COMMUNITY KNOWLEDGE AND DISASTER MANAGEMENT: MAPPING READINESS AND GAPS IN LANDSLIDE PREPAREDNESS IN WAYANAD, KERALA

By

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Community Knowledge and Disaster Management: Mapping Readiness and Gaps in Landslide Preparedness in Wayanad, Kerala

Abstract

India's diverse geography and climate render many of its states, particularly coastal and hilly ones, vulnerable to recuring floods and landslide. Despite the risk, many communities continue to live in such areas due to poverty, limited resources and a lack of viable relocation options. This study explores the complex socio-economic, cultural and policy dimensions of disaster management, with a focus on landslides in Wayanad, Kerala. It looks at synergies between community-based disaster risk management, traditional knowledge systems and government-led disaster planning at the local level.

The research also aims to identify the strengths and gaps in landslide preparedness and mitigation efforts in Wayanad by considering its unique circumstances and coping strategies. One of the key findings highlights the challenges of integrating effective disaster preparedness and mitigation practices due to the diversity within Wayanad's local communities. The general population, tribal communities and migrant plantation workers are socially distinct groups that do not necessarily function as a cohesive unit, contrary to assumptions of community unity. This fragmentation is further deepened by top-down disaster protocols implemented by the district authorities, which fail to bring these different groups together to integrate their knowledge and experiences into disaster planning. By looking at communities' perception of risk, socio-economic barriers, local practices and the role of government agencies, the study endeavors to generate insights that can potentially inform inclusive, context-sensitive disaster preparedness policies for vulnerable communities.

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List of Abbreviations

CESS	Centre for Earth Sciences and Studies
DDMA	District Disaster Management Authority
DEOC	District Emergency Operations Centre
EOC	Emergency Operations Centres
ESA	Ecologically Sensitive Area
GSI	Geological Survey of India
GST	Goods and Services Tax
IMD	Indian Meteorological Department
KILA	Kerala Institute of Local Administration
KSDMA	Kerala State Disaster Management Authority
NCESS	National Centre for Earth Science Studies
NDMA	National Disaster Management Authority
NDRF	National Disaster Response Force
NGO	Non-Governmental Organisation
NRSC	National Remote Sensing Centre
PVTG	Particularly Vulnerable Tribal Group
SDMF	State Disaster Management Fund
SEOC	State Emergency Operations Centre
UN	United Nations
YWCA	Young Women's Christian Association

Chapter 1: Introduction, Research Questions & Methodology

The Kerala model of development has long been hailed as an exemplar in India's development discourse, notably for its achievements in human development indicators, provision of public goods and strong governance frameworks. The state's success in attaining high literacy rates, healthcare outcomes and social welfare metrics has made it a model of inclusive development. However, this has come at a significant cost and presents a lopsided view of progress. Since 2018, with frequent disasters, the underlying fault lines have become increasingly visible and impossible to ignore, revealing the paradoxes within Kerala's development trajectory.

The Western Ghats range, one of the most ecologically fragile regions in India, was comprehensively studied in 2011 by an expert panel led by ecologist Madhav Gadgil. The panel recommended that 64% of the range be declared as an Ecologically Sensitive Area (ESA), along with strict regulations on mining, quarrying and large-scale construction. Specifically, it recommended that no new dams for large-scale storage be permitted in the region, which would have affected major projects in Kerala at the time. However, none of the concerned states, including Kerala, acknowledged he Gadgil committee report due to the implications it had for the planned development projects. As a result, the Ministry of Environment, Forest and Climate Change formed a High-Level Working Group on Western Ghats under K. Kasturirangan in 2012 to review the earlier report. The new committee significantly diluted the Gadgil report by recommending that only 37% of the Western Ghats be declared an ESA (Ministry of Environment and Forests 2013). This, coupled with unchecked activities, has exacerbated Kerala's vulnerability to recurring floods and landslides.

What is particularly concerning is that the institutions responsible for disaster management are inadequate in their capacity for disaster preparedness and mitigation. This is also apparent

when looking at the government's response to natural disasters and the inability to incorporate local knowledge into formal disaster management plans.

This study examines systemic gaps in the context of landslide management in Wayanad, Kerala. Wayanad, part of the Western Ghats, is one of the most landslide-prone districts in the state. It has witnessed massive landslides beginning in 2018, and despite the lessons, the toll on lives and livelihoods continues to be high. The research investigates the barriers to effective landslide preparedness and mitigation, attempting to understand how formal and informal institutions interact with each other and the extent to which local knowledge and practices are incorporated into government efforts. It also explores how community knowledge influences disaster phases, including prevention and mitigation of future risks based on experiences from the past. The study aims to understand how local knowledge, social vulnerability, and community engagement together can improve risk management. The said analysis applies James Scott's *metis* framework- Scott's concept of *metis* refers to localised, experiential and practical knowledge that communities develop over time to navigate complex and changing environments in contrast to *techne*. The latter embodies formal, scientific and technical expertise, while *metis* emerges from lived experiences, trial and error and cultural adaptation and in an ideal scenario, the two interact and complement each other to develop effective disaster preparedness and mitigation strategies (Chakraborty et al. 2021, Perodin et al. 2021).

This research uses a case study approach to examine how local communities in Wayanad cope with landslides, by weighing community-based knowledge (*metis*) against the scientific analysis (*techne*). By situating Wayanad's case in the *metis-techne* lens, this study will contribute toward a) advancing understanding of how local knowledge and social vulnerability influence disaster preparedness and mitigation b) providing evidence-based recommendations for integrating community knowledge into landslide risk management policies.

Wayanad is a compelling case for studying the relationship between traditional knowledge systems and scientific approaches to disaster management for a variety of reasons. First, as the 13th most landslide-prone district in India, there is an urgent need for effective disaster risk management, the gaps of which are already stark. Second, the district's distinct socio-ecological landscape characterised by hilly terrain, fluctuating precipitation patterns and human activities including deforestation and unregulated development makes it an ideal case for understanding inter-connectedness of various vulnerabilities. Third, Wayanad's diverse population which includes plantation workers and marginalised tribal groups such as the *Paniyas, Kurichiyas*, and *Kattunaickans*, allows for observing intersections between social vulnerability and geographical risk. Fourth, the recent major landslides of 2019 and 2024 offer timely opportunities to assess the failures and successes of existing disaster preparedness and response mechanisms. Finally, the district's relatively newer and evolving community-based approaches to landslide preparedness and mitigation provides an opportunity to understand the potential and challenges of integrating *metis* with *techne* toward creating a more resilient and community focused disaster management framework.

1.1. Research Questions

Research questions have been framed to capture community knowledge across the following phases:

a) **Preparedness-** how communities anticipate and prepare for landslides including rebuilding infrastructure and restoring livelihoods post future disaster
b) **Mitigation-** how they work to reduce future risks

RQ 1: How does the community perceive landslide risks, and how does this perception in turn shape their preparedness efforts and early warning strategies?

RQ 2: How do socio-economic vulnerabilities such as income disparities, education levels and housing conditions impact the community's ability when it comes to landslide preparedness and mitigation?

RQ 3: What social and economic challenges do communities face in preparing for disasters like landslides, including the opportunity costs of forgone wages and relocation expenses?

RQ 4: How do factors such as traditional knowledge, financial constraints and policy barriers affect communities' ability to implement effective risk reduction measures- and how do these locally driven approaches complement or differ from government-led disaster preparedness plans?

