POLITECNICO DI TORINO

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The Role of Indigenous Knowledge in Disaster Risk Reduction in India

Tutors
Prof. Elena Camilla Pede
Prof. Mesut Dinler

Candidate
Adarsh K M

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My research is deeply rooted in the landscape of my home, **Kerala, India**. The recurring natural disasters that have devastated the state in recent years serve as a somber reminder of the warnings issued by the legendary ecologist **Madhav Gadgil**. His passing on January 8th of this year marks the end of an era, but his lifelong dedication to the protection of the Western Ghats remains a guiding light. I wish to dedicate this humble work to his memory, to the **unheard voices of the indigenous people of India**, and to everyone who strives to protect nature, conserve our environment, and limit resource consumption for the generations yet to come.

I am profoundly grateful to the **indigenous communities** whose traditional wisdom forms the core of this study. Often the first victims of unchecked modernization and profit-driven exploitation, their resilience and ability to survive during disasters offer essential lessons for us all.

The process of creating this thesis from conducting interviews to the technical challenges of video editing has been a wonderful and enriching journey.

Finally, I want to thank my friends and family, especially my **father**, whose early conversations about sustainable living, agriculture, and conservation stayed with me and inspired this work. To everyone who shared their support: this would not have been possible without you.

Abstract

In the Anthropocene, the foundational assumption of stationarity,the concept that natural systems fluctuate within an unchanging envelope of variability is "dead" (Milly et al., 2008), rendering traditional, history-driven hazard mapping obsolete for predicting climate-amplified "Black Swan" events.

This research conducts a forensic reconstruction of the 2024 Chooralmala landslide in Wayanad, reclassifying it as a "Natech" (Natural-Technological) failure where anthropogenic triggers, specifically unscientific land use and resort construction, intersected with high-intensity precipitation to trigger catastrophic slope failure. Utilizing a "Visual and Verbal Forensic" methodology, the study triangulates post-disaster structural artifacts with situated tacit knowledge and geomorphological evidence.

Findings reveal a systematic maladaptation in state-sanctioned "hard" infrastructure; rigid reinforced concrete elements suffered catastrophic brittle failure (Chopra, 2017) under dynamic sediment pulses, whereas traditional "Safe-to-Fail" bio-engineering systems (Thayu) exhibited superior ecological resilience through energy absorption and soil cohesion. Crucially, the investigation validates Indigenous Knowledge not as aesthetic folklore, but as a rigorous vernacular science. The "Chandappan" legend is decoded as a precise encoding of retrogressive debris flow snout physics, while zoo-semiotic bio-sentinels functioned as reliable sensors for seismic precursors (P-Waves) that formal systems failed to capture.

The research concludes that the marginalization of this "Tacit knowledge" (Polanyi, 1966) constitutes "Epistemic violence", resulting in lethal blind spots in disaster risk governance. To navigate deep uncertainty, a policy shift toward "Epistemic pluralism" is proposed. This involves integrating community-based "soft sensors" into the State Disaster Management Plan, fulfilling the Sendai Framework's mandate for traditional knowledge to complement scientific assessment in fostering transformative resilience.

Keywords: Disaster Risk Reduction (DRR), Indigenous Knowledge, Wayanad Landslide, Natech, Epistemic, Forensic Architecture.

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Chapter 1

Introduction

1.1 The Hook: When "stationarity is Dead"

[56] [35] The foundational assumption of water-resource engineering and disaster planning for the last century has been in stationarity, the idea that natural systems fluctuate within an unchanging envelope of variability. This concept implies that any variable, such as the annual flood peak or rainfall intensity for example in the western ghats, possesses a time-invariant probability density function that can be reliably estimated from historical records.

However, as Milly et al. (2008) [56] famously asserted that, "stationarity is dead". In the era of Anthropogenic, climate change has pushed natural systems beyond the boundaries of historical records rendering the last 100 years of hydrological data an unreliable predictor for the next 100 years.

In the specific context of Western ghat in India, specifically the Wayanad District, this shift has manifested as a rise in the "Black Swan", as rare, unpredictable, high-impact disasters occur frequently, that fall outside the "bell curve" of standard statistical models. Historical rainfall data in the Western Ghats failed to forecast the hyper-local, extreme precipitation perception bursts of 2024, where peak intensities exceeded 373mm in 24 hours (Hume centre for ecology, 2024) [75] while the actual. These events represent a state of "Deep Uncertainty", where fundamental mechanics of the climate have shifted, making traditional, digital history-driven zonation maps partially obsolete. This thesis is structured to how local knowledge can serve as a valid forensic tool for the early warning and the sustainable construction techniques that can reduce the risk factor of a disaster.

1.2 The problem: The "Epistemic Violence" of disaster Management

The central problem identified in this research is the "Epistemic Violence" [80] inherent in modern disaster risk reduction (DRR). This refers to the systematic displacement and marginalisation of local, tacit knowledge systems in favour of centralised, "explicit" scientific models [70].

While the state relies heavily on "Hard" infrastructure rigid concrete retaining walls, dams, and electronic sensors, it remains blind to the "soft" intelligence of the people who have co-evolved with this landscape. Modern technocratic systems often suffer from "institutional ignorance", dismissing valid survival data as mere superstition, ignoring to find the scientific base behind that. for example, scientific models (Global circulation Models) have high uncertainty when downscaled to the village level, yet the state continues to prioritise these coarse digital maps over the historical granularity of community memory, formed through the lived experience.

This exclusion creates a lethal "blind spot": If the electronic grid fails during a disaster (even due to minute error such as power outages or signal loss), the state is left sensor less, having already dismantled the traditional "Anticipatory Intelligence" (such as the reading of Bio-indicators) that could have provided a precious last-mile early warning.

1.3 Research Question

How does the epistemic exclusion of traditional 'tacit knowledge' facilitate maladaptive engineering in the Western Ghats, and to what extent can the forensic validation of vernacular mythologies (e.g., Chandappan' found from semi-structured field interview after the disaster in chooralmala) provide a robust early warning framework in a non-stationary climate?

1.4 The case Study: Chooralmala as a "Natech" Disaster

This thesis focuses on the Mundakkai-Chooralmala region of Wayanad as a critical site of failure and survival. Where a devastating landslide occurred in the year 2024 July 30 from 2-4 am. Chooralmala represents a "Natech" (natural-Technological) disaster, where a natural hazard (extreme rainfall) triggered the technological failure of modern engineering.

Forensic analysis of the site reveals that modern concrete infrastructure, designed with a "Fail-Safe" resistance mentality, suffered catastrophic brittle failure. [16] (Chopra,2017) Reinforced concrete columns snapped cleanly because they lacked the ductility to move with the high-velocity debris flow, effectively trapping residents in what this research terms a "Concrete Trap" and the difficulty to find ways to safe grounds had took many live as found out from the field interview.

In contrast, those who survived often did so by relying on Traditional Knowledge (TK) and biological cues. While state sensors and Indian meteorological data failed to capture the specific "cloudburst" and error in the amount of precipitation over the Mundakkai peaks, survivors utilised a "sensory triad" auditory cue (specifically "Vambicha sound" roaring sound of the mountain as noted by a community elder), the later olfactory changes (the intense "manninte manam" - the smell of soil shearing), and zoo semiotic signals (the ranging and howling of domestic dogs-which the women sensed and said that there will be death). This case study highlights that while modern engineering failed to resist the energy of the flow, the biological and cognitive systems of indigenous resilience remained functional.

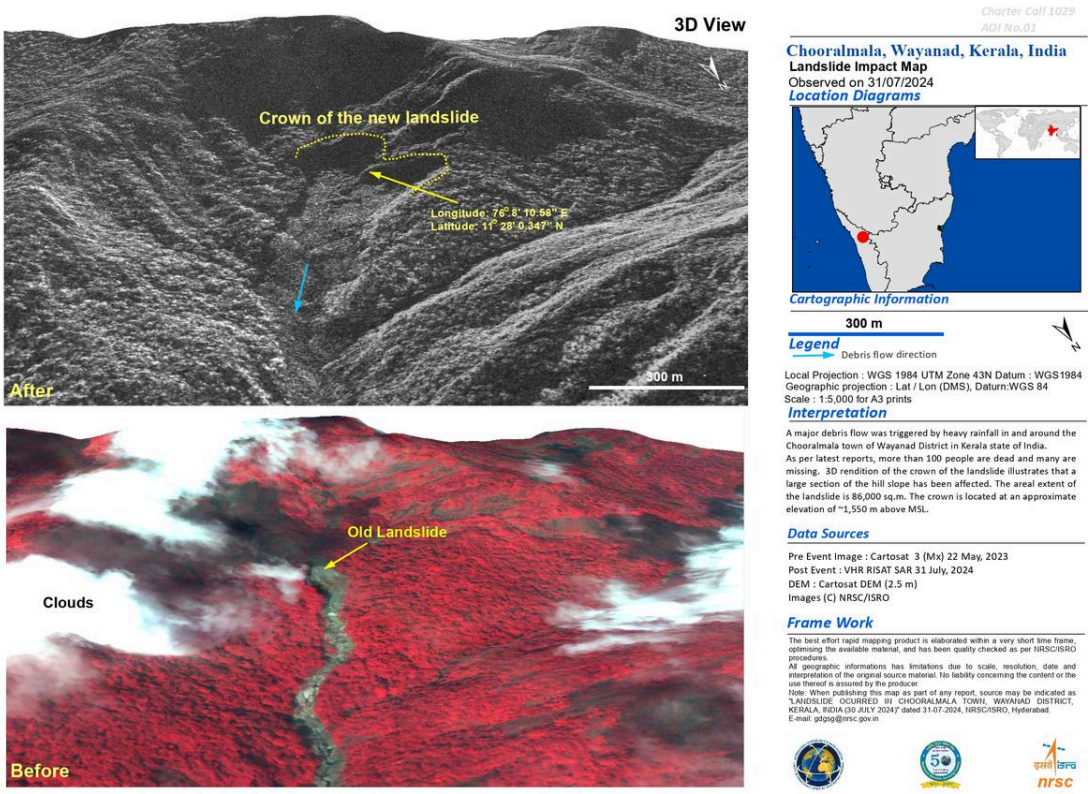


Figure 1.1: Satellite-based crown analysis of the Mundakkai-Chooralmala landslide. The visualization highlights the initiation zone and the catastrophic extent of the scarp. Source: National Remote Sensing Centre (NRSC), ISRO (2024).

