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## Building resilience: Safeguarding Odisha from natural calamities

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### Abstract

Due to its geographical location and socioeconomic circumstances, Odisha, an eastern state in India, is susceptible to several natural disasters, including earthquakes, floods, and cyclones. The present study examines strategies to protect Odisha from such calamities, considering the state's susceptibility and the imperative nature of preventive measures. Initially, it assesses the susceptibility of Odisha to natural calamities by analysing the area's physical attributes, notable past events, and socioeconomic factors that amplify the risk. The significance of community engagement in disaster preparedness and resilience building is underscored in conjunction with government initiatives and policies, such as early warning systems and evacuation procedures. The study also examines the significance of technological breakthroughs and strong infrastructure, showcasing innovative solutions implemented in Odisha. Moreover, it underscores the importance of safeguarding the environment and effectively managing natural resources to decrease the probability of calamities, with a specific emphasis on preserving natural buffers. Disaster preparedness necessitates education and awareness, with a focus on the media and educational institutions' responsibilities in disseminating information. The present intellectual endeavour advocates for a comprehensive approach to disaster management in Odisha, encompassing infrastructure development, community engagement, government policies, environmental preservation, and educational initiatives, with the aim of mitigating natural disasters.

**Keywords:** Odisha, natural disasters, disaster management, resilience, community engagement

### Introduction

The eastern Indian state of Odisha has long struggled with the devastating effects of natural disasters. Despite being endowed with a wealth of natural resources and a variety of habitats, its susceptibility to natural calamities is nevertheless a depressing fact. The state is especially vulnerable to a wide range of environmental disasters due to its geographic location, which includes earthquakes, cyclones, floods, and droughts. Understanding Odisha's susceptibility to these disasters helps us to realise how crucial it is to take precautions against them for the state's sustainable growth and citizens' welfare.

The various calamities wreak havoc on lives and livelihoods every year, resulting in great pain for people as well as financial losses. Particularly the state's coastline regions are frequently struck by cyclones, which leave a path of devastation in their wake. The devastation caused by calamities like Cyclones Fani in 2019 and Phailin in 2013 serves as a harsh reminder of how urgent it is to increase preparedness and resilience (Mohanty *et al.*, 2022) <sup>[23]</sup>. In addition, the effects of these catastrophes go far beyond the immediate physical harm; they frequently make poverty, food insecurity, and relocation worse, which keep vulnerable people in a circle of vulnerability.

In light of this, the goal of this paper is to investigate methods for reducing the hazards associated with natural disasters in Odisha (Ray-Bennett, 2009) <sup>[37]</sup>. Through an analysis of current programmes, regulations, and community-based endeavours, the goal is to provide insight into practical methods for boosting resilience and lessening the effects of disasters. The study aims to identify key areas for government involvement and novelty in disaster management by examining various government-related issues. Government infrastructure and policies are important, but communities, civil society organisations, and other stakeholders must also actively participate. The proposed strategy involves leveraging our collective knowledge and resources to foster cooperation and knowledge exchange among various stakeholders in Odisha.

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This study explores the socio-economic, environmental, and topographical factors affecting Odisha's vulnerability to natural disasters, focusing on current disaster management programs and tactics, aiming to promote a secure future for its citizens.

### Understanding Odisha Vulnerability

Odisha is an Indian state on the east coast. Its varied topography contributes to the state's abundance of natural resources but also makes it susceptible to a range of natural calamities. The state is vulnerable to storm surges, coastal erosion, and cyclones due to its vast coastline, which stretches over 480 km along the Bay of Bengal (Sahoo & Bhaskaran, 2018) <sup>[39]</sup>. Coastal regions are more vulnerable to flooding due to their low topography, especially during periods of high rainfall and cyclonic activity (Rao *et al.*, 2019) <sup>[35]</sup>. The topography of Odisha is made up of mountains, rivers, and deep forests. Although these characteristics sustain lives and add to the state's biodiversity, they also present difficulties during the monsoon seasons. Heavy rains frequently cause landslides, riverine floods, and soil erosion, which have an impact on communities living on hillside and low-lying locations (Kansal *et al.*, 2023) <sup>[15]</sup>. Flood dangers are further increased by the abundance of rivers, such as the Mahanadi, Brahmani, and Baitarani, particularly in the riverine plains and deltas (Kumar *et al.*, 2021) <sup>[17]</sup>. Although these rivers' fertile plains are attractive to agriculture and towns, they are also vulnerable to flooding during monsoons and cyclones, which can seriously harm livelihoods, infrastructure, and crops.