1.2. Research Hypotheses

Based on the research questions, the following are potential hypotheses for the study:

a) **H1:** Communities with local level perceptions of disaster risks are more likely to adopt preventive measures than those with low-risk perception (Ryan et al. 2020; Ma et al. 2021)
    - ***Rationale*:** Risk perception, based on local knowledge and vulnerability mapping, is key to effectiveness preparedness and mitigation

b) **H2**: Communities with higher social vulnerability- including factors such as poverty, weak social networks, inadequate infrastructure and in-migration of workers settling in high-risk and fragile zones for employment- will have lower capacity to prevent and mitigate natural calamities
    - ***Rationale*:** Social vulnerability exacerbates the impact of natural calamities

c) **H3**: Communities with higher levels of traditional or indigenous knowledge about landslides will have better preparedness and mitigation strategies compared to communities reliant solely on government (top-down) strategies (Kusumastuti et al. 2021)

- ***Rationale*:** Traditional knowledge encompasses historical and experiential insights that can enhance risk management at the local level

d) **H4**: Community-based approaches such as local action committees and responder groups will be more effective in prevention and mitigation than top-down approaches (Crosweller and Tschakert 2021)

- ***Rationale*:** Community engagement fosters local ownership and culturally acceptable solutions

1.3. Data Collection & Analysis

This research is qualitative in nature, drawing upon secondary quantitative data wherever necessary to support relevant arguments and findings. Primary data was collected through four semi-structured online interviews conducted with government officials, voluntary organisations and local NGOs (Appendix 1). The participants were identified using snowball sampling method, wherein each participant identified other members in the community who had the knowledge or expertise to talk about community-based disaster management and issues surrounding the same. Furthermore, the research does not involve any risks or harm as the interviews are conducted with organisational representatives rather than with actual marginalised or vulnerable communities.

Secondary data was gathered from government reports, academic publications and relevant newspaper reports. These include landslide data and reports and policy documents published by the National Remote Sensing Centre (NRSC), KSDMA and Geological Survey of India (GSI) as well as archives from prominent newspapers in Kerala including The Hindu and Mathrubhumi. These sources provide detailed reporting on landslide impact, responses, and policy measures. Additionally, the analysis includes a discussion of case studies of recent major landslides in Wayanad- the 2019 Puthumala landslide and 2024 Punjirimattom landslides.

The interviews were recorded with oral consent from the participants and later transcribed (and translated wherever necessary). Following transcription, data was organised and prepared for analysis to generate themes as identified in the literature, including disaster preparedness, community involvement, synergies with disaster management plans and frameworks prepared by the government, local knowledge and decision-making processes. Thereafter, content and thematic analysis was undertaken to arrange emergent themes in a meaningful qualitative narrative by interpreting data in relation to the literature (Creswell & Creswell 2018).

1.4. Expected Outcomes

1. Understand socio-economic vulnerabilities that impact disaster preparedness and mitigation of future risks
2. Identify current gaps in community-oriented strategies in Wayanad; highlight the importance of local participation to enhance landslide resilience in the community
3. Provide suggestions for incorporating community knowledge into disaster management plans formulated at the local level

1.5. Research Limitations

Sampling bias: The study is based on the snowball sampling method. While this is a practical and convenient method for selecting participants with advanced or expert knowledge, it could lead to biases in terms of selection of like-minded interviewees without much diversity in voices or opinions. Furthermore, it could underrepresent the voices of actual community members, especially marginalised groups like tribals and migrant workers who experience the consequences of landslides firsthand.

Data collection: Relying on online semi-structured interview, while necessary for practical reasons, may potentially exclude participants with limited internet access, who may also represent the most vulnerable community members. The format of the interview only partially

captures the complexity of interactions between traditional knowledge systems and government systems, as the former is often experiential, oral and deeply embedded in local practices and difficult to be fully captured through online interviews.

Temporal and contextual constraints: The study looks at community perspectives and knowledge through experts and NGO members at a specific point in time and may not fully reflect the evolving or changing nature of such knowledge. While qualitative methods and a case study approach provide depth, the findings may not be transferable to other landslide prone settings that are different from Wayanad in terms of social, cultural, political, economic and geographical characteristics.

Chapter 2: Literature review

2.1. Kerala: State Overview

Kerala, also known as “God’s Own Country”, is a state situated on the southwest coast of India. It encompasses 1% of the India’s total land area, measuring around 38,863 sq. kilometer. The state lies 30 miles inward from the Malabar Coast and is bordered by Karnataka to the north and northeast, Tamil Nadu to the east and south, and Arabian Sea to the west. Kerala experiences a distinctive monsoon season that brings heavy rainfall from the southwest monsoon from June through September and northeast monsoon from October through November. With its combination of hilly terrain and elongated coastline, the state is vulnerable to multiple natural calamities. Having a population density of 860 persons per sq. kilometer, one of the highest in India, the human and economic impacts during disaster events is multifold (Sphere India 2024).

Kerala's 590-kilometer coastline is among the most densely populated area in the state, with more than half the state situated just 4 meters above sea level. Vulnerable fishing communities, live across this coastal zone face high waves, storm surges and occasional sea erosion, that has intensified over the last decade due to climate change and rising sea levels. Despite protective measures like sea walls, breakwaters and geo-textile tubes, storm surges and erosion continue to overwhelm communities and impact livelihoods and infrastructure (Kuriakose 2019).

The state has also experienced numerous droughts throughout the years. A total of 66 drought years were recorded between 1881 and 2000 and more than half the state is classified to be moderately to severely drought prone. Particularly severe droughts occurred in 2002-2004, 2010, 2012- with the 2017 drought being the worst in 115 years (Kuriakose 2019). The occurrence and frequency of these drought events can be attributed to variations in weather patterns, land-use practices and cultural practices associated with the same. Other natural

hazards affecting the state include forest fires, soil piping (land erosion), swell waves and tsunamis.

Landslides are among one of the most recurring hazards for the state, especially during the monsoon season. India ranks among the top four countries in terms of highest landslide vulnerability, with an estimated loss of life per 100 sq. km exceeding one. With about 13.17 percent of land area prone to landslides and about 4.75 percent of it being 'very highly susceptible', the country constitutes approximately 8 percent of global landslide fatalities (National Remote Sensing Centre 2023). Kerala, in particular, is highly vulnerable, with about 14 percent of its land classified as 'very highly susceptible'. Beginning 2018 when Kerala was affected by one of the worst floods in nearly a century, the frequency of landslides also increased. In 2018 alone, over 5,000 landslides were reported in Kerala (IEEE 2019). Between 2015 and 2022, Kerala accounted for 59% of the 3,782 landslides reported in India, making it one of the most affected states (Azad, Salim and Das 2024). The fatalities are also high with 669 causalities, nearly seven times recorded between 2005 and 2014 as shown in Figure 1.

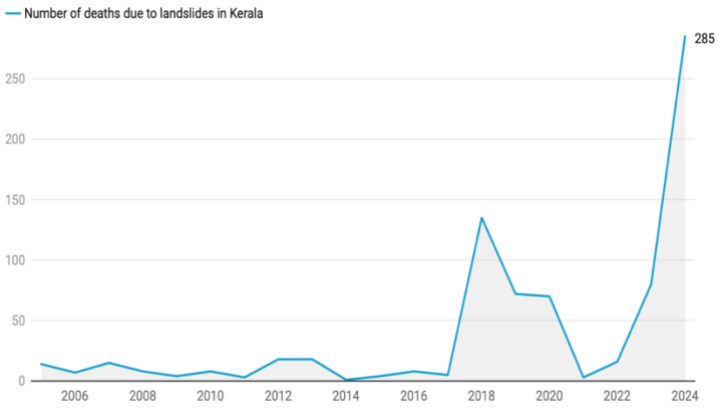

Figure 1: Landslide deaths in Kerala; Source: Down to Earth (https://shorturl.at/lktbi)

As depicted in figure 2, the hilly districts of Wayanad, Idukki, Kottayam and Kozhikode are particularly vulnerable and designated as some of the most landslide prone zone in India because of their location along the Western Ghats. Approximately 1,500 square kilometers of this mountainous stretch are at risk (Kuriakose, Sankar, and Muraleedharan 2009). Each year, as monsoon rains intensify, numerous landslide incidents are reported- disrupting roads, destroying property, silting riverbeds and severely impacting both public infrastructure and private assets.