1.5 The Objective: Validating Indigenous Knowledge as a Functional EWS

The primary objective of this thesis is to validate Indigenous Knowledge not a aesthetic folklore, but as a rigorous, decentralized Early Warning System (EWS). By using the Pressure and Release (PAR) Model, this research seeks to demonstrate that TK offers "high resolution" granularity stored in the memory of individuals that global models lack.

A central aim is to decode the "Chandappan" legend, a local myth of a "black elephant – sized entity" moving upstream, revealing it to be an accurate vernacular encoding of retrogressive failure mechanics and hyper-concentrated sediment pulses. The thesis seeks to prove that integrating these "soft sensors" into formal DRR protocols can bridge the "adaptation" in high-risk zones, replacing maladaptive, rigid structures with "Safe-to-Fail" hybrid [16].

1.6 Roadmap of the Thesis

The research structure as follows:

- **Methodology:** Employs a visual and Verbal Forensic approach, utilising transects walks, participatory mapping, and semi-structured interviews with survivors to reconstruct the disaster's spatial and cognitive reality.
- **Findings:** Documents the failure of concrete sedentarisation and the validity of the "Chandappan" snout physics; provides evidence of how maladaptation (fixed concrete housing) stripped the community of its traditional primary adaptive mechanism of mobility.
- **Discussion:** Argues for a shift from what Spivak (1988) terms as "Epistemic Violence" toward "Epistemic Pluralism", where scientific precision is synthesised with tacit, situated wisdom of local communities to create transformative resilience.

Chapter 2

Literature Review: Changes and challenges of risk

2.1 Definition of Key concepts

2.1.1 Risk

In disaster studies, risk is widely accepted not just as probability, but as a function of three distinct components. This is often referred to as the risk triangle or standard DRR notation. Mathematically expressed through a widely accepted equation:

$$Risk = Hazard \times Vulnerability \times Exposure \tag{2.1}$$

(the disaster risk formulae) [93]
Hazard (H): The physical event, a dangerous phenomenon, substance, human activity, or condition that may cause loss of life, injury, or other health impacts (e.g., The flood water, the ground shaking, illegal quarrying or >500mm rainfall).
Exposure (E): The people, property, systems or other elements present in hazard zones that are thereby the subject to potential losses (who or what in the path of Hazard).
Vulnerability (V): The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard (The susceptibility of those elements to be destroyed. E.g., poor building codes, poverty, lack of insurance).

Some scholars argue that capacity (the ability to cope) should be given as denominator to the equation:

$$Risk = \frac{Hazard \times Vulnerability \times Exposure}{Capacity} \tag{2.2}$$

[93]

In the domain of disaster risk reduction (DRR), "Risk" is formally defined by the United Nations office for disaster risk reduction (UNDRR) as the probability of harmful consequences or expected losses from interactions between natural or human induced hazards and vulnerable conditions in a specific period of time.

Contemporary scholarship, particularly the IPCC SREXX report (2012) [38], emphasizes that risk is not static. It is dynamic and "accumulative", So, risk levels rise over time

due to drivers such as poor land-use planning, environmental degradation, and poverty. This is often referred to as "Extensive Risk" that builds up silently until a threshold is breached.

2.1.2 Hazard

Definition: a process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation (UNDRR, 2021) [84]. According to the UNDRR/ISC Hazard Definition and Classification Review (2020) [85], hazards are grouped into specific clusters such as Hydrometeorological, Geological, Biological, Technological, and Environmental.

Changes in nature of hazards: Hazard vs Disaster: A crucial academic distinction is that "natural disasters do not exist; only natural Hazards exist." A disaster only occurs when a hazard meets a vulnerable population. Kelman (2020) [41] argues that disasters are social constructs resulting from failed development, not purely environment events. The behaviour is continuously changing due to the Anthropocene activities (the current geological epoch where human activity is the dominant influence on climate change).

Intensification: The intergovernmental panel on Climate Change (IPCC) notes that while we cannot say there are more hazards numerically, the intensity and frequency of extreme events are changing. Stationarity is dead. We can no longer look at the last 100 years of flood data to predict the next 100 years because the baseline climate has shifted [38, 56].

The rise of Natech Hazards: The change: A growing category of risk is Natural-Technological (Natech) hazards. This occurs when a natural hazard triggers a technological disaster (e.g., The 2011 Tohoku earthquake causing the Fukushima nuclear meltdown) [44].

Multi-Hazard and compound Risk: Most risk assessments are "single – hazard" (e.g., a flood map). However, hazards rarely happen in isolation. The challenge is modelling compound Events—when 2 Hazards strike simultaneously (e.g., a hurricane hitting during a pandemic) or sequentially (e.g., a landslide occurring days after a wildfire has destroyed stability) [94].

2.1.3 Vulnerability

Vulnerability is defined as the internal susceptibility of a system to be adversely affected. Unlike "Hazard" (which is external), Vulnerability is intrinsic to the system itself.

The IPCC has refined its definition to explicitly include "sensitivity" and "lack of adaptive capacity", linking disaster risk directly to climate resilience [**?**].

Challenges in the concept of vulnerability: The "Social Turn" From "physical Vulnerability" to "Social Vulnerability": From weak built structures to poverty, gender, disability, and lack of political voice.Cutter pioneered the social Vulnerability index (SoVI), arguing that social factors (like age, race, and income) explain disaster outcomes better than physical geography does [17].

Frameworks such as the Pressure and Release (PAR) Model, categorize vulnerability into 2 distinct features:

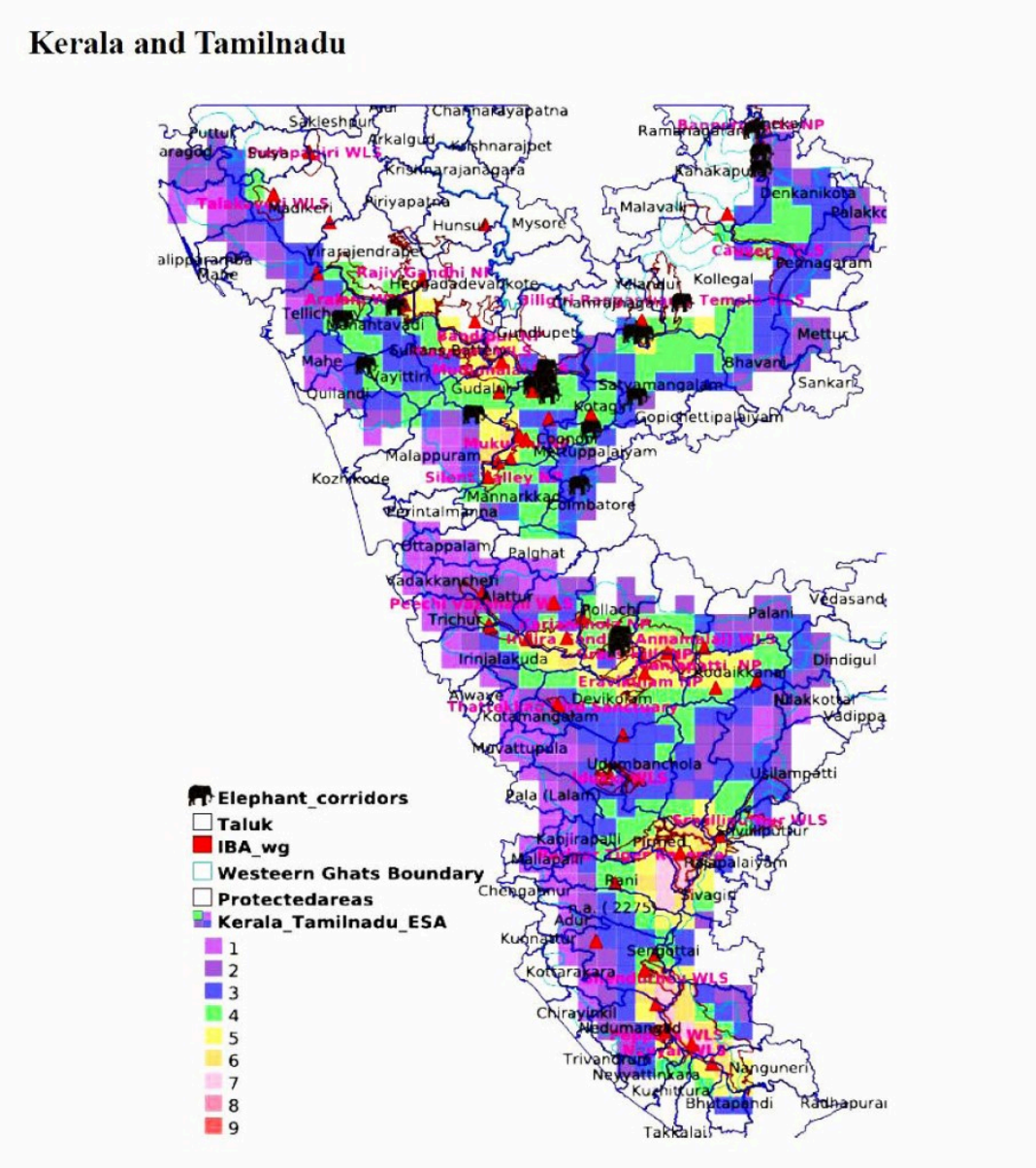


Figure 2.1: Transboundary Ecological Continuum of the Western Ghats. This geospatial analysis extends beyond state administrative lines to visualize the Western Ghats as a singular, contiguous ecosystem. By mapping Elephant Corridors (Black Icons) and Ecologically Sensitive Areas (ESA) across the Kerala-Tamil Nadu border, the visual evidence validates the [21]core premise: that ecological risks (and wildlife movements) do not respect political boundaries. This establishes that the vulnerability of Chooralmala is not isolated but linked to the systemic destabilization of the wider Nilgiri Biosphere Reserve. Source: [21].