Devastating natural disasters, including cyclones, floods, and droughts, have long plagued Odisha. The state's geographic location and climatic characteristics highlight how vulnerable it is to such disasters (Patel *et al.*, 2020) <sup>[33]</sup>. Often called Cyclone Paradip, the 1999 Super Cyclone is remembered as one of the most devastating storms in living memory. Along the shore, the cyclone caused significant destruction of homes, infrastructure, and agricultural fields with wind gusts surpassing 260 km/h. Millions of people were forced from their homes and thousands of people lost their lives in the horrific human toll (Mohanty *et al.*, 2022b) <sup>[24]</sup>. Odisha frequently experiences floods in addition to cyclones, especially in the deltas and riverine plains. Large areas of land were submerged by the floods in 2008 and 2011 (Ghosh *et al.*, 2019) <sup>[11]</sup>, which resulted in community displacement, fatalities, and destruction of infrastructure and agriculture. Similar to this, droughts are a common occurrence in Odisha, particularly in the western and southern parts, where they have a negative impact on livelihoods, agriculture, and the availability of water.

Odisha's susceptibility to natural disasters is still increased by socioeconomic variables, even in the face of notable advancements in disaster management and resilience-building initiatives (Mukherjee *et al.*, 2023) <sup>[26]</sup>. Marginalised communities are disproportionately affected by poverty, substandard housing, and restricted access to essential services, making them more vulnerable to the effects of natural catastrophes. Dependence on agriculture as the main source of income in rural regions increases vulnerability since crop losses from droughts or floods can force households into even greater poverty (Panda, 2016) <sup>[32]</sup>. Moreover, as informal settlements are frequently found in hazardous places like floodplains and coastal regions,

rapid urbanisation and poor urban planning exacerbate vulnerability in urban areas. Inadequate drainage systems, flimsy dwelling structures, and constrained evacuation routes are just a few examples of how infrastructure resilience reduces hazards.

### Government Initiatives and Policies

Odisha has exhibited a proactive stance towards disaster management by putting in place a number of frameworks and regulations at the state and federal levels. The Disaster Management Act of 2005 establishes a legal framework for preparedness, response, and recovery, which forms the cornerstone of efforts to mitigate and respond to disasters (Pal *et al.*, 2017) <sup>[31]</sup>. To coordinate disaster management efforts at various administrative levels, this legislation established the State Disaster Management Authority (SDMA) and District Disaster Management Authorities (DDMAs). Furthermore, the state government's commitment to disaster risk reduction is outlined in the Odisha State Disaster Management Policy (OSDMP), which places special emphasis on the incorporation of disaster management principles into development planning procedures (OSDMA, 2005) <sup>[30]</sup>. The policy places a strong emphasis on strengthening capacity, early warning systems, infrastructure resilience, and community involvement. In addition, state governments and the federal National Disaster Management Authority (NDMA) work together to develop national disaster management rules and guidelines. The NDMA ensures cooperation among many stakeholders by offering a comprehensive framework for disaster planning, response, and recovery through projects like the National Disaster Management Plan (NDMP) (Madan & Routray, 2015) <sup>[19]</sup>.

By giving at-risk people timely information, early warning systems help to lessen the effect of disasters by empowering them to take necessary precautions to save lives and livelihoods. The India Meteorological Department (IMD) has an advanced early warning system for floods, cyclones, and other weather-related calamities in Odisha (Ray-Bennett, 2018) <sup>[38]</sup>. Cyclones Phailin (2013) and Fani (2019) in Odisha showcased the efficacy of early warning systems in the region (Das *et al.*, 2023) <sup>[8]</sup>. By combining cutting-edge forecasting methods with effective dispersal strategies, millions of people were able to be safely evacuated from dangerous regions in a timely manner, greatly lowering the number of fatalities and infrastructure damage.

In Odisha, evacuation and shelter management are essential elements of preparedness and response for disasters. The state administration has created thorough evacuation plans for cyclones and floods, establishing safe routes and designated shelters for evacuees in cooperation with local authorities and community organisations (Mohanty *et al.*, 2021) <sup>[25]</sup>. The administration initiates these evacuation preparations in times of emergency, deploying resources to enable the safe evacuation of vulnerable populations. In order to house refugees until the situation stabilises, makeshift shelters with basic amenities including food, water, and medical services are erected in key areas.