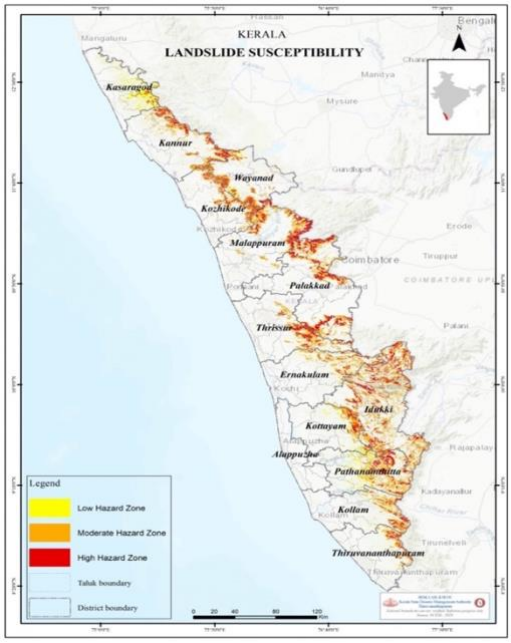

Figure 2: Kerala landslide susceptibility map, Kerala State Disaster Management Authority (2010)

The unprecedented events of 2018, during which all 14 districts of Kerala experienced floods and massive landslides due to heavy rainfall, highlighted the instability of the terrain and subsequent vulnerability of communities living in such regions. Landslide frequency and magnitude have increased since 2018, and numerous studies attribute its causes to the state's physiographic features and monsoon patterns. However, comparatively, very little emphasis has been placed on the role and participation of communities in landslide hazard mitigation and preparedness.

While Kerala's natural terrain contributes to its landslide vulnerability, a number of external factors also play significant roles. The most common trigger is heavy rainfall and cloudbursts, when heavy precipitation within a short span of time penetrates soil and destabilises slopes. Other factors include earthquakes, groundwater level fluctuations, coastal storm surges and anthropogenic activities. Among these, human activities in the Western Ghats have been the most detrimental- illegal and unregulated mining, large-scale infrastructure and resort

development projects, hill-cutting for construction and the expansion of single crop system over vulnerable slopes all interfere with the fragile ecological balance. Vegetation loss and altered natural drainage patterns affect slope cohesion, rendering them easily vulnerable to rain-induced slips. Road construction is especially problematic as it involves cutting into hillsides, weakening natural support systems and making adjacent areas vulnerable.

Another emerging threat is land subsidence caused by tunnel erosion or soil piping, a gradual process that weathers the ground away from underneath in hilly areas. Though less intense than landslides, it increases long-term risks by destabilising ground over time, creating structural weakness that can lead to quick and unexpected slips during monsoons.

Overall, Kerala's vulnerability to landslides is rooted in a unique combination of its location, geological conditions, high population density and land use changes. While natural factors play a role, human intervention coupled with inconsistent climate patterns have transformed the Western Ghats into a hotspot for frequent monsoon-related catastrophes such as floods and landslides. Effective risk reduction requires a multi-pronged approach- stricter regulation of hill development, sustainable land-use planning and implementation, vulnerability or hazard mapping and responsive early warning systems. Most importantly, involving at-risk communities in both planning and implementation is essential for comprehensive disaster preparedness and response.

2.2. Kerala's Disaster Management: Legal Framework & Institutional Challenges

The Kerala State Disaster Management Authority (KSDMA) was established under the Disaster Management Act (2005), promulgated following the Indian Ocean Tsunami (2004). The disaster management policy governing the state defines standard operating procedures for a wide range of stakeholders including but not limited to KSDMA, state and central government departments, district disaster management authority, local authorities including

municipal corporations, district/block/ gram panchayats[1], village officers, voluntary and civil society organisations, Red Cross, multilateral aid agencies, village disaster management committees and task forces, public and private sector undertakings, Army, Navy, Air Force, Coast Guard, Airport Authority, National Disaster Response Force (NDRF) etc.

KSDMA is the key body that facilitates, coordinates, reviews and monitors all disaster related activities in the state including capacity building of relevant personnel and institutions. It is noteworthy that while Kerala established its legal disaster management structure in 2005, KSDMA did not begin operations until 2012 and until cyclone Ockhi in 2017, KSDMA operated with a lean staff of nine members before hiring multidisciplinary scientific experts. Further down the chain of command is the District Disaster Management Authority (DDMA), headed by District Collectors, who besides being tasked with coordinating disaster preparedness and response activities are also authorised to mobilise resources across relevant departments. Similar administrative mechanism including roles and responsibilities have been defined further down the village and panchayat levels (Kerala State Disaster Management Authority 2010).

The Emergency Operation Centres (EOC) set up under the Department of Revenue and Disaster Management and linked with the offices of the state and district disaster management authorities is the executive body and nerve center of all on ground operations in the events of manmade, chemical, biological, radiological and nuclear disasters. The administration and protocols pertaining to EOCs are designed in a way to facilitate prompt exchange of information and coordination of activities among concerned parties including community members, first responders, relief agencies and local non-governmental organisations (NGOs). EOCs remain the focal point for coordinating all disaster related efforts and decision making

[1] A gram panchayat is a village council in India, comprising an elected council of about five members organised that serves as an organ of village self-government.

under one command. It maintains access to a comprehensive information network for timely collection of hazard-related data and rapid dissemination of alerts and warnings**.** EOCs operates round the clock and maintains regular communication with control rooms via phone, fax, wireless and the internet (Kerala State Disaster Management Authority 2010).

2.3. Disaster Management Approach & Strategy

KSDMA defines a disaster as per the Disaster Management Act (2005) of India. Section 2(d) of this Act defines a disaster as "a catastrophe, mishap, calamity or grave occurrence affecting any area from natural or man-made causes, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of property, or damage to, or degradation of environment and is of such a nature or magnitude as to be beyond the capacity of the community of the affected area (Kerala State Disaster Management Authority 2016)."