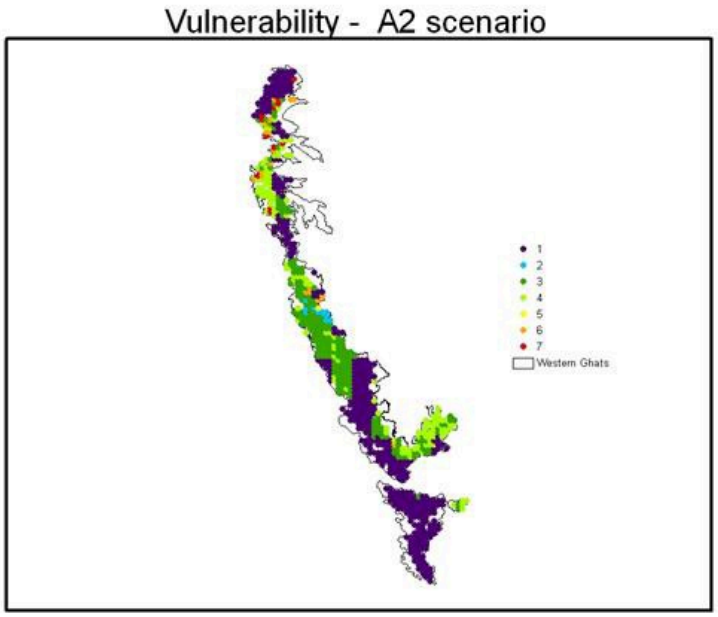


Figure 2.2: Vulnerability to climate change in the Western Ghats. **Source: WGEEP Report (2011)** [21].

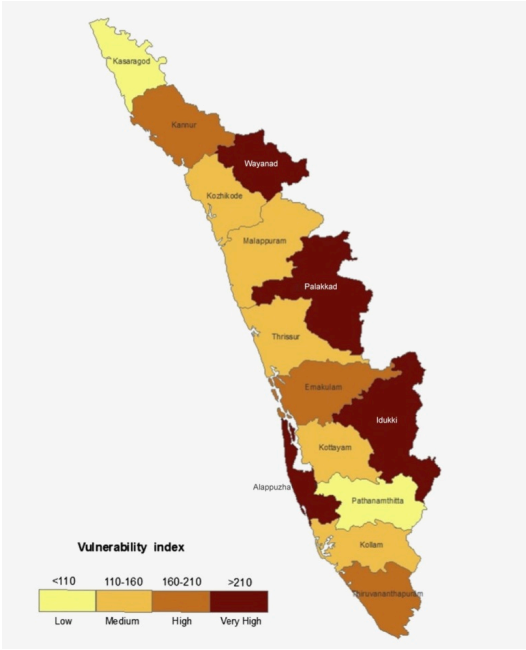


Figure 2.3: District-wise Vulnerability of Kerala. High-risk zones (dark red) correlate with Wayanad. **Source: KSDMA maps** [47].

- **Structural Vulnerability:** This refers to the engineering capability of the built environment to withstand physical stress. In geotechnical engineering, a key concept is "Ductility" versus "Brittleness." Ductile structures (like timber or bamboo) can deform and absorb energy without collapsing. Brittle structures (like unreinforced masonry or rigid concrete) possess high compressive strength but fail catastrophically when subjected to shear forces or soil liquefaction.

- **Social Vulnerability:** This refers to the inability of people to anticipate, cope with, resist, and recover from the impacts of disasters. This includes lack of access to early warning systems, political marginalization, and the exclusion of local knowledge from decision-making processes.

The PAR model conceptualizes that Disaster occurs when "Root causes" (e.g., rapid urbanization, deforestation) create "unsafe conditions" [93].

Table 2.1: Evolution of the Concept of Vulnerability in Disaster Studies. This summary illustrates the theoretical shift from viewing disaster as a purely physical event to viewing it as a socio-political construction.

Scholar/Source	Year	Core Definition / Perspective
Varnes [88]	1984	**Physical:** The degree of loss to a given element at risk resulting from the occurrence of a natural phenomenon.
Blaikie et al. [93]	1994	**Socio-Political:** The characteristics of a person or group that influence their capacity to anticipate, cope with, resist, and recover from a hazard.
Cutter [17]	1996	**Hazard of Place:** Vulnerability is the interaction between social risks (poverty, age) and biophysical risks (slope, flood zone).
IPCC [38]	2012	**Climate Resilience:** The propensity or predisposition to be adversely affected, encompassing sensitivity or susceptibility to harm.
Gadgil Report [21]	2011	**Ecological:** Vulnerability arising from the systemic degradation of natural buffers (e.g., deforestation of sensitive zones).

Challenges of vulnerability: 1. **The Western "Discourse" criticism:** Bankoff [8] argues that labelling developing countries as vulnerable is a form of neo-colonialism that frames them as helpless and "dangerous," justifying Western interventions. 2. **Measuring vulnerability:** Indexes like SoVI are useful but static. They take a snapshot

Figure 2.4: Material Forensics of Brittle Failure. Close-up inspection reveals that the reinforced concrete snapped cleanly rather than bending. This validates the thesis argument that modern rigid materials suffer catastrophic failure under dynamic loads, unlike flexible vernacular systems. **Source: Author's Fieldwork**.

[**?**]

of census data, but vulnerability is dynamic; a family might be resilient today but vulnerable tomorrow if the primary earner gets sick [18]. 3. **The political resistance:** Governments love to blame "Natural Disasters" because it absolves them of blame. Admitting that a disaster was caused by "social Vulnerability" is an admission of political failure (e.g., failing to provide affordable housing).

In my forensic analysis of the site, high level of vulnerability was revealed in brittle failure as in Figure 1. The modern concrete columns snapped because they lacked the ductility to move with the landslide. In contrast, local bio-indicators such as coconut tree or bamboo (vernacular structures in some indigenous cultures) showed higher resilience.

"The concept of 'Structural Vulnerability' became terrifyingly clear when I inspected the ruins shown in Figure 9. The reinforced concrete pillars had snapped cleanly at the base. In contrast, some building components used in the vernacular traditional structures such as the dhajj dewari in bihar, though if damaged, had 'flexed' with the flow. Hence, they were destroyed and constructed again or they resisted the damage with their flexibility. This suggests that our modern definition of strength using rigid concrete in a fluid landscape is actually a form of vulnerability."

2.1.4 Exposure

UN defines exposure as an inventory of elements at risk. The academic Definition: Exposure is strictly defined as the "inventory of elements" (people, infrastructure, housing, production capacities and other tangible human assets) located in Hazard-prone area. It is distinct from vulnerability as building can be strong and not vulnerable if there isn't a high exposure factor.

IPCC emphasizes that exposure is a necessary determinant of risk. Without exposure, there is no disaster, regardless of the hazard's intensity. The presence of people livelihoods, species or ecosystems, environmental functions, services and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected (IPCC) [39].

Exposure = Location or Presence. Vulnerability = Susceptibility

Changes in exposure: The "Expanding Bull's eye": Ashley and Strader [6] coined this term to describe how urban sprawl expands the "target" size for hazards like tornadoes or floods. Even if the weather stays the same, losses from disaster increases because the city has physically expanded into the path of the storm.

Coastalization and Urbanization: The trend that globally, the populations are migrating toward risk rather than away from it. This is coastalization. Neumann et al. [65] estimate that by 2060, over one billion people will live in the low-elevation coastal zone (LECZ), drastically increasing exposure to sea level rise.

Challenges of managing exposure: Reducing exposure is politically and economically much harder than reducing vulnerability (reinforcing building) because reducing exposure requires moving people. 1. The only way to eliminate exposure to rising seas is to move communities inland (managed retreat). This faces massive psychological, cultural and economic resistance. The sunk cost fallacy – people and government refuse to abandon infrastructure (road utilities) they already paid for, even if the area is doomed (Hino et al.,). 2. **Safe development paradox:** Sometimes, building flood defences (like levees) actually increases exposure in the long run. When a levee is built, people feel safe and develop the land behind it (the "Levee effect "). When the levee eventually fails or is overtopped, the disaster is far worse than if the land had remained undeveloped (Di Baldassare et al.,) [19].

In modern urban planning, exposure is managed through "zonation Mapping'. The primary goal of zonation is to identify "red zones" in high probability of impact and ensure that critical infrastructures such as schools' hospitals and emergency shelters is placed outside these boundaries. When critical infrastructures are found inside a hazard zone, it is classified as a "planning Failure" or" Zonation failure or error".

Site attribution: Again, Vellarimala school (Figure 2) is a case of exposure because of its location, this shows a failure of zonation mapping that didn't account for the historical water Path (thodu). Thus, exposure in Chooralmala school had a spatial marking error of water path.

Figure 2.5: Institutional Failure at Vellarimala School. The destruction of the school—a designated evacuation centre—demonstrates a lack of "Spatial Memory" in planning. Public infrastructure was constructed in a historical high-risk drainage path (paleo-channel) known to locals but ignored by official maps. **Source: Author's Fieldwork**. [37]

2.2 How the concept of Risk is changing

2.2.1 Uncertainty

Uncertainty in Risk: In the "climate change argument: in traditional risk management, planners relied on "stationarity" in the assumption that future weather patterns would look like the past, while in this Anthropocene era it is characterized by "deep uncertainty" (Knightian uncertainty) [43]. The intergovernmental panel on climate change (IPCC) [38] defines this as a state where the probability of events is unknown because the fundamental climate mechanics are shifting.

In the academic literature, these terms uncertainty and the risk, are not synonyms. The distinction was established by economist Frank Knight in 1921 [43] which remains a standard theory.

