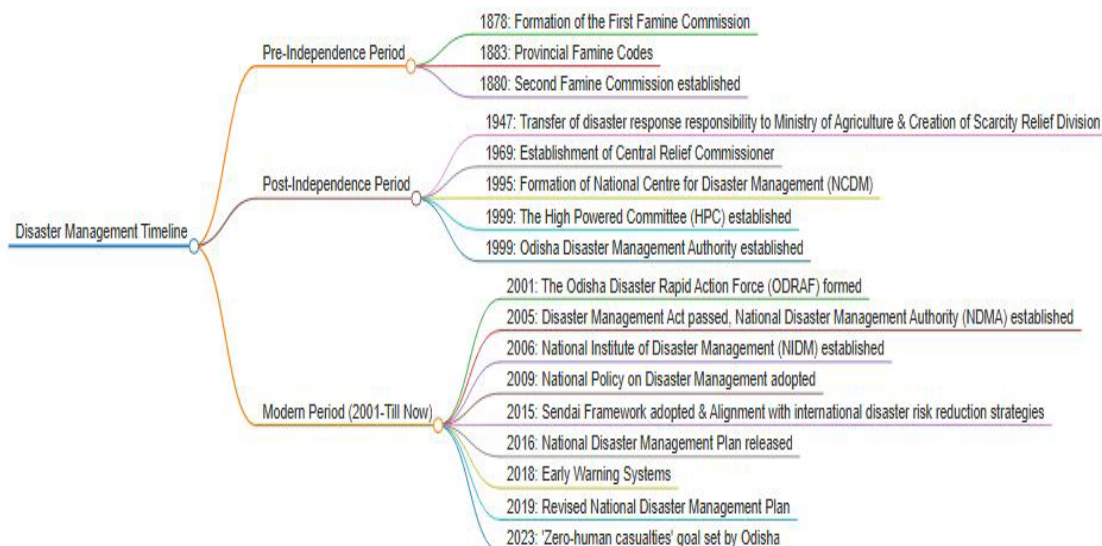


Figure 1. Institutional Response to Disaster Risk Reduction in India. Source: Government of India (GoI), 2009; NIDM, 2021; Prasad 2008; Ray-Bennett, 2011; The Asia Foundation, 2022

3.1.1 Pre-1999: Fragmented and Relief-Oriented Approaches

Prior to 1999, disaster governance in Odisha primarily focused on famine relief and post-disaster assistance. The absence of early warning systems and structured emergency response led to high casualties during major cyclones like the 1999 Super Cyclone, which claimed over 10,000 lives (Sahu, Das, & Mishra, 2023; Tomar et al., 2024).

3.1.2 1999–2010: Institutionalisation and Systemic Reforms

The 1999 disaster marked a turning point, leading to the establishment of OSDMA, which set the foundation for structured disaster governance. The Odisha Disaster Rapid Action Force (ODRAF) was launched in 2001 to conduct rapid disaster response operations (A. Mohanty et al., 2022; OSDMA, 2008). Odisha also aligned its governance framework with national policies, including the Disaster Management Act, 2005, strengthening institutional accountability (Government of Odisha, 2005), (NIDM, 2020). By the time Cyclone Phailin struck in 2013, Odisha’s disaster governance had matured significantly, leading to mass evacuations and a sharp decline in fatalities (U. C. Mohanty et al., 2015).

3.1.3 2001–Present: Resilience-Building and Global Benchmarking

Since 2011, Odisha has invested in advanced early warning systems, GIS-based hazard mapping, and adopted a zero casualty policy (Chisty et al., 2022; Mohapatra et al., 2025). These initiatives align with global frameworks such as the Sendai Framework for Disaster Risk Reduction (2015) (Chisty et al., 2022). Comparative studies show Odisha’s governance model shares similarities with Japan’s community-led disaster drills and the Netherlands’ embankment protection strategies (Nayak, 2020).