Disasters are also classified across various categories that are as follows (Kerala State Disaster Management Authority 2010):

1. **Category 1- Water & climate disasters**
    - Flood
    - Drought
    - Coastal erosion
    - Thunder & lightening
    - Cyclone & storm
2. **Category- Geological disasters**
    - Landslide & mudflow
    - Earthquake
    - Dam failure
    - Tsunami

- Dam burst

3. **Category 3- Chemical, industrial & nuclear disasters**
   - Leakage of hazardous materials during manufacturing processing and transportation
   - Disasters arising from the manufacturing, storage, use and transportation of products, pesticides etc. and waste by products produced during the process therein
4. **Category 4- Biological disasters**
   - Epidemic
   - Cattle epidemic
   - Pest attack
5. **Category 5- Man made disasters**
   - Forest fire
   - Urban fire
   - Village fire
   - Mishaps during festivals including stampedes
   - Road, rail & air accidents
   - Boat capsizing
   - Oil spill
   - Major building collapse
   - Serial bomb blast
   - Illicit liquor tragedy
   - Communal riots

To manage the aforementioned, KSDMA outlines an integrated approach in its policy that cross cuts three vital phases that includes:

a. Pre disaster phase includes prevention, mitigation & preparedness; while prevention focuses on elimination of the occurrence of disaster and/or reducing its intensity,

mitigation focuses on advance implementation of measures to reduce the impact of a disaster on people and livelihoods by enhancing community's ability to absorb the shock without much disruption. Preparedness, on the other hand, includes measures that enable the government and communities at risk to respond to disasters in the most effective manner possible. Key activities in the pre disaster phase include hazard, risk and vulnerability mapping by enlisting community participation. It maps vulnerable areas and anticipated loss of people, structures and property. These maps are key to the development of emergency plans and mitigation activities including building capacities of the community, land use planning and zonation, retrofitting buildings and structures to make them disaster resilient, designing disaster resistant construction codes etc. Other activities include preparation and updation of disaster management plans at the state and district levels, capacity assessment and enhancement of personnel, equipment and resources including community centres to house displaced families, deployment of early warning systems, maintenance of inventories and training of personnel.

b. Disaster response during and immediately after; key activity in the disaster response phase includes operationalisation of disaster management plans of which the foremost priority is evacuation, search and rescue of affected people. Other activities include making necessary provision for immediate relief encompassing food, shelter, sanitation, maintenance of law and order for uninterrupted relief operations and restoration of basic infrastructure and essential services including road, transportation, power supply, communication systems etc.

c. Post disaster covers recovery, rehabilitation and reconstruction; activities marking the post disaster phase are designed and implemented in a way that it empowers at risk communities by reducing their risks to future disasters. Rebuilding is envisioned in a way that it addresses the root causes of social, economic and ecological vulnerabilities.

> Kerala bases recovery in major development programs that focus on land reforms, livelihood strengthening, disaster resilient technology, housing and infrastructure. Key activities in the recovery phase include assessment of damage sustained in housing, livelihoods, industries, services, infrastructure, agriculture, health facilities and educational centers in the affected areas. This is followed by fund estimation and preparation of budget to support livelihood restoration and infrastructure reconstruction.

To an extent, KSDMA has been able to fulfill its mandate by raising disaster risk awareness and developing scientific evidence for risk proof development planning. The state offers one of the highest minimum relief code in the country- 30 times over national standards and implements relocation program tied to disaster vulnerability, by providing $4,819 for housing, INR $7,229 for land acquisition to families living in uninhabitable areas or within 50 meters of the high tide line (Kuriakose 2019).

KSDMA has also leveraged institutional capacity building programs by the National Disaster Management Authority (NDMA) and UN organisations, implemented the Tsunami Rehabilitation Project with multilateral agency supervision and participates in the World Bank-funded National Cyclone Risk Mitigation Project. Additionally, existing programs like the Integrated Coastal Zone Management Programme, National Hydrology Programme, and Dam Rehabilitation Implementation Project contribute to risk reduction, though they operate without direct KSDMA consultation.

While the policy and programs may in itself seem comprehensive and well-defined, it is not without its challenges. KSDMA's facilitation of pre-disaster risk management has faltered due to lack of coordination with departments and involvement of at-risk communities in local planning. The institutional set up for disaster risk management is governed by a number of government departments, that often function in silos, leading to coordination challenges.

Primary responsibilities lie with agencies such as the India Meteorological Department, Central Water Commission, Geological Survey of India, and Indian National Centre for Ocean Information Services, with KSDMA providing vital support.

While the state disaster management plan mandates projects to undergo risk assessment before funds are disbursed, departments do not comply. To improve efficiency, protocols strengthening relationships between KSDMA and institutions providing data need to be strictly defined and enforced. Besides, funding challenges need to be addressed as well. At present, KSDM has a budget of $602,409 annually with additional state disaster mitigation funds at its disposal. For disaster management, the state has access to both national and state disaster response funds, wherein 90% contributions are made by the central government and remaining 10% by the state (Kuriakose 2019).

The aforementioned shows that Kerala needs a comprehensive investment policy and sustainable funding program to institutionalise disaster-resilient practices across sectors. The state has explored implementing a temporary "disaster cess" on GST to support rebuilding efforts, which is currently pending central government approval. To strengthen disaster preparedness, integrated risk assessment, early warning systems and information management systems require enhancement. While nodal agencies need to improve hazard detection capabilities, KSDMA also needs personnel as recommended by several committees and experts. Building community resilience through non-structural interventions and youth education represents another essential long-term strategy for disaster risk reduction, which the state is yet to fully develop.

2.4. Wayanad: District Overview & Hazard Vulnerability

Being a landlocked district in Kerala, Wayanad shares its borders with many adjoining states and districts. It shares borders with the state of Karnataka and Kannur district to its north and the state of Tamil Nadu to its east. To its south, its bordered by the districts of Kozhikode and Malappuram and Tamil Nadu and the western boundary is shared with Kozhikode and Kannur districts. It has three administrative subdivisions of which the Centre for Earth Sciences and Studies (CESS) has identified the Wayanad- Kozhikode border along the western borders of the Mananthavady and Vythiri subdivisions as the most active landslide area.

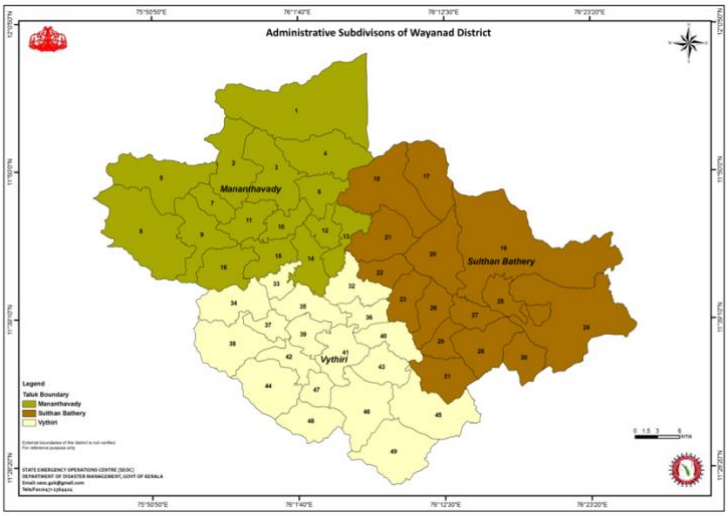

Figure 3: Wayanad administrative subdivisions, DDMA Wayanad

A snapshot of the district profile and hazard profile of Wayanad is as given below (District Disaster Management Authority Wayanad 2015; Sphere India 2024):

Table 1: Wayanad district profile

Headquarters	Wayanad Collectorate
Total area	2,132 sq. km
Population	780,619
Male	391,273
Female	389,346
Sex ratio	995 female per 1000 male
Population density	366 people per sq. km
Taluks	3 (Mananthavadi, Sulthan Bathery, Vythiri)
Blocks	4
Villages	49

District Panchayats	1
Gram Panchayats	25
Municipalities	1

Table 2: Wayanad hazard profile

Classification	**Disaster Type**
Naturally triggered/ weather based	Flood
	Thunder & lightening
	Drought
Geological	Earthquakes
	Landslides
Biological	Epidemics
	Cattle epidemics
	Food poisoning
	Pest attack
Anthropogenically/ technologically triggered	Fireworks accident
	Road accidents
	Human triggered forest fire
	Short circuit & related fore
	Building collapse
	Tourism related drowning
	Hooch accident