1. **Knightian Risk (Measurable):** Risk exists when you don't know the outcome, but you know the distribution of probabilities. For example, in the case of disasters: Traditional flood planning. We have 100 years of river data, so we can calculate a "1-in-100-year flood line. 2. **Knightian Uncertainty (unmeasurable):** Uncertainty exists

when you don't know the outcome and we do not know the distribution of variables. I.e., In disasters: we can climate tipping points. We do not know what happens if the amazon rainforest collapses, because it has never happened before. F.H (1921) [43]. Risk, uncertainty and profit. Houghton Mifflin.

Calculable risk to "deep uncertainty": Death of stationarity, [56]: For decades, engineers designed dams and levees assuming that the future climate would look like the past climate or based on stationarity. Because of the climate change, historical data is no longer a reliable predictor of the future. We can no longer calculate the probability of a flood (Risk); we can only guess (Uncertainty). Milly et al. (2008) [56] famously declared stationarity is dead, arguing that water management can no longer rely on historical probabilities.

The rise of "deep uncertainty": Schools now use the term Deep uncertainty to describe modern disasters. This occurs when experts cannot agree on: a) The models that represent the system, b) The probability distributions of the inputs, c) The value of outcomes. Walker [92] define this framework, leading to new methods like "Decision Making under Deep Uncertainty" (DMDU).

Challenges of Uncertainty in Disasters: Epistemic vs Aleatory Uncertainty. If we distinguish between two types of uncertainty:

- Aleatory Uncertainty: Uncertainty due to natural randomness (e.g., the exact path of a hurricane). This cannot be reduced.
- Epistemic Uncertainty: Uncertainty due to lack of knowledge (e.g., we don't understand how ice sheet melts). This can be reduced with better science.

Politicians often confuse the two, waiting for "more certainty" (reduction of epistemic uncertainty) on issues where randomness (aleatory) makes perfect prediction impossible. Beven [12] discusses this in the context of environmental modelling.

The "Black Swan "illusion: Organizations treat uncertainty as if it were a risk. They use complex mathematical models to predict the unpredictable, creating a false sense of security. Taleb [81] argues that we ignore "Black Swans" (rare unpredictable events) because they don't fit into our nice bell curves (gaussian distributions).

This shift renders historical data driven tools like the zonation maps partially obsolete. When a region experiences "High intensity short duration" rain fall events such as a considerable share of about 30% of the annual monsoon load in 48 hours historical flood lines become irrelevant. This event is known as "black swan" event in disaster theory: an unpredictable, high impact event that digital models fail to forecast because they are trained on average historical data.

Site attribution: Meteorological data confirms that the Mundakkai - Chooralmala region experienced "Hyper-local" extreme rainfall that deviated significantly from regional averages. While the India meteorological department (IMD) district-level data initially triggered an orange alert (predicting 115-204 mm), local gauges operated by the Hume centre for ecology and wild life and private estates recorded far higher numbers. The rain in 2024 was not the same as the rain in 1980. The KSDMA maps looked in the past. by not taking into account climate change. If the rain was compared with the rain of 1980, it's a question if state considered the climate change along with KSDMA maps.

The IMD gauges where sparsely distributed and average rainfall over large districts (Grid scale) They could have missed the specific orographic lift (cloud burst effect) happening directly over the Vellarimala and Mundakkai peaks. The event was physically real but statically invisible to the state's coarse models until it was too late.

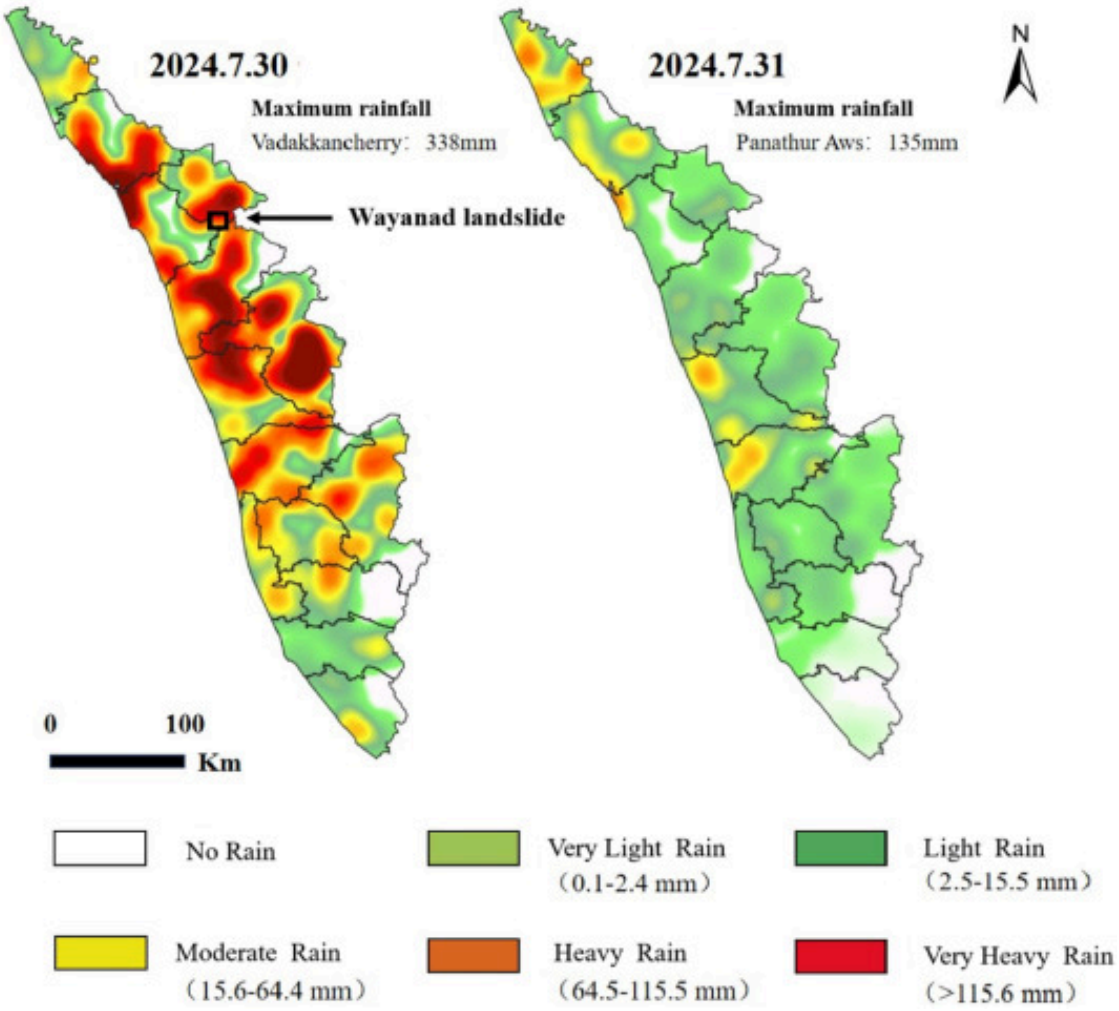


Figure 2.6: Spatial distribution of anomalous rainfall over Kerala during the July 2024 event. Note the hyper-local concentration of 'Very Heavy Rain' in the Wayanad highlands. Source: Adapted from Sreejith et al. (2024) [75].

2.2.2 Resilience

Resilience is a contested term in DRR. It is a concept borrowed from physics and ecology, and it has a two distinct school of thought: 1. **Engineering Resilience (static):** this is the ability of a system to resist a shock and return to its exact previous state (e.g.; a dam wall). It focuses on "stability" and "resilience". I.e., returning to equilibrium after a disturbance. "Bouncing back". The faster the return to normal, the more resilient is

the system (Pimm, 1984). 2. **The "Ecological Resilience" (Adaptability):** This is the dominant definition in modern disaster research, originating from C.S.Holling. It focuses on the ability to absorb change and persist, even if the system changes its structure. "Bouncing Forward". Here the system changes to survive [31]. 3. **The Institutional Definition (UNDRR):** The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of Hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions (UNDRR, n.d.) [85].

"Fail-safe" to "Safe-to-Fail": 1. **The Shift from Resistance to Resilience.** The Old Paradigm (Resistance): The system must be built as a "Fail-Safe" system. For example, to build a levee so high that the water never gets over it. The New paradigm (Resilience): A system should be built as "Safe-to-Fail" systems. For example, we forecast the possibility and accept the water will might get over the levee eventually, so we design parks behind it that can flood safely without destroying homes (Ahern) [3]. 2. **"Bouncing Back" to "Bouncing Forward":** In the case of disasters risk reduction and disaster risk management. Earlier the definitions focused on returning to "pre-disaster status". The critique is if the system returns to exact state, it was "In" before the earthquake, then it is just recreating the same risk that caused the disaster. The Evolution: Transformative Resilience. The goal is not to return to a "status quo", but to build back better and improve the system (Manyena et al., 2011) [51].

Challenges of Resilience: 1. **The Neoliberal Critique (politicizing Resilience):** Critiques argue that "community resilience" is often a code word for government abandonment. Argument: By telling a poor community they need to be resilient", the government is shifting the responsibility onto the victims, implying they should" pull themselves up by their bootstraps" rather than expecting state protection or funding (Evans and Reid,) [20]. 2. **The "Resilience of what, to what?":** Resilience is not a universal good. A system can be resilient in a bad way. Example: A dictatorship can be very resilient and a corrupt bureaucracy can be resilient to reform. Who benefits form the resilience must be well defined. Making a city's economy resilient might make its poor population more vulnerable (e.g., through gentrification after a storm) (Meerow et al.,) [54]. 3. **Ecological resilience (dynamic):** Defined by C.S. Holling, this is the ability of a system to absorb disturbance and reorganize while undergoing change. It focuses on the "flexibility" and the "adaptability" of the system.

Modern DRR is shifting from Engineering resilience (i.e., building stronger structures) to adaptive resilience (i.e., building a system that can fail safely) which aligns with the concept of safe to fail designs, where infrastructures such as the Bihar's dhajj dewari allows water to pass through (permeability) rather than trying to block them entirely.