### Community Engagement and Resilience Building

Communities act as the first line of defence, ready to act quickly and decisively in the face of difficulty. Their function in times of catastrophe goes beyond simple spectatorship; they become the resilience's heartbeat,

bringing preparations to life. Their proactive participation in disaster readiness strengthens the group's determination against future uncertainty and equips them to handle calamities. Through the active engagement of community people in catastrophe risk assessments, strategic planning projects, and intensive training programmes, authorities plant the seeds of a resilient defence system (Ray *et al.*, 2021) <sup>[36]</sup>. This cooperative method creates the foundation for an all-encompassing and effective crisis management framework in addition to improving reactivity to disasters (Malakar *et al.*, 2023) <sup>[20]</sup>. The distinct perspectives, backgrounds, and skills of each member combine to create a safety net that can handle even the most unanticipated situations.

Local non-governmental organisations and community-based groups are essential to disaster relief operations (Walch, 2018) <sup>[42]</sup>. They are in a good position to organise communities and offer focused support since they frequently have in-depth understanding of the dynamics, networks, and resources in the area. Through a variety of programmes, including capacity-building workshops, awareness campaigns, and joint projects with government agencies, these organisations promote community engagement. Additionally, they act as a liaison between local communities and outside parties, promoting local needs and priorities in preparations for and after disasters.

The effectiveness of fostering community resilience is exemplified by a number of commendable projects in Odisha. The "Cyclone Shelter Management Committee" programme is one such effort that involves local communities in the upkeep and management of cyclone shelters (Haider & Ahmed, 2014) <sup>[13]</sup>. Community members receive the necessary training and drills to equip them with the skills needed to use these shelters efficiently during cyclonic occurrences, minimising damage and casualties. Initiatives centred on managing natural resources and diversifying sources of income have also increased community resilience against recurrent calamities (Fazeli *et al.*, 2024) <sup>[10]</sup>. Communities in Odisha are better prepared to endure the effects of climate-related disasters and develop long-term resilience by supporting sustainable agriculture practices, alternative livelihood options, and ecosystem restoration initiatives.

### **Infrastructure and Technological Solutions**

The foundation of efforts to prepare for and respond to disasters is resilient infrastructure. In an area like Odisha where natural catastrophes happen frequently, having a strong infrastructure is crucial to reducing deaths and financial losses (Mishra, 2023) <sup>[21]</sup>. Buildings, roads, bridges, and communication networks are just a few examples of the components that make up resilient infrastructure. These structures are made to survive natural calamities. In order to better withstand future storms, Odisha, for example, concentrated on fortifying its infrastructure following the destruction inflicted by Cyclone Phailin in 2013 (Dresser *et al.*, 2022) <sup>[9]</sup>. Priority has been given to creating reinforced structures, elevated roadways, and cyclone shelters in susceptible locations. These precautions guarantee quick recovery and restoration following an incident in addition to saving lives during disasters.

In order to improve the efficacy and efficiency of disaster management initiatives, technology is essential. Technology

integration has greatly enhanced emergency response coordination, post-disaster assessment, and early warning systems in Odisha (Ogra *et al.*, 2021) <sup>[29]</sup>. The installation of automated weather monitoring stations throughout the state is one noteworthy example. Because these stations provide up-to-date weather information, authorities are able to warn in good time and evacuate populations that are at risk. Additionally, planning evacuation routes and charting hazard-prone locations have been made possible by Geographic Information System (GIS) technology. Furthermore, Odisha's disaster response has been transformed by the usage of drones for quick damage assessment and search and rescue missions. Drones fitted with high-definition cameras can swiftly assess impacted regions, giving relief organisations vital information for focused assistance operations (Gupta *et al.*, 2022) <sup>[12]</sup>.

### **SATARK**

The Odisha State Disaster Management Authority (OSDMA) created the cutting-edge early warning system known as SATARK (System for Assessing, Tracking, and Alerting Disaster Risks) (Banerjee & Mohapatra, 2023) <sup>[2]</sup>. In order to track weather trends and send out warnings about approaching disasters, SATARK makes use of a network of sensors and satellite data. The state is now much more prepared for cyclones, floods, and other natural disasters thanks to the system.

### **Mobile apps for disaster management**

To improve Odisha's readiness and response to disasters, a number of mobile applications have been created (Nanda *et al.*, 2020) <sup>[28]</sup>. Users can get real-time updates on weather, evacuation routes, and emergency contacts by downloading apps such as "Odisha Disaster Rapid Action Force." With the help of these apps, residents can protect their communities and themselves in an emergency by being proactive.

### **Community Radio Networks**

Community radio networks have become essential lifelines in distant and disaster-prone locations where traditional communication networks may be affected during catastrophes. Radio broadcasts are a useful tool for organisations such as Puri district's Radio Namaskar to reach vulnerable populations with safety instructions, early warnings, and information about relief programmes (Pavarala & Malik, 2021) <sup>[34]</sup>.