4. Key Components of Odisha's Disaster Governance

Odisha's disaster governance framework has evolved into a comprehensive system integrating institutional, legal, technological, and community-driven mechanisms. The institutional framework is led by the Odisha State Disaster Management Authority (OSDMA), which was established after the 1999 Super Cyclone. OSDMA collaborates with multiple stakeholders, including government agencies, NGOs, and international organizations, to implement disaster risk reduction (DRR) measures effectively (OSDMA, 2008). This institutional setup ensures a well-coordinated approach to preparedness, response, and recovery.

4.1. Institutional Governance and Policy Framework

Component	Key Factors	Relevance to Odisha's Disaster Governance	Authors
Institutional Framework	OSDMA, Revenue & Disaster Management Department, Odisha Disaster Rapid Action Force (ODRAF)	Established a post-1999 Super Cyclone for governance coordination and rapid response	Sahu et al. (2023), OSDMA (2021)
Legal & Policy Framework	Disaster Management Act (2005), Odisha Disaster Management Policy (2021)	Strengthens governance structure and aligns with national disaster management policies	Government of India (2005), OSDMA (2021)
Inter-Agency Coordination	Coordination between State, NGOs, Local Bodies, and Last-Mile Connectivity in Early Warnings	Ensures effective disaster response and reduces delays in relief operations	Raju & Becker (2023), OSDMA (2022)
Financial & Insurance Mechanisms	Government Disaster Funds, Micro-Insurance for Disaster-Affected Communities	Supports economic resilience and aids faster recovery for affected populations	Bhowmik & Roy (2024), Govt. of Odisha (2023)
International & National Benchmarking	Sendai Framework for DRR, Comparisons with Gujarat & Andhra Pradesh, Best Practices from Japan & Netherlands	Odisha's disaster governance model is globally recognized for cyclone management	UNISDR (2015), Nakasu et al. (2021)

The legal and policy framework provides the foundation for disaster management in Odisha. The state aligns its policies with the Disaster Management Act of 2005, which mandates proactive DRR strategies, institutional accountability, and community involvement (Government of India, 2005). Furthermore, Odisha's disaster management policy emphasizes risk mitigation through resilient infrastructure and climate adaptation strategies (NIDM, 2020, 2021).

4.2 Disaster Preparedness and Risk Mitigation

Component	Key Factors	Relevance to Odisha's Disaster Governance	Authors
Cyclone Resilience Strategies	Early Warning Systems, Evacuation Planning, Cyclone Shelters	Odisha's proactive measures significantly reduced cyclone-related casualties	Tomar et al. (2025), Mishra & Mohanty (2021)
Community-Based Disaster Management (CBDM)	VDMCs, Trained Volunteers, Public Awareness Programs	Encourages local participation in disaster preparedness and response	Nayak (2022), Das et al. (2022)
Technology & GIS Mapping	Satellite-Based Monitoring, GIS Hazard Mapping, Automated Weather Stations	Enhances disaster forecasting and improves localized risk assessments	Mall et al. (2021), IMD (2020)

Odisha has significantly enhanced its early warning systems, integrating advanced meteorological technologies to predict extreme weather events. The India Meteorological Department (IMD), in coordination with OSDMA, utilizes satellite-based monitoring and GIS mapping to provide real-time cyclone warnings. These alerts are disseminated through SMS, radio, and digital platforms, ensuring timely communication to vulnerable communities. Additionally, automated weather stations have been deployed to improve localized forecasting accuracy (Mohapatra et al., 2025).