Site Attribution: The Core argument: The modern "resistant" concrete structures failed. the traditional adaptive systems could survive better. The forensic evidence in figure 9 (broken columns) serves as a critique of modern 'engineering resilience'. The concrete retaining walls were designed with philosophy of 'resistance'. Attempting to block the soil mass entirely. When the force exceeded the design limit, the failure was catastrophic and brittle. In contrast, the ecological landscape showed adaptive resilience. the native vegetation and bamboo clumps on the periphery of the landslide zone did

not try to stop the water, they bent and allowed it to pass, retaining the soil through root friction rather than rigid mass. this suggests that the region needs 'safe to fail' infrastructure (like the vernacular architecture) rather than 'Fail Safe' attempts that inevitably collapse." The debris flow, carrying the massive boulders and slurry, completely flattened reinforced concrete (RCC) homes, the school, and the bridge in Chooralmala. This validates the failure of "resistant" (static structures) against dynamic, high-energy events.

Bamboo/nature survival, while bamboo clumps and riverine vegetation present in the valley, the direct path of the landslide (the "runout zone") was high velocity approx. 10-15 m/s that it wiped out everything, including trees and bamboo. Slope retention on the fringes with deep rooted native vegetation (like bamboo and riparian flora) generally. bamboo's root matrix rhizomes create a "soil nail" that is an adaptive, flexible defence while the rigid concrete can destabilize the slope when undercut.

A. **Engineering resilience in Chooralmala:** Defined by the ability of a system to return to a stable equilibrium (steady state) after a disturbance .as it focuses on resistance, efficiency and constancy, is a Theoretical failure in Chooralmala: The concrete structures are designed based on static load calculations. they are 'go' designed to withstand a specific maximum force. However, when that force is exceeded even by a percentage, the failure is catastrophic and sudden collapse known as brittle failure. The concrete structures in Chooralmala with high rigidity and low transformability. They become static fabric in the environment resisting the flow of nature, and when the flow exceeded the design parameters, the system will collapse partially or entirely.

B. **Ecological resilience in Chooralmala (the bamboo or adaptive):** Defined as the magnitude of the disturbance a system can absorb before it changes its structure .it focuses on persistence, adaptability and flexibility. Why it "serves better" in a vulnerable site like Chooralmala. Safe to fail: unlike concrete which is "fail safe" the adaptive systems are "safe to fail", but it does not break structurally. Once the water recedes it can bounce back. The Panarchy Theory [31]: this theory explains how fast variables (rain/floods) interact with slow variables (soil/root). Concrete: disconnects the fast and slow variables .it seals the soils, preventing the drainage, leading to pore - water pressure buildup behind the structure, eventually causing a blowout. Bamboo: integrates variables. The rhizome network allows water to drain (dissipating pore pressure) while mechanically holding the soil it works with the energy of the event not against it.

C. **Site attribution and socioecological system (SES):** Site attribution and socioecological system (SES) aspects of resilience, this argument implies that resilience is site specific. Resilience is not an imported product. It has to be attributed to the site's geology. Bamboo here is "site attributed" to the geology of the flood-prone regions of the Western Ghats or Wayanad because it is co-evolved with the river banks of Wayanad in the western ghats; hence, its root depth matches the soil shear strength needed for that specific geography.

Maladaptation: Building heavy concrete structures on the slopes composed of loose debris (colluvium) is academically termed as maladaptation an action taken to reduce risk (building a strong house) that actually increases vulnerability in a hazard prone area such as Chooralmala in Wayanad by adding weight to an unstable slope and blocking

natural drainage paths. Aligning with Sendai framework this thesis argues for a rigid "fail-safe" infrastructure to a flexible 'safe to fail' designs in the infrastructure. By integrating indigenous intelligence with scientific validation, we create hybrid resilience model that can be both technologically informed and locally grounded, ensuring that structural systems can bend and adapt rather than suffer catastrophic brittle failure.

2.3 From Disaster Risk Management to Disaster Risk Reduction (DRR)

The paradigm shifts from Disaster Risk Management to Disaster Risk Reduction. The evolution from reactive management to proactive reduction. Historically, the dominant approach to disasters was characterized by a "relief-centric" or "reactive" paradigm. In this traditional view, disasters were often perceived as extreme physical events or "Acts of God" largely beyond human influence, necessitating a focus on post event emergency response, recovery, and humanitarian aid . 2022) [73] [89]. This approach, often termed Disaster Risk Management (DRM) in its earlier iterations, prioritized the management of the disaster event itself rather than the underlying causes of vulnerability . [13].

However, the increasing frequency and severity of global catastrophes in the late 20th and early 21st centuries precipitated a fundamental shift in scientific and policy discourse. scholars and practitioners began to argue that disasters are not merely natural events but are also "outcomes of societal implications "and the intersection of hazards with vulnerable social, economic, and political environments (Rajabi et al.,) [73]. This realization led to the emergence of disaster risk reduction (DRR), a proactive paradigm aimed at identifying and mitigating risk drivers before they result in catastrophe. Unlike the reactive DRM model, which asks how to handle a crisis, DRR integrates prevention, mitigation, and preparedness into sustainable development planning to build resilience (Asih,) [7].

The Hyogo Framework for Action (2005-2015)

The global operationalization of this paradigm shift was formalized with the adoption of the Hyogo Framework for action (HFA) 2005-2015 Hyogo Framework [**?**]. Adopted by the 168 member states at the world conference on disaster reduction in Kobe, Japan, the HFA represented the first comprehensive global blueprint intended to "explain, describe and detail the work required from different sectors and actors to reduce disaster losses" (UNISDR, 2005) [86]. The HFA was developed in direct response to the gaps identified in previous strategies, most notably the 1994 Yokohama Strategy, and the devastation caused by the 2004 Indian ocean tsunami. Its primary goal was the substantial reduction of disaster losses in lives and in the social, economic, and environmental assets of communities and countries by 2015 (UNISDR, 2005) [86]. The Catalyst: the 2004 Indian ocean Tsunami was a wakeup call. It demonstrated that even with effective relief management, the lack of prevention (like early warning systems and education) led to massive, avoidable loss of life.

The 5 priorities for action: The HFA operationalized the shift to "Reduction"

through five specific priorities. These moved the conservation from "ambulances and sandbags" to policy and planning"

- Priority 1: Governance. Make disaster Risk reduction a priority. Ensure that DRR is a national and a local priority with a strong institutional basis for implementation.
- Priority 2: Risk Identification: Identify, assess, and monitor disaster risks and enhance early warning systems. Know the risks and take action.
- Priority 3: Knowledge. Build understanding and awareness. Use knowledge, innovation, and education to build a culture of safety and resilience at all levels.
- Priority 4: Underlying Factors. Reduce risk. Reduce the underlying risk factors (e.g., poor urban planning. Environmental degradation, poverty).
- Priority 5: Preparedness. Be prepared and ready to act. Strengthen disaster preparedness for effective response at all levels.

The evolution continues From Hyogo to Sendai. Impact and transition to Sendai: The HFA played a critical role in establishing DRR as a priority on the global political agenda. It successfully encouraged the creation of national disaster management agencies and the improvement of early warning systems (Priority 2). which contributed to a reduction in mortality for certain hazard (UNISDR,) [86]. However, literature suggests that while the HFA succeeded in institutionalizing DRR (Priority 2), it struggled to effectively address the underlying drivers of risk (Priority 4), such as rapid urbanization and poverty. This limitation necessitated the subsequent evolution towards the Sedai framework for disaster risk reduction (2015-2030), which emphasizes not only reducing existing risk but also creation of new risk (Rajabi et al.,) [73]. While the Hyogo Framework was successful in raising awareness and creating institutions(priority1), it faced criticism for not doing enough to address the root cause of disasters (Priority 4).

The Sendai framework and the shift to Risk Reduction

As a result, when the HFA concluded in 2015, it was replaced by the Sendai framework for Disaster Risk Reduction (2015-2030) [87].

1. **Critiques of Hyogo and the Need for Evolution:** while the Hyogo Framework for action (HFA) succeeded in institutionalizing disaster risk reduction (DRR) and establishing national disaster management agencies, critical gaps remained as its tenure ended in 2015. Literature indicates that while HFA priority 1 (Governance) saw significant progress, priority 4 (Reducing Underlying Risk Factors) was the least implemented (Mizutori,) [58]. scholars argued that the HFA focused heavily on preparedness and response structures but failed to arrest the creation of new risks driven by rapid urbanization, environmental degradation, and climate change (Tozier de la Poterie & Baudoin,) [82]. consequently, global disaster losses continued to rise, necessitating a framework that moved beyond "reducing" existing risk to "preventing" the accumulation of new risk. The nuance: the Hyogo framework focused on Disaster Risk Reduction. The Sendai Framework took it a step further to focus on disaster risk management in the broadest

sense - managing the risk of disaster creation, not just the disaster event. Sendai's innovation: It introduced the concept that we must stop generate new risk (e.g., by stopping construction in flood plains) while reducing existing risk.

Table 2.2: Paradigm Shift in Disaster Risk Reduction (DRR). A comparison between the dominant "Technocratic" approach (criticized in this thesis) and the emerging "Community-Based" approach.

Dominant Paradigm (Technocratic)	**Alternative Paradigm (Community-Based)**
View of Nature: Nature is a resource to be engineered and controlled (e.g., Retaining Walls).	**View of Nature:** Nature is a complex system to be adapted to (e.g., Root Systems).
Knowledge Source: Expert-led, top-down, relies on remote sensing and GIS.	**Knowledge Source:** Participatory, bottom-up, relies on oral history and local observation.
Response Style: Reactive (Relief after the event).	**Response Style:** Proactive (Mitigation before the event).
Key Weakness: Fails to account for local "site-specificity" and cultural context.	**Key Weakness:** Often lacks the funding and political scale of state interventions.

2. **The Sendai Framework for Disaster Risk reduction (2015-2030):** Adopted at the Third UN world conference in Sendai, Japan, the Sendai framework represents the current global instrument for DRR. it fundamentally shifts the narrative from "managing disaster" (a reactive focus in the event) to "managing disaster risk "(a proactive focus on the Hazard, Exposure and vulnerability) (UNISDR,) [87] Unlike its predecessor, the Sendai framework broadens the scope of DRR to include not only natural hazards but also man-made hazards, technological, and biological) such as the pandemics). it articulates a clear outcome: the "substantial reduction of disaster risk and losses in lives, livelihoods and health" (UNISDR) [87].