The district is located on the southern tip of the Deccan plateau and is part of the Western Ghats range. Local elevations range from approximately 700 to 2100 m above sea level, giving rise to topographical features consisting of ridges, valleys, peaks and hillocks (Wang et al., 2025). It is most impacted by floods and landslides. As per the Landslide Atlas of India released by Indian Space Research Organisation in 2023, 10 out of Kerala's 14 districts are among the 30 most landslide-prone districts in the country. Wayanad ranks 13th out of 147 districts based on socio-economic indicators related to landslide vulnerability. Within Kerala, Wayanad ranks 5th among the 14 districts, after Thrissur, Palakkad, Malappuram and Kozhikode. Notable landslides in the past include *Mundakkai* (1984) resulting in 14 fatalities; the *Kappikkalam*

landslide (1992) causing 11 deaths; and the *Valamthode* landslide (2007) resulting in 4 deaths (Sphere India 2024). Other major landslides include the *Amboori* landslide (2001) with 39 fatalities; the *Pamba* landslide (1999) resulting in 25 deaths and the *Nittumkoottamala* landslide (2004) with 10 fatalities (Kuriakose, Sankar, and Muraleedharan 2009)

In the last decade especially, the district has experienced frequent landslides, triggered by changing precipitation patterns and aggravated by anthropogenic activities such as deforestation, unregulated mining and unsustainable agricultural practices. Two notable events in Wayanad include the 2019 *Puthumala* landslide, which claimed 17 lives, and the more devastating series of landslides in 2024 that occurred in the villages of *Punjirimattom, Mundakkai and Chooralmala*, claiming over 400 lives.

Wayanad has a predominantly agrarian rural population characterised by a plantation economy. It is known for its tea and spice plantations on steep slopes, which combined with the district's rugged terrain and dense vegetation, makes it susceptible to landslides. Although most of the district is prone to landslides, certain groups are particularly vulnerable due to their socio-economic status and geographical location. For example, indigenous tribal groups such as the *Paniyas*, *Kurichiyas* and *Adiyas* live in more remote and hilly landslide prone areas. Likewise, small-scale farmers and migrant plantation workers who depend on daily wages and continue living in these areas face increased risks both in terms of exposure, preparedness and rehabilitation (Siddiqy 2024).

Preparedness and mitigation measures for landslides typically include both structural and non-structural interventions. While structural interventions include measures such as slop stabilisation, vegetation management and construction codes that alter physical environment, many developing countries face financial and technical barriers to its implementation. As a result, non-structural measures like land use planning, early warning systems, and public awareness campaigns acquire significance. Community-led mapping of slopes and drainage

systems contribute to not just better risk perception but also enhanced response. These approaches are feasible and inexpensive compared to the more elaborate structural measures, especially in the context of resource poor communities (Azad, Salim and Das 2024).

At the community level, preparedness is also essential in reducing impact because local community members are typically the first responders in emergencies. In South Asia, where several countries experience recurrent earthquakes, floods and cyclones, community knowledge and engagement play an important role in strengthening preparedness and mitigation. For instance, community-based disaster risk management programs implemented in Odisha (India) augmented cyclone preparedness through the establishment of early warning systems and evacuation preparedness drills. In Pakistan, mosques and other religious centres play a similar role as a source of disaster awareness initiatives, where sermons are used to disseminate information about flood preparedness. This demonstrates that leveraging community expertise is not only less resource- intensive but also enhances preparedness and mitigation actions on ground. However, despite such evidence, the implementation of landslide risk management strategies faces several challenges such as limited budgets, complex and/or myopic policies and inadequate risk information.

Chapter 3: Findings

The District Disaster Management Plan for Wayanad, released in 2015, is a comprehensive document that defines roles and responsibilities for government and non-government stakeholders while emphasising community participation and ownership of the local disaster management plan. However, very little has been implemented on the ground. The consequences of these implementation gaps were felt in 2018, 2019 and 2024 when major disasters including rain-induced flash floods and landslides ravaged Wayanad, claiming lives and property. The 2018 flood affected the entire state, but the 2019 and 2024 landslides in Wayanad were particularly catastrophic due to lack of preparedness, response and mitigation mechanisms, despite the hard-won lessons from 2018.

The 2024 landslide, the most recent and most fatal to date, occurred during the early morning hours of July 30 in Wayanad. Incessant precipitation triggered a series of massive landslides that swept downhill, carrying soil, large boulders and vegetation. Roads, homes and farmland downstream were washed away. The disaster resulted in over 400 deaths, with more than 300 people injured and many more reported missing. Most of the victims were workers employed in tea and cardamom plantations, housed in temporary shelters. The areas most affected included the four villages of *Punjirimattom, Mundakkai, Chooralmala* and *Vellarimala*, all located in the Meppadi panchayat of Vythiri taluk- one of the taluks most prone to landslides, as shown in Figure 3.

The origin of the landslide was approximately 8 kilometers deep in an uninhabited forested area southeast of the *Iruvanipuzha* river. From there, it spread to the surrounding villages and forested areas. In the days leading up to the event, the Indian Meteorological Department (IMD) had placed Wayanad under an ‘orange’ alert, indicating heavy to very heavy rainfall. Local accounts recall that the first landslide struck Chooralmala, followed by a series of other landslides that washed away entire villages (Kolathayar, Menon, and Kundu 2024). The

collapse of the *Punapuzha* bridge, the only bridge that connected *Mundakkai* to *Chooralmala* and the rest of Wayanad, entirely cut off the *Mundakkai* area. This infrastructural collapse delayed emergency operations and amplified the scale of the disaster.

A host of other factors also contributed to the occurrence of the landslides and the aftershocks. These include climate-change-induced shifts in the rain belt, altering the spatial distribution of rainfall in the region, inadequate disaster warning systems and limited emergency response capacity. There was also a lack of awareness and preparedness for landslide risk among the community, which largely constituted migrant labourers, plantation workers, and tribals, resulting in poor response to early warning notifications. In many other remote areas, delays in the transmission of alerts also affected timely responses, reducing the effectiveness of preventive measures (Wang et al., 2025).

Why, despite having a scientific disaster management plan and lessons from past disasters, was Wayanad caught off guard by the events of 2024? More importantly, why do communities continue to remain vulnerable to future landslides?

To understand this, it is important to take a closer, deeper look at the disaster management landscape in Wayanad. Scott's theory suggests that this landscape should be ideally characterised by synergies between government-led initiatives or *techne* and community-based responses and traditional knowledge or *metis*, with each complementing and reinforcing the other. However, insights from key stakeholders including a former official from the Wayanad District Emergency Operations Center (DEOC) and community-based voluntary organisations and NGOs paint a different reality- Wayanad lacks both effective *techne* and functional *metis* when it comes to landslide preparedness, response, recovery and mitigation.

While *techne* exists in nascent form as evident in various government initiatives, it remains underdeveloped, lacking the community focus and integration necessary for effective disaster preparedness and mitigation. On the other hand, the *metis* which forms the premise for

community resilience has remained relatively weak due to the heterogeneity of local communities in Wayanad and the resulting socio-economic and cultural disparities that characterise these different groups. The heterogeneity of the local community here refers to the presence of diverse social groups, including the general population, tribal communities with distinct cultural identities and migrant plantation workers who are not originally from the district. These groups differ significantly in terms of livelihoods, socio-economic status and access to resources, resulting in fragmented community dynamics. This dual absence explains why, despite having a scientific disaster management plan and lessons from past disasters, Wayanad continues to remain vulnerable.