### **Environmental Conservation and Natural Resource Management**

Reports suggest that the state of Odisha is seeing a worrisome pattern of environmental deterioration, including deforestation, soil erosion, and loss of biodiversity. Between 2001 and 2020, the state of Odisha lost around 1,483 square kilometres of its forest cover, making it more vulnerable to natural calamities (Acharya & Das, 2015) <sup>[1]</sup>. Natural disaster-prevention buffers lose some of their effectiveness as a result of environmental degradation. For example, the ability of mangrove forests to absorb storm surges during cyclones is reduced when these forests are lost along the shore (Blankespoor *et al.*, 2016) <sup>[4]</sup>. Populations along the seaside are consequently more susceptible to erosion and flooding. The information shows that there has been a significant rise in pollution and habitat invasion, two things



that contribute to the environment's deterioration. Industrialization and rapid urbanisation are additional important causes. Natural disasters are more common as a result of this degradation, which also reduces the capacity of humans and ecosystems to withstand the effects of such disasters.

Data-driven solutions must be implemented if Odisha is to manage its environment in an efficient manner. Making informed judgements is made easier by the beneficial insights provided by data from remote sensing and Geographic Information System (GIS) analysis of land use changes, rates of deforestation, and the general health of ecosystems (Borrelli *et al.*, 2017) <sup>[5]</sup>. By implementing programmes for forestation and restoration based on spatial analysis of hotspots for deforestation, it may be possible to help restore damaged ecosystems and increase natural resilience to disasters. The selection of species appropriate for restoration initiatives is aided by data on the dynamics of tree cover and species distribution. Encouraging sustainable land use practices, such as agro forestry and watershed management, can improve the ability of the soil to retain water, reduce soil erosion, and protect against flooding (Bhattacharyya *et al.*, 2016) <sup>[3]</sup>. The planning and execution of these initiatives are guided by data from hydrological models and soil erosion rates.

Research emphasizes the crucial role of natural buffers, such as mangroves, wetlands, and coastal dunes, in mitigating the impacts of catastrophes in Odisha. During hurricanes, mangrove trees, for instance, can lower wave heights by up to 90%, protecting coastal infrastructure and people (Chang & Mori, 2021) <sup>[6]</sup>. Investing in natural buffer protection and restoration is an affordable way to lower the risk of a catastrophic event. Technologies for ecological modelling and satellite photography help determine the size and state of these buffers, guiding conservation efforts and pointing out areas that should be protected first. Building resilience in Odisha requires incorporating ecosystem-based methodologies into plans and strategies for disaster risk management. Ecosystem services like carbon sequestration and coastal protection are assessed using data, which highlights the socio-economic advantages of preserving natural areas.

### Education and Awareness in Disaster Preparedness

In the midst of the turmoil caused by natural catastrophes, education acts as a ray of hope, promoting community empowerment and resilience (Saul, 2021) <sup>[40]</sup>. Education plays a varied role in the changing terrain of disaster preparedness, providing people and society with the essential information and skills to negotiate the turbulent waters of adversity. The role of education in disaster mitigation is crucial, especially in the heartland of Odisha, which is frequently hit by powerful natural disasters like floods and cyclones (Chhotray, 2014) <sup>[7]</sup>. In this case, education becomes more than just an academic endeavour and becomes a powerful tool for transforming and preserving society. In the rough and tumble state of Odisha, where the power of nature never sleeps, it is even more crucial than ever to teach people how to be prepared for disasters. Education is the means by which communities acquire the ability to anticipate, endure, and bounce back from the devastation caused by calamity. Education serves as the foundation for creating disaster resilience by providing essential knowledge on evacuation protocols, first

aid procedures, and resilience-building strategies. An informed public emerges as active players in their own survival as well as passive consumers of knowledge, capable of identifying warning signs, following safety procedures, and proactively preparing for disasters.

In the meantime, the media—in all of its forms—emerges as a potent ally in the fight against the devastation caused by natural catastrophes (Hewitt, 2019) <sup>[14]</sup>. The media takes on the role of a guardian angel, spreading vital information before, during, and after calamities hit thanks to its unmatched reach and impact. The media, using both conventional and digital channels, acts as a lighthouse in the dark, showing struggling communities the way to safety and deliverance. Accurate and timely reporting becomes a lifesaver, providing crucial information about approaching dangers and pointing helpless people in the direction of emergency services and evacuation routes.