3. **Core innovations: The four priorities:** The Sendai Framework operationalizes this shift through 4 such priorities for action, which refine and consolidate the five priorities of the HFA:

- Priority 1: Understanding Disaster risk. Moving beyond mere "risk identification" this priority emphasizes that policies must be based on a deep understanding of risk dimensions, including vulnerability, capacity, exposure of persons and assets, and hazard characteristics (Aitisi-selmi et al.,) [4].
- Priority 2: Strengthening Disaster Risk Governance. This priority managing disaster risk than just managing disasters. it calls for clear vison, plans, competence,

guidance, and coordination within and across sectors, and participation of relevant stake holders (UNISDR,) [87].

- Priority 3: Investigating in disaster Risk Reduction for Resilience. The framework argues that investigating in prevention is not a cost but an opportunity to enhance economic social, health, and cultural resilience. It promotes structural and non-structural measures to build resilience (Mizutori) [**?**].

- Priority 4: Enhancing Disaster Preparedness for effective response and to "build back better". While maintaining the importance of preparedness, Sendai introduces the concept of "Build Back Better" in recovery, rehabilitation, and reconstruction. This ensures that post-disaster recovery does not replicate the vulnerabilities that led to the disaster in the first place (UNISDR) [87].

4. **Global Targets to measure progress:** the Sendai framework introduced seven distinct global targets to be achieved by 2030, including substantially reducing global disaster economic loss in relation to global GDP (Maini et al) [49].

Sendai framework for disaster risk reduction (SFDRR) (2015-2030) Core innovations: 1. The Sendai framework (SFDRR) marks a paradigm shift from "managing disasters" to "managing disaster risk". it aligns with complexity theory and post normal science. Acknowledging that risks in 21st century are, non-linear, systemic and uncertain. Shift to understanding risk (priority 1): unlike HFA, Sendai argues that risk is a product of Hazard × vulnerability × Exposure. it emphasizes that risk is created by humans' decisions (bad land use), not just by nature. Multi-Hazard and people - centred: Sendai explicitly calls for multi-Hazard early warning systems that are "people- centred". It rejects the "one size fits all" model, Advocating for localized community- Based solutions. Build back better (priority 4): this concept argues that reconstruction must not replicate previous vulnerabilities. It promotes Eco DRR (ecosystem-based disaster risk reduction), where "green infrastructure" (forests wetlands) is prioritized over or alongside "grey infrastructure" (concrete). 2. The Role of Education and Awareness (HFA priority 3) The Hyogo Framework for action (HFA) explicitly operationalized this cultural shift through its priority action:3 "Use knowledge ,innovation, and educated to build a culture of safety and resilience at all three levels"(UNISDR) [86]. This priority highlighted that technical solutions alone such as early warning systems are ineffective if the population does not understand the risk or how to react. Literature emphasizes that education is the primary vehicle for this cultural change. By integrating DRR into school curricula, nations can foster a "culture of safety" that permeates future generations (Aponte et al.,) [5]. For example, Japan's rigorous disaster education system is often cited as a model where a deeply ingrained culture of preparedness significantly reduces mortality rates compared to similarly exposed nations with lower disaster awareness (Shaw et al.) [78]. 3. Sendai and the "all of society" engagement the Sendai framework (2015-2030) deepened this concept by moving beyond formal education to a broader "all-of-society) engagement. it posits that a true culture of prevention requires the active participation of all stakeholders, including women, children, the elderly, and indigenous peoples, ensuring that risk information is accessible and culturally relevant (Aitsi-Selmi et al.) [4]. Furthermore, the Sendai Framework's emphasis on "build back better "(priority 4) reflects a cultural shift

in the recovery phase .it dictates that the post - disaster period should not merely be a return to the status quo (which was vulnerable) but an opportunity to instil new, resilient habits and construction standards, thereby embedding prevention into the very fabric of recovery (UNISDR) [87]. 4. challenges in cultural Adaptation Despite these frameworks, the literature notes that establishing a culture of prevention remains challenging. Cultural barriers, such as religious fatalism or deep-seated distrust of government authorities, can impede the adoption of safety measures (Bankoff) [8]. Moreover, "prevention" is often invisible successful DRR results in nothing happening which makes it difficult to maintain political; and public enthusiasm for long-term investment compared to the high visibility of disaster response (Twigg) [83].

Culture of disaster prevention

Culture of disaster prevention is defined academically as a societal state where risk awareness is embedded into the values, norms and daily practices of a community rather than treating it as a specialized technical task. Building a culture of disaster prevention A pivotal component of the shift from disaster risk management(DRM) to Disaster Risk Reduction(DRR) is the transition from a culture of fatalism and recreation to a "culture of prevention"(UNISDR) [86]. Historically, many societies perceived disasters as inevitable "Acts of God" or uncontrolled natural events, a mindset that fostered reliance on post- disaster relief rather than pre-disaster mitigation (Rajabi et al.) [73]. a cultural of prevention challenges this fatalism by empowering communities with the understanding that while hazards (e.g., earthquakes) may be inevitable, disasters (the loss of life and systems) are not (Mizutori) [58].

Risk normalization: In the absence of this culture, societies suffer from risk normalization the psychological tendency to downplay danger because "nothing happened last time". Technocratic vs socio ecological: a prevention culture respects the geomorphology of the land .it views land merely as a static substrate for economic extraction (real estate agriculture).

Evidence: the presence of the school and dense housing in the direct path of the historical water path "thodu" [37](Paleo -channel) proves a lack of prevention culture. the land use planning prioritized economic utility (estates/tourism) over the geological reality. The presence of the Vellarimala school on a paleo-channel is the typical manifestation of 'spatial amnesia'-a cultural state where digital maps failed to render the community's historical memory, objective4 seeks a solution to this by legally integrating 'memory lines'(historical stream paths) into the state's GIS attribute tables. This ensures that a water path or river's right of way is respected and protected in future land use planning, replacing economic expediency with geological reality. Integration: it moves DRR from "specialized agencies" (like the fire dept) to "everyday decisions" (e.g. a family deciding not to build a house near a stream even if it's cheaper).

2.4 Between scientific knowledge and traditional knowledge

2.4.1 Explicit scientific knowledge and tacit traditional knowledge

The distinction was formalized by Micheal Polanyi [70] is fundamental for understanding why integrating these two systems is methodologically challenging in fields like disaster risk reduction (DRR) and environmental management.

Explicit knowledge (scientific): this is the knowledge that can be codified, written down, and transmitted across distances without loss of meaning .in DRR this takes the form of meteorological data, satellite imagery hazard maps and standardized building codes. it is universal a rain gauge works the same way in Kerala as it does in London it relies on objectivity (separation of the observer from the observed). Universalism: it seeks universal truths that apply across all contexts (reductionism). it isolates variables (e.g., measuring soil moisture) often ignoring the wider spiritual or cultural context of the land. Transmission: it is transferred formally through institutional education.

Tacit knowledge (traditional): it is situated knowledge; this is knowledge that is embodied, situational and difficult to articulate. it is acquired through direct contact experienced and practice (learning by doing) In the context of traditional knowledge is "situated" it is valid specifically for a particular valley or a slope. It relies on subjectivity; the observer is also part of the system. Contextual dependence: It is local and specific. A survival technique valid in a Rain Forest may be irrelevant or dangerous in the Andes mountains. It is transferred socially through oral storytelling, imitation, and ritual. This is often referred to as "socialization" in knowledge management theory (Nonaka & Takeuchi) [66].

Table 2.3: Comparative Framework of Knowledge Systems in Wayanad

Feature	**Scientific Knowledge (Explicit)**	**Indigenous Knowledge (Tacit)**
Primary Sensor	Satellite Imagery, Radar, Rain Gauges	Biological Indicators, River, Colour, Sound
Data Resolution	Micro-Scale (District / State level)	Micro-scale (specific slope /stream level)
Transmission	Written reports, Standard Operating Procedures.	Oral history, Mythology, Rituals
Temporal Scope	Short- term (Decades of recorded data)	Deep Time (Centuries of memory)
Limitation	Subject to "stationarity" bias	Subject to erosion of memory"
Role in DRR	Strategic planning & Post-Disaster Relief	Real-time Early Warning & Response.

The challenge of "translation": A critical theme in academic literature is the difficulty of converting Tacit (TK): into Explicit (science) data without losing its meaning a process often called scientization or knowledge conversion. The problem of decontextualization: when researchers extract TK (e.g., writing down a planting calendar) without

recording the associated rituals or social norms, the knowledge becomes "sterile". Agarwal [2] warns that "scientizing "TK often strips it of the political and cultural context that gives it power. Epistemological violence: Requiring TK to fit into scientific spreadsheets can be seen as a form of colonial dominance, where science is the "judge" of whether traditional beliefs are valid (Nadasdy) [61].

Synthesis: Towards "knowledge co production": Modern research advocates moving beyond the dichotomy. the most robust approach is in the knowledge Co-production, In the knowledge co-production, where both explicit and tacit forms are valued equally. Complementarity: science provides the precision of the future climate models (explicit), while TK provides the historical granularity of local impacts (tacit). The knowledge conflict in DRR: Modern state mechanisms privilege explicit knowledge because it is measurable and bureaucratic. Tacit knowledge is often dismissed as" anecdotal" or "unscientific" because it cannot be easily quantified in government report.

2.4.2 What is traditional knowledge/indigenous knowledge?

Traditional or indigenous knowledge (often abbreviated as TK, IK, or TEK for traditional ecological knowledge) is a cumulative body of knowledge, practices and beliefs developed by indigenous peoples and communities over centuries of close interaction with their environment. Traditional knowledge (TK) of communities is not merely "old stories" or folklore). academically, it is defined by Fikret Berkes [10] as cumulative body of knowledge, practice and belief, evolving by adaptive process and handed down through generations by cultural transmission.