4.3. Post-Disaster Recovery and Adaptation

Component	Key Factors	Relevance to Odisha's Disaster Governance	Authors
Post-Disaster Recovery & Rehabilitation	Build Back Better Approach, Livelihood Restoration, Infrastructure Development	Focuses on sustainable recovery and minimizing economic disruption post-disaster	UNDP (2019), World Bank (2022)
Climate Adaptation & Risk Mitigation	Coastal Zoning, Mangrove Restoration, Climate-Resilient Infrastructure	Odisha faces increasing risks due to rising sea levels and intensified cyclone patterns	Bisaria et al. (2024), Dash & Akhter (2023)

Odisha's preparedness and response mechanisms include extensive evacuation plans, mock drills, and specialized rapid response teams such as the Odisha Disaster Rapid Action Force (ODRAF). Over 800 cyclone shelters, equipped with emergency supplies, have been constructed to safeguard affected populations (Banerjee & Mohapatra, 2023). These shelters have played a critical role in reducing casualties during major cyclones like Phailin (2013) and Fani (2019) (Das et al., 2022). Odisha's coordinated evacuation strategy has been widely recognised as a global model for disaster preparedness and response.

Post-disaster, recovery and rehabilitation efforts focus on rebuilding resilient infrastructure and restoring livelihoods. Odisha follows the "build back better" principle, incorporating disaster-resistant construction techniques in housing, roadways, and coastal embankments (The World Bank, 2013). Additionally, skill development programs and financial assistance are provided to affected communities, ensuring socio-economic recovery bank (The World Bank, 2013).

4.4 Community Participation in Disaster Governance

Odisha's disaster governance framework places significant emphasis on community participation, fostering local engagement in disaster preparedness and response. Village Disaster Management Committees (VDMCs) and Panchayati Raj institutions actively contribute to capacity-building initiatives, equipping residents with emergency response skills (Nayak, 2020). The involvement of local volunteers has significantly strengthened disaster resilience, particularly in coastal regions prone to cyclonic threats (UNISDR, 2015).

Odisha's disaster governance framework exemplifies a proactive, multi-dimensional approach that integrates institutional coordination, legal frameworks, technological advancements, and community-based resilience strategies. By continuously evolving its disaster management policies and infrastructure, Odisha has emerged as a global leader in disaster preparedness and response.

4. 5. Literature Gaps Table

Category	Identified Gaps	Relevant Studies
Governance & Policy	Lack of proactive disaster prevention measures in the Disaster Management Act, 2005.	Hanspal & Behera (2024), Gupta (2018)
	Insufficient integration of local governance and community participation in policy implementation.	Syal et al. (2021), Ogra et al. (2021)
	Gaps in national-level coastal climate adaptation policies in India.	Jyotsna et al. (2024)
Data & Methodology	Limited socio-economic vulnerability data and uncertainties in datasets for flood risk assessment.	Jain et al. (2025)
	Lack of high-resolution spatial data for urban expansion modelling.	Joshi & Bhatt (2024)
	Subjectivity in Multi-Criteria Decision Making (MCDM) for landslide risk assessment.	Kadapa (2024)
Community & Social Aspects	Marginalised voices (e.g., gender-diverse groups) are excluded from disaster governance frameworks.	Sharan & Gaillard (2025)
	Barriers to meaningful community participation in post-disaster housing reconstruction.	Rahmayanti & Rukmana (2024)
	Limited focus on livelihood security in disaster recovery.	Iwasaki (2016)
Technology & Innovation	Limited empirical validation of AI and cloud-based disaster management frameworks.	Gupta et al. (2022)
	Challenges in Integrating Blockchain Technology for Disaster Response.	Poonia et al. (2021)
	GIS-enabled mobile apps lack governance and policy integration.	Sharma et al. (2020)
Economic & Infrastructure	Private sector lacks incentives for disaster risk reduction in infrastructure projects.	Jain (2015)
	High costs of private adaptation in flood-prone urban areas.	Shukla et al. (2025)
	Fiscal strain on state governments due to disaster financing.	Suresh et al. (2024)
Environmental & Ecological	Need for micro-level planning for mangrove conservation in coastal areas.	Singha et al. (2024)
	Limited focus on slow-onset disasters (e.g., droughts) in Odisha's disaster model.	Sahu et al. (2023)
	Challenges in integrating international agreements (e.g., the Sendai Framework) into domestic policies.	Raikes et al. (2022)
	Lack of longitudinal studies on post-disaster recovery outcomes.	Maly et al. (2022)