Even though the media and education are essential resources for disaster preparedness, reaching Odisha's isolated and marginalised populations presents particular difficulties (Krishnan & Twigg, 2019) <sup>[16]</sup>. Effective information distribution is hampered in these locations by low literacy rates, linguistic diversity, cultural obstacles, and limited access to communication infrastructure. In addition, the inclement weather and erratic topography frequently make it more difficult to access isolated communities in an emergency. But these difficulties also offer chances for creativity and cooperation. In rural locations, communication gaps can be filled by utilising local networks, community radio, and mobile technology. Adapting instructional materials to the linguistic and cultural context of the area improves comprehension and adoption of disaster preparedness practices. Additionally, collaborations among governmental bodies, non-governmental organisations, and grassroots groups have the potential to expand the scope of awareness campaigns and support community-led projects.

### Tough Challenges Ahead

A wide range of socioeconomic, institutional, political, and environmental elements that obstruct effective disaster resilience are included in the challenges and barriers to the implementation of strategies against natural disasters in Odisha. Socioeconomic problems include high levels of poverty and inequality that impede vulnerable groups' access to essential resources, as well as a lack of funding allotted for disaster preparedness and mitigation efforts (Mishra, 2017) <sup>[22]</sup>. Furthermore, the state is more vulnerable to natural disasters as a result of insufficient knowledge and instruction about disaster risk reduction. Institutional limitations show themselves as inadequate capability and training of local authorities and emergency responders, as well as disjointed coordination among governmental entities in charge of disaster management (Nalla *et al.*, 2021) <sup>[27]</sup>. Vulnerabilities are also made worse by lax enforcement of land-use and building laws. Long-term resilience initiatives are frequently overshadowed by political agendas, with corruption and poor management having an influence on the distribution and application of funding for disaster assistance. The situation is further made worse by political meddling and a lack of willingness to address core flaws. Climate change and ecosystem degradation are two environmental factors that increase the

frequency and severity of natural catastrophes (Lohani, 2022) <sup>[18]</sup>. Poor land management techniques and biodiversity loss further increase the state's susceptibility to natural disasters (Senapati, 2019) <sup>[41]</sup>. The complex issues require a team effort, focusing on sustainable environmental practices, institutional capacity building, political commitment to long-term resilience, and improved stakeholder coordination.

### Concluding Remarks

The present article is a modest attempt to analyse several programs and strategies aimed at mitigating risks and enhancing resilience in order to save Odisha from the persistent danger of natural calamities. A comprehensive approach to disaster management is crucial for the sustainable development of the state and the well-being of its citizens. This can be achieved by considering previous experiences, laws, community involvement programs, technological advancements, environmental preservation strategies, and educational initiatives. Upon careful examination of the primary strategies discussed, it becomes clear that effective evacuation plans and timely warning systems are crucial in minimizing the fatalities resulting from disasters. The essential components of a comprehensive framework for disaster preparedness consist of the disaster management policies enacted by the state and federal governments. These policies comprise investments in technological integration and resilient infrastructure. Moreover, as local communities often serve as the initial responders in emergency scenarios, the importance of community engagement and grassroots efforts to enhance resilience cannot be overstated.

Despite progress in various areas, persistent challenges remain, particularly in relation to environmental degradation and climate change. The vulnerability of coastal areas to floods and storms is heightened due to the depletion of natural protective barriers such as mangroves and wetlands. Therefore, it is crucial to give priority to sustainable resource management strategies and the preservation of the environment. Odisha can enhance its capacity to endure future natural calamities and promote long-term environmental sustainability by safeguarding natural ecosystems and adopting eco-friendly development techniques. Moreover, enhancing individuals' awareness and understanding is crucial in empowering both communities and individuals to proactively respond to disasters. Local organizations, media outlets, and educational institutions have a responsibility to disseminate information regarding risk reduction and disaster preparedness, especially in remote and susceptible regions. Odisha has the potential to establish a durable culture that endures for many generations through investing in education and enhancing public awareness of the importance of being well-prepared for calamities.

### Conclusion

Odisha's vulnerability to natural disasters demands a multifaceted approach for mitigation and resilience. Despite its rich resources, the state faces recurring challenges from cyclones, floods, and droughts, exacerbated by socio-economic factors. Government initiatives like the Disaster Management Act and early warning systems show promise, yet institutional, political, and environmental barriers persist. Community engagement and technological solutions

offer pathways to resilience, alongside environmental conservation efforts. Education and awareness play pivotal roles, especially in marginalized areas. Despite persistent challenges, Odisha can enhance its resilience through sustainable practices, improved governance, and public involvement. A comprehensive strategy, encompassing all these aspects, is essential for Odisha's sustainable development and citizens' well-being.

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