Following the 2018 floods and landslides, several initiatives were rolled out to strengthen the disaster management framework. However, these initiatives have, at best, have been erratic and piecemeal. Conversations with the former DEOC official highlighted these initiatives as well as reasons why they have not been able to achieve the desired outcomes, namely, improving communities' perception of risks and preparedness mechanisms, and integrating these with government efforts.

3.1. Unprepared Institutions, Unprepared Communities

The disaster management framework operates through a three-tier system that was established following the Disaster Management Act of 2005- district, state and central government. The DEOC functions as what the official calls the "*epicenter*" or "*energy-generating room of the district*," serving as the executive or implementing arm of DDMA.

This institutional framework, however, only gained prominence after the 2018 floods, which served as a wake-up call for the authorities. The government official reflects on this transformation: *"In 2018, we experienced an unexpected incident. We were all caught off guard...this was an eye-opener for both the Kerala government and the central government.*

Although we had the Disaster Management Act in place, the machinery wasn't active. We were essentially 'sleeping' and definitely not in a state of readiness."

This shows a lack of institutional preparedness in dealing with a subject as critical and urgent as disaster management. While the formal disaster management mandate came into existence in 2005, it took more than a decade for the authorities to set the institutional levers in motion. When the government machinery itself is unprepared and inactive, it becomes unrealistic and even unfair to expect communities to be adequately prepared. This institutional slack is further evidenced in the continued reliance on outdated landslide susceptibility map, last prepared in 2010 by the National Centre for Earth Science Studies (NCESS) for KSDMA and Wayanad DDMA. These maps no longer capture the evolving vulnerabilities brought about by changing land-use patterns, climate and geological conditions, rendering preparedness, mitigation and response strategies grossly misaligned with current risks.

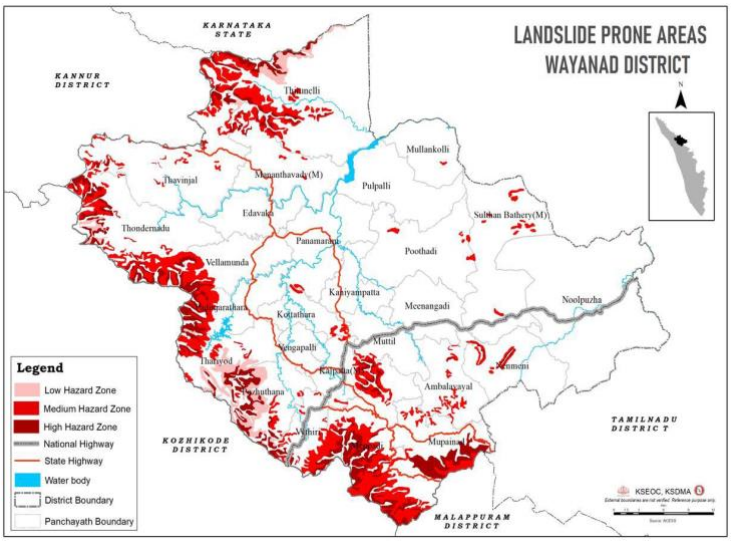

Figure 4: Wayanad landslide susceptibility map, District Disaster Management Plan Wayanad (2015)

3.2. Disaster Preparedness at the Grassroots: What's Working, What's Missing

It is against the larger backdrop of a still nascent and only recently activated district disaster management authority that its efforts at community mobilisation and integration need to be analysed. A few recent and noteworthy initiatives include:

School-based disaster management clubs: Conceived in 2021 and implemented by 2022, these clubs have achieved remarkable scale, with over 6,000 registered student volunteers across approximately 200 schools throughout the district. Each school usually enrolls around

40 students in this network, creating a substantial base for community-wide disaster awareness through a multiplier effect. The former official remarked that *"We've calculated that 6,000 students mean 6,000 families. Younger students typically share what they learn with their parents and siblings. So, with 6,000 families and a minimum of 4 members per family, that's 24,000 people. Additionally, in Kerala, most households are connected to Kudumbashree units (self-help groups) or some kind of association and these families are further expected to pass on the learnings to these groups."*

The curriculum encompasses a comprehensive 10-module program that covers fundamental disaster management (including landslides) concepts such as what constitutes a disaster, how frequently disasters occur and the differences between various types of disasters- topics that aren't otherwise part of the regular school curriculum.

Community-wide rain gauge network: One of the most innovative aspect of Wayanad's landslide and flood preparedness is the extensive rain gauge network developed in collaboration with the Hume Centre for Ecology and Wildlife Biology. DEOC Wayanad described this initiative as *"a revolutionary initiative. None of the approximately 900 districts in India have this unique system of obtaining weather predictions, reports and data from local households. It's a micro-level initiative."*

The idea behind this collaboration is to combine community participation with scientific monitoring, with Hume Center operating approximately 250 rain gauges while the government has distributed an additional 40-50 gauges to tribal colonies and government offices. This collaboration is emblematic of the potential for government-community partnerships, as the official explains: *"They (Hume Centre) have mechanisms to reach interior places that the government cannot easily access and they've installed rain gauges...We collaborated with them, secured some funding and implemented this in tribal colonies and government offices where feasible."*

Alert systems and communication channels: Perhaps the weakest of all interventions is the alert system and communication flow due to lack of technical infrastructure and digital integration. The communication channel for landslide alerts relies on social networks rather than technological solutions. WhatsApp groups operate at ward, village and panchayat levels, complemented by conventional methods including microphone announcements and radio broadcasts.

While these announcements were initially based on the local language Malayalam, recognising population and linguistic diversity in the district owing to presence of tribal groups and migrant labourers, the district has now developed alert messages in seven languages- Bengali, Hindi, Kannada, Tamil, Paniya, English, and Malayalam, broadcast through Radio *Mattoli* in Mananthavady.

However, significant gaps still remain in timely and accurate alerts. While plans exist for an improved SMS-based system with multi-level alerts, at present, the machinery relies on human networks and informal WhatsApp groups. Moreover, in this case, the SMSs sent by KSDMA and DDMA are only in Malayalam and limited to general weather alerts. They are not tailored for warnings or evacuation in the face of vulnerabilities, such as landslides.

Relying solely on informal networks and WhatsApp based groups during emergencies such as an imminent landslide is counterproductive. Many areas are difficult to access for the physical dissemination of alert messages by ward, village and panchayat members as is the current practice. Moreover, not everyone, particularly those in tribal communities has a smartphone, access to the internet or is part of such mainstream WhatsApp groups.

Another challenge with manual communication channels is that they are time-consuming, as they rely on the physical mobilisation of officials and follow established protocols involving multiple agencies. The General Secretary of the Pulse Emergency Team, a Wayanad-based voluntary organisation says, *"Directions are given from the District Operations Center to*

panchayats and municipalities... The Collectorate informs the panchayat, tahsildar and village officials, who then go to the field to inform and evacuate people." While such an approach may be effective for nearby towns and villages, it is ineffective for rural interiors and forest settlements, that are typically characteristic of the Wayanad terrain.

Earlier in 2025, the Government of Kerala launched 'KaWaCHaM', a weather alert system designed to improve rescue and rehabilitation efforts during natural calamities. According to KSDMA, the significance of this system lies in its integration of alerts, sirens and global weather models to enhance disaster preparedness and public safety. Developed with funding from NDMA and the World Bank, its features include hazard assessment, alert dissemination and action planning based on the severity of threats.