The literature reveals key gaps in disaster management, including weak policy implementation and insufficient integration of local governance. For instance, Ogra et al. (2021) underscore the persistence of top-down, response-driven frameworks with limited conceptual shift toward prevention, while Syal et al. (2021) highlight institutional resistance to frameworks like the Sendai Agreement. Additionally, community participation remains limited, as noted by Rahmayanti & Rukmana (2024), who emphasise barriers to meaningful inclusion in post-disaster housing efforts. Data limitations, such as low-resolution modelling (Joshi & Bhatt, 2024) and subjectivity in MCDM-based assessments (Kadapa, 2024), hinder accurate risk analyses. Marginalized groups, particularly gender-diverse identities like hijras and baklas, continue to be excluded from governance spaces due to binary policy frameworks (Sharan & Gaillard, 2025). Meanwhile, innovations like AI and blockchain show promise but often lack empirical validation in disaster contexts (Gupta et al., 2022; Poonia et al., 2021). On the economic front, Jain (2015) critiques the limited private-sector engagement, citing regulatory disincentives. Furthermore, environmental vulnerabilities—especially slow-onset disasters and ecosystem-based risks—receive inadequate attention (Sahu, Das, & Mishra, 2023; Singha et

al., 2024). Addressing these multifaceted gaps requires inclusive governance, high-resolution data integration, critical engagement with social identities, and robust validation of technological interventions to strengthen disaster resilience in India.

5. Effectiveness and Challenges

Odisha's disaster governance has proven effective in mitigating cyclone-related casualties through the implementation of improved early warning systems, mass evacuations, and community engagement. Notably, the Odisha State Disaster Management Authority (OSDMA) has played a central role in reducing cyclone-related fatalities. During Cyclone Phailin (2013) and Cyclone Fani (2019), Odisha successfully evacuated over a million people, drastically reducing mortality compared to the 1999 Super Cyclone, which caused over 10,000 deaths. Odisha's Zero Casualty Goal (2023) further highlights the state's commitment to protecting lives. Studies confirm that multi-organisational coordination and robust cyclone mitigation measures were instrumental in Odisha's success. The integration of structural and non-structural mitigation approaches, such as cyclone shelters, embankments, and improved forecasting technology, has strengthened Odisha's disaster resilience. Research also shows that Odisha has become a global model for disaster risk reduction (DRR) due to its proactive governance and policy reforms, which are aligned with the Sendai Framework for Disaster Risk Reduction (2015).

Beyond cyclone resilience, Odisha has made remarkable strides in coastal disaster preparedness, notably becoming India's first state to implement Tsunami Ready Villages. This initiative, driven by OSDMA and the Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO), has enhanced community-based preparedness against tsunamis. Under this program, coastal villages such as Venkatraipur and Noliasahi, along with 24 other villages, have received the Tsunami Ready recognition, signifying their ability to conduct timely evacuations, access early warnings, and implement local disaster response mechanisms (Kumar & Pradhan, 2022; PTI, 2024). Odisha's community-driven preparedness model, including mock drills, public awareness campaigns, and infrastructure strengthening, serves as an example for other coastal states prone to tsunami threats.

Despite Odisha's remarkable disaster governance, several persistent challenges remain, particularly in inter-agency coordination and last-mile connectivity. Research indicates that coordination gaps between state agencies and local disaster management committees occasionally hinder rapid response and resource allocation (Raju & Becker, 2013). The National Cyclone Risk Mitigation Project in Odisha has addressed these challenges, but implementation inconsistencies persist (OSDMA, 2008). Additionally, last-mile connectivity in early warning dissemination remains a critical issue, particularly for remote and tribal communities in Odisha. Studies highlight the difficulty in ensuring timely alerts to these populations due to limited mobile network coverage and inadequate infrastructure. Disaster research has underscored the need for community-driven DRR initiatives, emphasizing Panchayati Raj institutions and local governance participation (Das et al., 2022).