Core characteristics:

- Holistic: it views everything as connected. humans are viewed as part of the natural world rather than separate from it, integrating spiritual, social and ecological dimensions (Berkes) [10].
- Oral and intergenerational: Knowledge is transmitted orally from elders to youth through stories, ceremonies, and practical demonstrations, ensuring the transfer of wisdom across generations (Vázquez-Varela et al.) [90].
- Place based: it is specific to a unique ecosystem. the knowledge is "situated ", meaning it is deeply tied to the specific landscape and resources of a community (Morgan&Manuel) [59].
- Adaptive: it is dynamics environmental conditions change, the knowledge system evolves through trial and error to ensure survival (Berkes,) [11].

These adaptive strategies are increasingly recognized as essential for the climate change adaptation. Their long-term observational data provides baselines that wester science often lacks (Vazquez-Varela et al.). [90] A widely cited world bank report estimates that while indigenous peoples own or occupy about 22% of world's land surface, these areas hold approx. 80% of the planet's biodiversity (Sobervila) [79]. It is practiced by communities in variety of fields from agriculture to medicine.

It is best understood as a complex adaptive system comprising 4 levels: 1. Local knowledge: specific empirical facts (e.g., the soil slides when wet). 2. Resource management systems practices used to manage land (e.g., bamboo planning for soil cohesion). 3. Social institutions: rules and codes of conduct (e.g., taboos against building near a river). 4. Worldview the belief system that shapes the human nature relationship as a living entity). In the study of Chooralmala, there is a difference in settler's knowledge and Adivasi knowledge as a local knowledge and traditional knowledge.

Why Indigenous knowledge is critical for DRR

Traditional knowledge (TK) is critical for Disaster Risk Reduction (DRR) because it serves as a "living survival manual" developed over millennia. the intergenerational observation, offering solutions that are locally specific, cost -effective, and culturally sustainable. Theoretically Indigenous knowledge is also critical for disaster risk reduction because it offers "high resolution" granularity that modern science often lacks.

1. **Indigenous early warning systems.** Modern technology can fail due to maintenance issues or lack of reach in remote areas indigenous communities, however, utilize "bio-indicators" and oral history to predict hazards effectively. Oral History as Survival strategy: The most famous example of this is the "smog tradition on Simeulue island, Indonesia. During the 2004 Indian ocean Tsunami, Modern warning systems failed, but the local community recognized the earthquake and receding sea as signs of smog(tsunami). Because this knowledge was embedded in lullabies and stories passed down since a 1907 event, nearly the entire population evacuated to the hills immediately. consequently, only 7 people died in the Simeulue, compared over 160,000 in nearby Aceh (Rahman et.al) [72]. 2. **Nature as a sensor:** "communities frequently predict environmental hazards by observing subtle changes in for a and fauna. For instance, rural communities in south Africa use the behaviour of birds, cloud formations, and changes in vegetation to anticipate droughts and floods weeks before meteorological services issue warnings (Motsumi & Nemakonde) [60]. 3. **Resilient Vernacular Architecture.** Indigenous architecture often engineers structures to work with nature rather than resisting it, proving resilience where modern concrete often fails. Seismic flexibility: In the Himalayas, the traditional Dhajj-Dewari constructions which consist of timber frames filled with stone masonry. Engineering studies have confirmed that this system allows buildings to dissipate energy and sway during earthquakes without catastrophic collapse. In contrast, rigid modern concrete structures in the same region frequently suffer "brittle failure" during tremors (Hicyilmaz et al.) [28]. Flood adaptation: In flood prone regions, traditional architecture often incorporates elevation or amphibious designs. For example, traditional architecture often incorporates elevation or amphibius designs. for example, traditional stilt houses in southeast Asia allow floodwaters to flow underneath the structure, preserving the living space and reducing structural stress, a practice that modern amphibious architecture is now attempting to replicate (Adger et al.) [1]. 4. **Ecosystem – based mitigation.** Indigenous land management practices often act as natural barriers against disasters, maintaining ecological balance to prevent hazards. Forest conservation: indigenous cultural beliefs often protect specific environmental zones. for example, the aka tribe in India considers certain mountains sacred (Vojophu). strictly prohibiting resource extraction.

this conservation preserves forest cover, which naturally stabilizes slopes and mitigates landslides and flash floods (Namachow et al.) [62]. Coastal defence: Research indicates that traditional ecological knowledge regarding the preservation of mangroves and coral reefs provides effective "bio shields" against storms surges and tsunamis, often out performing man -made sea walls in terms of long-term sustainability and cost (Hiwasaki et al,) [30].

Filleting the data void: scientific models (global circulation models) have high uncertainty when downscaled to a village or panchayat level fills this void with centuries of site-specific observation. Bio indicators: indigenous systems often use biological indicators (ants moving to higher ground, flowering of specific plants) which provide earlier warnings than mechanical sensors. IK provides a historical baseline that goes back hundreds of years (through oral history), whereas scientific records in many developing regions may only go back 30-50 years. This helps in understanding "return periods" of major disasters that modern data might miss.

Contextual; application: The 500 mm anomaly: while the 500 mm rain event was an anomaly "for the 50 years dataset of the scientific gauges, it might not even have been an anomaly in the 500 years oral history of the region. Sentinel species: the Hume centre noted that local observers (acting on a form of localized /traditional sensing) saw the stream colour change to muddy hours before the main debris flow. the classic Tk bio indicators (turbidity as a proxy for upstream slope failure) that could have served as a last mile early warning if formally integrated into DRR protocol.

2.4.3 Using traditional knowledge for DRR

Approaches for identifying existing traditional knowledge in DRR practices

To extract this tacit knowledge for scientific use, academic literature suggests participatory methodologies:

- **Transect walks:** researchers walk through the terrain with elders, allowing the landscape to trigger memories and knowledge (e.g., "we never built a physical relief model of their territory. this allows them to visualise and map "risk zones" based on memory rather than contour lines.
- **Triangulation:** validation of traditional claims with scientific data (e.g., if elders say a slope is unstable, geologists verify with soil testing).

Contextual application: Forensic investigation: in the reconstruction of Chooralmala," identifying existing knowledge" means finding the oldest surviving residents and mapping the historical path of the river before modern encroachment. The paleo channel evidence: identifying the paleo channel (the old river path that the landslide re-occupied) is a geological task, but it is also an anthropological one. Elders likely knew this path as a wet / marshy zone unsuitable for housing. Using P3DM with survivors could help designate "no-build zones" that aligns with the river's natural memory.

Theoretical: Erosion of IK: The rapid urbanization of Chooralmala represents a loss of the "resource management system". The replacement of native vegetation (deep-rooted trees/bamboo) with shallow-rooted tea plantations or heavy concrete structures indicates

a disconnect from the traditional understanding of the soil's shear strength. The taboo as a science: traditional taboos often function as "risk avoidance mechanisms" if indigenous oral history considers a specific valley (like the Mundakkai runout zone) as "haunted" or forbidden it is often a codified memory a past geological disaster. Modern planning ignored these "cultural hazard maps".

Approaches for identifying existing traditional knowledge:

Identifying existing traditional knowledge (TK) is often challenging yet interesting because it is rarely written down; it exists in the memories of elders, in songs, in the landscape, and in daily routines. to uncover this "hidden databases" of survival strategies there are several participatory and ethnographic approaches. The integration of traditional knowledge (TK) into formal disaster risk reduction (DRR) framework presents a significant methodological challenge: TK is predominantly "tacit "embedded in culture, oral tradition, and daily practice rather Explicit or codified often insufficient. to successfully identify and document this knowledge, researchers must employ participatory and ethnographic methodologies that prioritize community engagement and epistemological pluralism.

1. **Participatory learning and action (PLA) tools.** We can identify TK by co -creating with it with the community using visual and interactive tools. Participatory Hazard Mapping: instead of bridging satellite maps to the community members collaborate drafting maps to identify locals' hazards, vulnerabilities, and capacities. Unlike top-down cartography, this approach reveals cognitive gaps the mental landscape of risk held by locals. Application; it is particularly effective for identifying historical hazard extents (e.g., flood run-up zones based on memory) and vernacular safe havens that do not appear on official topographical surveys (Gaillard & Macede) [22]. Transect walks: a transect walk is a systematic, observational walk across a community's territory conducted by researchers in the company of local knowledge holders like elders or healers. Applications: this method contextualizes knowledge within the physical environment .it allows for the in-situ identification of ecological indicators such as specific soil types prone to liquefaction or vegetation used for slope stabilization that may be omitted in decontextualized interview settings (Mercer et al.) [55]. Seasonal calendars: this tool documents the temporal dimensions of risk by mapping annual cycles of climate, livelihoods and disease against local perceptions of time. Application: it instrumental in identifying "bio-indicators "used for forecasting (e.g., Phenological changes in the plants preceding a storm) and for determining the socio-economic windows when communities are most vulnerable to hazards (Motsumi &Nemakonfr) [60].

2. **Ethnographic and qualitative inquiry.** Ethnographic methods are essential for decoding the cultural and symbolic languages in which TK is often embedded. These approaches move beyond the "what" of disaster risk to the "how" and "why" of traditional coping mechanisms. Oral History and folklore: analysis to frequently encoded in mythology, songs, and proverbs to ensure intergenerational transmission. Researchers utilize narrative analysis to decode these cultural products for technical data. Application: evaluating oral traditions allows researchers to reconstructs the return periods of rare, high – magnitude events (e.g.,"100-years floods") that exceed the temporal depth of

modern instrumental records. Rahman et al. [72] demonstrated this through the analysis of smog traditions in Indonesia, which effectively acted as intergenerational tsunami early warning system. Semi structured interviews and focus group discussions (FGD): these standard qualitative tools are adapted to triangulate "findings. Interviews with "key informants" (specialized knowledge holders like hunters or farmers) provide depth, FGDs Provide consensus on community – wide strategies. Application: Iloka [34] argues for the use of these methods to explore the sociological aspects of DRR, such as traditional social safety nets and resources sharing mechanisms activated during crisis.