Headed by the State Emergency Operations Centre (SEOC) and implemented at the sub-district level, the project is set to install 126 sirens and strobe lights on tall towers, government buildings, and schools. These devices will broadcast pre-recorded voice messages and audio alerts for warnings. The sirens can broadcast warnings up to 1,200 meters away and provide necessary information about shelter locations and safety precautions. This system is especially expected to benefit regions frequently impacted by floods and landslides. However, smaller districts like Wayanad, which is also one of the most landslide-prone districts in the state, have fewer sirens, only 5, compared to districts like Thiruvananthapuram and Ernakulam, which have 13 sirens each (Shaji 2025).

3.3. Does Metis Exist in Wayanad as We Know It?

To answer this question, it is important to first unpack the definition of 'community'. The research initially assumed a narrow understanding of community as households directly impacted by disasters. However, stakeholder interviews showed that in Wayanad, this definition of community, in the context of landslide preparedness and mitigation goes beyond individual households. It includes various groups such as migrant plantation workers, tribal

groups such as the *Paniya, Kurichiyas, Urali, Kuruma* and the Particularly Vulnerable Tribal Group (PVTG)[2] *Kattunaickans,* as well as students who act as knowledge carriers, local volunteers, NGO members and elected leaders at the ward, village, and panchayat levels who serve as crucial links between the government and grassroots communities.

In this context, *metis* or traditional knowledge does not exist as a well-defined repertoire of knowledge and practices, due to the heterogeneity of Wayanad's community, which comprise different groups with varying degrees of socio-economic vulnerability and experiences of marginalisation. In particular, migrant labourers, often employed as plantation workers, tend to lack the familiarity with local geography that is essential for developing the kind of experiential or traditional knowledge typically associated with *metis*. As a result, stakeholder discussions reveal that different community groups tend to rely on district authorities, voluntary organisations and NGOs for support in landslide preparedness and response. From the interviews conducted, it becomes evident that these informal institutions are more effective and responsive to the disaster management needs of the community compared to formal institutions. However, they are also constrained in the scale of their operations due to funding and personnel limitations, as discussed in the following section.

3.4. Exclusion & Vulnerability: At the Margins of Preparedness

The DEOC in Wayanad has implemented several promising measures to improve landslide preparedness, as outlined in the previous section. However, according to the respondents, these efforts have yet to make a significant impact due to a) narrow policies and b) a failure to effectively include hard-to-access groups that are not just geographically and socially isolated

[2] This classification is a sub-category within the Scheduled Tribes in India, created by the Government of India to identify and support tribal communities that are especially marginalised and at risk. PVTGS are groups that primarily rely on hunting, gathering, shifting cultivation and have a stagnant or declining population with extremely low literacy levels.

but also among the most vulnerable- migrants, plantations workers and more importantly, the tribal communities. Two striking examples are:

Inadequate preparedness training & outreach: Despite tribals making up nearly 20% of Wayanad's population, with around 200,000 people living across 3,000 colonies, DEOC's training programs have penetrated only a miniscule of this population. According to the former DEOC official, training programs launched in 2022 covered only 10 such colonies across 10 gram panchayats, providing preliminary training to approximately 600-1,000 individuals and advanced training to just 100 people. As the DEOC official candidly admitted, *"what we've done is just a drop in the ocean"*, with the program reaching less than 1% of the tribal groups in need of disaster preparedness training.

The respondent partly attributed the sporadic and inconsistent nature of such training programs, not just for tribals, but for the broader population as well, to funding constraints. This systemic gap gets compounded by social marginalisation, as tribal communities are either excluded from or hesitant to participate in the mainstream panchayat level training sessions. When disaster management officials visit these colonies, they always find residents *"completely unaware of any disaster management initiatives or precautionary measures",* demonstrating the need for broader, culturally sensitive trainings to bridge the gap between current efforts and the true scale of vulnerability faced by the tribals.

Interestingly, tribal communities show greater willingness to both evacuate and relocate. The General Secretary of Pulse Emergency Team, observes, *"It is quite interesting that it is tribals who're usually more willing to move compared to the general population."*

Further interviews reveal the reasons behind this difference. The Executive Member of the Rise Up Forum NGO, explains that the contrast stems from fundamental differences in baseline living conditions. He says, *"When we look at places designated by the government for temporary shelters or long-term relocation, the tribals get better facilities. Despite holding*

land rights, the houses they typically live in are dilapidated and lack basic amenities. In contrast, shelter provided by the government offer improved toilet facilities, bedding and a more comfortable environment overall."

For tribal communities, while these facilities mean improved infrastructure and comprehensive support, for the general population, they are a significant downgrade as the respondent observes, *"For the general public, their regular living standards are much better. There is no such advantage or incentive for them to evacuate as facilities at government camps are perceived to be of substandard quality."*

This illustrates how socio-economic disparities shape disaster preparedness and response behaviours- evacuation and relocation represent a temporary improvement for marginalised communities and a temporary hardship for more well-off groups. It also suggests that targeted, culturally appropriate interventions could yield substantial results if implemented consistently and at scale, as tribal communities ate generally more responsive and open to proactive preparedness measures.

Evacuation and wage opportunity costs: The opportunity cost in terms of wages forgone is glaring for daily wage workers and families of modest means. When evacuation alerts are issued, these families incur wage loss as they are required to move into temporary shelters. Under the State Disaster Management Fund (SDMF), the compensation policy for livelihoods or wage lost is designed in a way that proactive community response is almost financially penalised. The former DEOC official explains the criteria: *"If you are evacuated from your household for safety reasons and placed in a camp... SDMF provides compensation for people during the days they have stayed in evacuation centers. It may be a fixed amount of 3,000 rupees or 5,000 rupees per family, but it depends on the available funds."* However, compensation is strictly tied to official evacuation orders. As the official says, *"Only for government-ordered evacuations... If, say, five families decide to evacuate on their own*

because of a warning issued by Hume Centre or general weather alerts, unfortunately, the government won't provide compensation."

This creates a disincentive for early evacuation, compromising safety for financial survival. The compensation system's conditionality associated with official government orders rather than community-initiated evacuations weakens the very community-based approach that authorities want to promote.

3.5. Formal vs. Informal Institutions: Complement or Conflict?

Interviews with respondents across the spectrum, from government officials to local organisations, demonstrated that NGOs and voluntary organisations play a critical role in plugging the gaps in government's disaster preparedness and response efforts, even though their relationship with official agencies is often complex and occasionally tense. As the Executive Member of Rise Up Forum remarks, when disasters occur, *"help would reach the people near the landslides, closer to the towns, the fastest,"* but remote communities are frequently overlooked.

This gap is evident not only during disaster response but also in preparedness, recovery, rehabilitation and mitigation. While mainstream, accessible areas receive timely and abundant aid, tribal communities and migrants remain at the margins throughout the disaster management process.

Top-down planning & lack of harmony: A main issue underlying these gaps is the inadequacy of formal disaster management plans, developed without any meaningful community participation. As revealed in the interviews, the plans currently used at the panchayat level in Wayanad were developed by the Kerala Institute of Local Administration (KILA) and implemented through various stakeholders, without direct involvement of the communities they are meant to serve.

As reported by the former DEOC official and echoed by other respondents, the core issue here is that of ownership, *"Current plans are top-down and made by the government, not by the people."*

The inadequacy is conspicuous considering that community members possess valuable experiential knowledge, accumulated through lived experience of dealing with landslides. However, this knowledge is usually informal and not integrated or codified into the formal disaster management framework.

This disconnect is further visible in operational conflicts during disaster response, which also emerged as a major point of contention during the 2024 landslides in Wayanad. Local volunteers who are the *"first responders at disaster sites"* and whose *"assistance and knowledge of the area determines the effectiveness of rescue operations"* are sidelined when national and state rescue teams arrive. As the General Secretary from the Pulse Emergency Team says, *"when Civil Defense or NDRF teams arrive, we're usually instructed to stop our work. Yet who knows the local terrain better than we do?"* Community members with deep knowledge of the area are dismissed during critical response phases, reducing the overall effectiveness of disaster management efforts.