Odisha faces new and emerging challenges, particularly in adapting to climate change. Rising sea levels, increasing cyclone intensity, and coastal erosion pose significant threats to Odisha's long-term sustainability. Research on coastal climate risks in India points out that Odisha's adaptation measures need to integrate nature-based solutions like mangrove restoration and improved coastal zoning (Jyotsna et al., 2024). Current policies have primarily focused on disaster preparedness, but researchers argue that Odisha must transition toward a climate-resilient governance model that includes micro-level planning and synergy among sectors (Dash & Akhter, 2023). The State Disaster Management Plan (SDMP) emphasises climate adaptation strategies; however, financial constraints and administrative delays remain key barriers to effective implementation. Studies also note the need for increased investment in disaster insurance to cover infrastructure losses due to extreme weather events (Bhowmik & Roy, 2024).

6. Discussion

Odisha's disaster management framework has evolved into a globally recognised model, particularly in cyclone preparedness and response efforts. Compared to other Indian states, Odisha has demonstrated proactive governance, effective community engagement, and robust early warning systems that significantly reduce the impacts of disasters. For instance, Gujarat's earthquake resilience strategies focus on infrastructure retrofitting, while Odisha emphasizes early evacuation and shelter management (OSDMA, 2008). Globally, countries like Japan and the United States integrate technology-driven early warning systems and multi-agency coordination, similar to Odisha's OSDMA-led disaster governance (UNISDR, 2015).

Additionally, Odisha has made significant progress in tsunami preparedness, with 26 coastal villages officially recognized as "Tsunami Ready" by the Intergovernmental Oceanographic Commission (IOC) of UNESCO. This achievement places Odisha alongside Indonesia and the Philippines, two nations highly vulnerable to tsunamis. Indonesia, which experienced the devastating 2004 Indian Ocean tsunami, has implemented community-based tsunami preparedness programs, including early warning systems and evacuation drills. Similarly, the Philippines, located in the Pacific Ring of Fire, has developed multi-hazard early warning systems and coastal zoning regulations to mitigate tsunami risks. Odisha's Tsunami Ready initiative, which includes mock drills, evacuation route mapping, and stakeholder training, aligns with these global best practices, reinforcing its position as a leader in disaster resilience.

6.1 Lessons for Other Disaster-Prone Regions

Odisha's success offers valuable lessons for other vulnerable regions:

1. **Community-Based Disaster Management (CBDM)** – Odisha's Community-Based Disaster Management (CBDM) approach emphasises the use of trained volunteers and local shelters, which have significantly minimised casualties during disasters. By empowering communities with preparedness strategies and localized response mechanisms, CBDM enhances resilience and ensures swift action in emergencies (PTI, 2024).
2. **Early Warning Systems** – Odisha has effectively implemented risk-informed decision-making in its Early Warning Systems, aligning with the Sendai Framework's principles. By integrating real-time risk assessments and proactive communication strategies, the state enhances preparedness and minimizes disaster impacts (Mitra & Shaw, 2023).
3. **Institutional Coordination** – Odisha's disaster response framework adopts a multi-stakeholder approach, integrating government agencies, NGOs, and local communities to enhance coordination and resource allocation. This collaborative model ensures timely intervention, effective risk management, and improved resilience against disasters (Kumar & Pradhan, 2022).
4. **Policy Integration** – Odisha's disaster governance integrates climate adaptation strategies, creating a resilient framework for managing environmental risks. By prioritizing sustainable infrastructure, proactive risk assessments, and community engagement, Odisha sets a precedent that other coastal states can emulate to strengthen disaster preparedness (Srinivasan & Nagaraj, 2006).