Economic impact and livelihood support: According to the Program Coordinator at Shreyas, a local NGO, organisations like theirs play a crucial role in supporting not only communities directly impacted by disasters but also those indirectly affected or at risk. Shreyas relies on donor funding, local household knowledge and mental models to identify flood- and landslide-prone areas.

The organisation is currently facilitating the construction of a community hall, funded by the Young Women's Christian Association (YWCA), recognising that schools, often used as temporary camps by the government cannot serve as long-term shelter homes. This closes a

critical gap, as government camps tend to operate beyond capacity and face operational constraints when school buildings must be vacated once classes resume.

Disaster affected communities also incur economic losses during evacuations, as they receive no compensation when they evacuate voluntarily. In particular, tribal communities are at a disadvantage when it comes to relief and rehabilitation due social marginalisation, unequal distribution of aid and the logistical challenge of reaching these communities. It is here that Shreyas steps in to provide livelihood support through their numerous programs such as poultry farming, cattle rearing, the setting up of petty shops and tailoring units, helping communities rebuild their livelihoods post disasters.

While NGOs have played an important role in addressing such gaps, their work is limited as they typically operate on a smaller scale. Each panchayat and ward has its own local organisations that work directly with communities, but their reach is constrained. What emerged from the interviews is that these voluntary organisations and NGOs are keen for the district disaster management authority toc coordinate and align their efforts with those of the NGOs. This would not only ensure scalability but also improve overall effectiveness by utilising government platforms to reach a wider population.

Chapter 4: Conclusions

This research provided insights into the landslide risk management in Wayanad wherein community perceptions, socio-economic vulnerabilities and lack of synergy between formal and informal institutions create a fragmented approach to disaster preparedness. The findings answer each research question, uncovering gaps between policy goals and ground-level realities.

RQ1: Community risk perception and preparedness

Community perception of landslide risks dictates preparedness behaviors and practices but is complicated by information accessibility and lack of harmony with government efforts. According to the NGOs and voluntary organisations, while communities are aware of landslide threats, their preparedness efforts are reactive than proactive. The potential of early warning mechanisms and improvised communication channels is undermined by lack of comprehensive reach, particularly among migrants workers and tribal groups and the district's continued reliance on outdated hazard maps. This creates a contradiction where communities understand risks but lack the tools to take proactive measures, increasing their dependency on post-disaster response for survival.

RQ2: Socio-economic vulnerabilities and preparedness capacity

Income disparities, education levels, and housing conditions impact individual ability to prepare for and respond to landslide threats. The exclusion of tribal communities and migrants from preparedness measures show how socio-economic factors compound disaster vulnerability. As seen in the findings, these groups have limited access to preparedness trainings and insufficient resources to cope with landslides, reinforcing the cycle where the most vulnerable communities are also the ones that receive the least support.

RQ3: Economic challenges and landslide preparedness

The research corroborates that the opportunity costs of forgone wages pose a significant barrier to proactive disaster behavior. Economic vulnerabilities prevent timely evacuation, as communities weigh financial losses against perceived risks, resulting in delayed response or no evacuation at all, increasing exposure in the event of actual emergencies. Moreover, short-sighted policies that only compensate families evacuated under official orders, but not families that evacuate proactively, disincentivise preparedness behaviours.

RQ4: Traditional knowledge, constraints and policy integration

Traditional knowledge systems exist within communities, but not in conventionally assumed ways, as evident in the expanded definition of 'community' and the practices that have evolved over time with NGOs and voluntary organisations assuming an active role. There remains a disconnect between community-based approaches and government-made plans, highlighting deeper structural issues in disaster governance at the district level. Successful initiatives including school-based knowledge dissemination and public-private partnerships like the one between DEOC and the Hume Centre demonstrate potential for integration when local capacity is recognised and supported.

In conclusion, the study validates the hypothesis that a lack of comprehensive focus on preparedness and mitigation increases vulnerability to disasters, regardless of how effective the response measures may be. While efforts are currently underway in Wayanad to strengthen preparedness, significant gaps persist with the exclusion of marginalised communities, affecting overall effectiveness. Moreover, beyond response, the focus right now appears to be exclusively on improving preparedness, with limited attention given to long-term mitigation measures. It is important for the DEOC to synergise its efforts with local community-based organisations, not only to promote grassroots approaches but also to scale up their impact and ensure better sustainability, in contrast to the current pattern of sporadic activities. Only by addressing these systemic issues can both the government and local community transition from

reactive to proactive policies, redesigning landslide risk management as a community-driven initiative rather than a top-down emergency response.

Declaration: *This thesis has used AI tools, specifically Grammarly and ChatGPT, strictly for proofreading purposes. The content and structure of the thesis have been entirely developed by the author in consultation with their supervisor, without the use of AI-generated material. All sources have been correctly referenced where relevant and primary data obtained from stakeholder interviews has been accurately credited, with responses presented in quotation marks and italicised for clarity.*

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Appendix I: Stakeholders and Organisations Interviewed

Name	Designation & Organisation
Former Official	District Emergency Operations Centre (DEOC), Wayanad
Saleem Kalpetta	General Secretary, Pulse Emergency Team, Kerala, Voluntary Organisation
Sanal Suhas	Executive Member, Rise Up Forum, NGO
Melna Romeo	Program Coordinator, Shreyas

Appendix II: Interview Checklist

a) Community risk perception (RQ1, H1)

1. From your experience, how would you describe the community's overall approach to landslide risk?
2. How do community members perceive the risk of landslides in Wayanad?
3. Are there traditional signs, stories, or experiences that people rely on to anticipate landslides? If yes, what are they?
4. What early warning systems, if any, are currently used by the community?
    1. Are there government early warning systems in place?
    2. How do community based early warning systems complement government systems?
5. In what ways does the perception of landslide risk influence community preparedness actions? Are there examples where traditional knowledge has helped reduce the impact of landslides?

b) Social vulnerability factors (RQ2, H2)

1. How do factors such as income levels, education, or housing conditions affect people's ability to prepare for landslides?
2. What vulnerabilities are faced by specific groups such as tribal communities, migrant tea plantation workers in terms of landslide risk?
3. How does in-migration exacerbate the risk and vulnerability to landslides in Wayanad?
    1. Probe for construction and human activity on tea plantations and its impact on slopes including deforestation
4. Do poorer or socially marginalized groups have less access to disaster preparedness resources?
    1. Probe about the condition of migrant workers, isolated tribal groups residing deep in the forests

c) Economic and social challenges (RQ3)

1. What are the main economic challenges that households face when preparing for or recovering from a landslide?
2. How do relocation expenses or loss of wages affect a family's ability to prepare for disasters?
3. Are there social challenges (like lack of trust in authorities or information gaps) that impact community preparedness?

d) Community vs. top-down approaches (H4)

1. Are there any community-based disaster risk management groups or local action committees in Wayanad?
2. How effective are these when compared to top-down interventions by the government?

3. Are there ways in which community involvement in disaster planning can be strengthened?
4. What challenges do communities face in participating in formal disaster management planning
5. How can local and indigenous knowledge be better incorporated into formal disaster preparedness and mitigation plans by the government?
6. What role has your organisation played in disaster preparedness and resilience building in Wayanad?
7. Could you share any best practices/ successful stories and challenges faced while working with local communities on landslide preparedness and mitigation?