7. Conclusion

Odisha's disaster governance has transformed from a response-focused model to a proactive and resilience-driven framework. The state's institutional reforms, such as the Odisha State Disaster Management Authority (OSDMA) and the Odisha Disaster Rapid Action Force (ODRAF), have significantly enhanced disaster preparedness and mitigation efforts (Sahu, Das, & Mishra Prakash Chandra, 2023). The adoption of early warning systems, GIS-based hazard mapping, and community-led initiatives has reduced cyclone-related fatalities by 99% (e.g., Cyclone Phailin in 2013 compared to

the 1999 Super Cyclone). Despite these successes, persistent challenges remain, such as coordination inefficiencies, last-mile connectivity issues, and climate adaptation gaps (Tomar et al., 2024).

7.1 Policy Recommendations

7.1.1 Strengthening Governance Mechanisms

- Decentralized DRR Frameworks: Empower Panchayati Raj institutions and urban local bodies to lead community-based disaster risk management (CBDM), as demonstrated by Odisha's successful model of cyclone preparedness (Das et al., 2022; Sahu & Mishra, 2023).
- Institutional Coordination: Address gaps in inter-agency collaboration by mandating "After Action Reviews" (AARs) post-disasters to document lessons and improve SOPs (Pal et al., 2017).
- Accountability Measures: Implement gender-sensitive and inclusive governance, as highlighted by Ray-Bennett (2018a) to ensure marginalised groups (e.g., gender-diverse communities) are included in DRR planning (Sharan & Gaillard, 2025).

7.1.2. Climate Adaptation and Nature-Based Solutions

- Ecosystem-Based DRR: Scale up mangrove conservation in Gujarat and Tamil Nadu to mitigate coastal flooding, leveraging community participation and scientific transplantation (Shah & Ramesh, 2022; Singha et al., 2024).
- Micro-Level Planning: Integrate climate adaptation into district-level policies, as seen in Sri-kakulam's mainstreaming of DRR and CCA (Dash & Akhter, 2023).
- Urban Resilience: Adopt Surat's "Urban Form Resilience Index" (UFRI) to balance formal/informal settlement adaptation strategies (Shukla et al., 2025).

7.1.3. Technological and Data-Driven Innovations

- AI and GIS for Early Warning: Deploy AI-driven platforms (e.g., 4-AIDE framework) for real-time hazard prediction and resource allocation (Gupta et al., 2022).
- Blockchain for Transparency: Use blockchain to track relief distribution, addressing corruption delays in post-disaster recovery (Poonia et al., 2021).
- Crowdsourcing and Mobile Apps: Expand GPS-enabled apps for community reporting, as tested in Chennai floods (Bhuvana & Arul Aram, 2019), with Odisha's early warning systems as a model (Sahu, Das, & Mishra, 2023).

7.1.4. Financial and Institutional Reforms

- Disaster Risk Financing: Establish state-level insurance pools for manufacturing units in high-risk states (Bhowmik & Roy, 2024) and incentivize CSR investments in resilience (Kanji & Agrawal, 2020).
- International Alignment: Align with Sendai Framework priorities by integrating DRR into G20 infrastructure agendas (Shaw & Kishore, 2023) and leveraging UNDP partnerships for funding.
- Livelihood Protection: Strengthen formal credit markets and livelihood diversification for farmers, as recommended by Padhan & Madheswaran (2023) in Odisha's coastal districts.

7.1.5. Community-Centric Approaches

- Participatory Reconstruction: Adopt Gujarat and Bihar's "progressive spiral" housing model, emphasizing community-led design and long-term support (Vahanvati & Mulligan, 2017).
- Social Capital Mobilization: Train local volunteers (e.g., Odisha's "Aapda Mitra") and leverage networks to reduce post-disaster conflicts (Lee & Kim, 2021).

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