3. **Frameworks for validation and integration.** Acritical Gap in a thesis methodology is describing how TK is validated alongside scientific data to ensure reliability – a process often termed "cross -walking "or "hybridization. The two – eyed seeing approach: originally coined by elder albert Marshall, this theoretical framework guides the methodological integration of indigenous and western epistemologies without privileging one over the other (Barcett et al.) [9]. Scientific triangulation: scholars such as Hiwasaki et al. [30] propose a validation process where local observations (e.g., "the ground here is unstable ") are cross-referenced with geological surveys. this ensures that the integrated DRR strategy is scientifically robust while being culturally accepted. intergenerational transmission. Researchers utilize narrative analysis to decode these cultural products for technical data.

Approaches implementation in DRR practices (before during and after)

1. **Pre-disaster: Mitigation and preparedness.** In this phase, the goal is to prevent hazards from becoming disasters and to prepare communities for inevitable events. A. Indigenous early warning systems (EWS) Approach: create "hybrid" warnings protocols where local observations trigger official alerts. Implementation: Bio – monitoring: training community focal points to report specific animal behaviours (e.g., ants moving their eggs to higher ground) or meteorological signs (e.g., halo around the moon) to local disasters committees. Example: in Philippines, the dagudag system involves indigenous monitors who observe river colour changes to predict flash floods, providing warnings hours before official gauges react (Cadag & gaillard, 2012) [14]. B. Ecosystem – based disaster risk reduction (Eco – DRR). Using traditional land management to buffer against hazards. Approach: revitalizing traditional resource management laws (often called taboos or customary laws (e.g., Andeans in Peru) to prevent landslides. Coastal defence: Enforcing traditional "no- take zones" (e.g., Bul in Palau) in mangrove forests or coral reefs, which act as natural barriers against storms surges (Hiwasaki et al.) [30].

2. **During disaster: Emergency response.** When the event occurs, TK provides immediate survival strategies when external aid is cut off. A. Traditional evacuation routes and safe havens. Utilizing historically proven safe zones rather than designated government shelters that may be unfamiliar or poorly located. Approach: Mapping and designating "vernacular safe sites "in official evacuation plans. Implementations: Safe sites: in the pacific islands, communities retreat to specific caves or hill tops known through oral history to be safe from cyclones. Integrating these locations into the official "civil defence "plans prevent confusion during chaos (Mercer et al.) [55]. Food security: Utilizing "famine crops "traditional crops buried or stored specifically for disasters

(e.g., fermented breadfruit in the pacific) to ensure food supply before the relief aid arrives (Cambell) [15]. Social Cohesion and Communication. Leveraging traditional social structures for rapid mobilization. Approach: Activating traditional leadership hierarchies (e.g., council of elders) rather than relying solely on appointed government officials. Implementation: Communication: Using traditional instruments (e.g., drums. conch shells) or runners to disseminate warnings in areas where electricity or cell towers fail. in rural Zimbabwe, specific drum beats communicate the type and urgency of treat (Mavhura et al.) [53].

3. **Post – disaster: Recovery and Reconstruction.** This phase focuses in "Building Back Better "by using culturally adapted and sustainable methods. A resilience Vernacular Architecture. Rebuilding using traditional engineering principles that have withstood past disasters, rather than importing rigid modern designs. Approach: promoting "owner – driven reconstruction" that utilizes local materials and traditional joinery techniques. Implementation: Seismic Resilience: in post – earthquake reconstruction in Kashmir and Nepal, agencies like the UN often encourage Dhajj – Dewari (timer-laced masonry). It is cheaper, uses local material, and is more earthquake – resistant than cheap concrete (Hicyilamaz et al.) [28]. Climate comfort: traditional housing designs (e.g., raised floors, steep roofs) are often better ventilated and more flood -resistant than standard government-issued relief tents or prefabs. Psychosocial healing and community recovery. Using traditional rituals to process trauma and restore social order. Approach: Integrating traditional healing ceremonies into post-disaster mental health programmes. Implementation: Collective healing: Western psychology focuses on individual trauma (PTSD) indigenous approaches often focus "social Harmony". Ceremonies to "cleanse the land or appease spirits can significantly reduce community anxiety and restore sense of normalcy and control (Iloka, 2016).

Theoretical academic expansion: Mercer's framework (2010) integrates IK into standard DRR cycle: Before (prevention/mitigation): using traditional architecture (lightweight materials) and land use planning (zoning based on oral history of floods). During (response): Using traditional communication channels (drums, lightweight materials) and land use planning (zoning based on oral history of floods). During (response): using traditional communication channels (drums, runners, community networks) when electronic grid fails. Understanding "safe routes" known to locals. After (recovery): "building back better" using local materials that are accessible and climatically appropriate, rather than importing alien solutions.

In Chooralmala site Attribution: Before disaster: the resistant concrete failed. Implementation implies a return to "adaptive" architecture houses on stilts or utilizing bamboo-reinforced mud/plaster on the fringes, which can withstand vibration better than rigid concrete. During: When the bridge collapsed in Chooralmala. The "scientific" evacuation route was severed. local knowledge of forest paths or shallow river crossing (if known preserved) becomes the only lifetime. After: the "next step" for the government is not just new concrete blocks, but to consult the community on where the water flows during extreme monsoons. This is "socializing the science" combining the 500mm rainfall data with the community's memory of the landscape to create a hybrid, resilient village map. To understand the administrative context of Chooralmala landslide, it is essential

to review the legislative history of disaster management in India . while the 2005 act shifted the focus from relief to prevention, the subsequent dilution of ecological protocols has created a regulatory gap.Table2.4 outlines the key policy shifts and failures that have defined the governance of the Western Ghats

Table 2.4: Legislative Timeline of Disaster Management in India. This chronology highlights the reactive nature of policy formation, where major laws are often passed only *after* catastrophic events.

Year	Event / Act	Significance for Western Ghats
2005	*Disaster Management Act*	Established the NDMA [64]; shifted focus from "Relief" to "Prevention" (though implementation remains poor).
2011	*Gadgil Report (WGEEP)* [21]	Designated Ecologically Sensitive Zones (ESZ). **Key moment:** The report was rejected by state governments.
2013	*Kasturirangan Report* [40]	Diluted the Gadgil recommendations to allow more development/mining in sensitive zones.
2018	*Kerala Floods* [47]	Exposed the failure of the diluted policies; re-ignited the debate on the Gadgil Report.
2024	*Chooralmala Landslide*	Demonstrated the catastrophic cost of ignoring the 2011 ESZ-1 protocols.

Chapter 3

The Case Study of Chooralmala

3.1 Methodology

The research utilises a Single-Case Study design centred on the Mundakkai-Chooralmala landslide event in the western ghats region of Wayanad. This design is selected to provide a "High-Resolution" granular analysis of a specific Natech (Natural-Technological) disaster, where traditional engineering failed to withstand climate-amplified geological stresses.

The methodology is anchored in the Access Model [93], which serves as a micro-level research framework to track the trajectory of vulnerability from "normal life" through the transition to disaster". By employing a visual and verbal forensic approach, this study seeks to synthesise explicit scientific data with the tacit, situated knowledge of the indigenous community, moving beyond standard top-down hazard mapping. The sources have been gathered from the from a field visit, in the western ghats region of Wayanad India, specifically the Chooralmala grama panchayath. By incorporating the data gathering approaches such as, semi-structured interviews, small community meetings, transect walks.

3.1.1 Visual Forensics: Analysis Material Failure

The visual forensic component of this methodology involved a systematic analysis of post-disaster artefacts and field footages taken during the transect walk conducted during the field visit, specifically Videos MVI_1607. This footage captures the aftermath of the high-energy debris flow, documenting modern multi-story concrete structures with completely undercut foundations.

The primary objective was to identify the "Brittle Failure" of reinforced concrete in the disaster affected infrastructures of Chooralmala. In geotechnical engineering, brittleness refers to the tendency of rigid materials to fail catastrophically and suddenly when their design threshold is exceeded, a phenomenon observed in the snapped concrete columns at the "Chooralmala" site. By contrast, the methodology sought to identify "Ductile" alternatives, materials like timber or bamboo that deform and absorb energy. This forensic analysis serves as a critique of "Fail-Safe" engineering resilience, which prioritises resistance over transformability, often results in a "concrete trap" for inhabitants.

Table 3.1: Forensic Data Log. (Source: Fieldwork 2024)

Data ID	**Source Type**	**Location**	**Forensic Value**
MVI_1536	Video Interview	Community Elders' Home	Retrogressive Failure: [37] Witness description of "Black Elephant" (upstream surge) validates granular segregation.
MVI_1546	Video Log	Residential Zone	Zoo Semiotics: Recorded "Ranging Behaviour" [37] of domestic dogs prior to slope failure (P-Waves).
IMG_202	Site Photo	Estate Margin	Root Cohesion: Visual evidence of shallow-rooted monoculture failing to hold shear strength.
IMG_205	Site Photo	Resort Debris Field	Brittle Failure: Reinforced concrete (RCC) columns snapped at base (Shear force vs Structural resistance).
Doc_01	Archival	Gadgil Report [21]	Policy Gap: Site identified as ESZ-1 (Ecologically Sensitive Zone) but warnings were ignored.

3.1.2 Verbal Forensics: Decoding Indigenous Encoding

Verbal forensics were conducted through semi-structured interviews with survivors and elders (e.g., Video MVI_1536) to extract tacit knowledge that is typically omitted from formal scientific reports. A central focus was the decoding of the "Chandappan" legend, a local narrative describing a "black elephant-sized entity" moving in a counter-intuitive direction along the riverbed.

Through narrative analysis, this study treats such mythology as "encoded science" rather than superstition. The description of the "black elephant" corresponds to the physics of a debris flow snout, where granular segregation pushes the largest, darkest boulders to the leading edge of the surge. Furthermore, the observation that the entity "climbed upstream" (Keripoyi) provides critical data on retrogressive failure mechanics, accurately describing the back-propagation of a debris dam breach. This methodology allows the researcher to convert subjective oral history into explicit geographical data, identifying a high-viscosity sediment pulse that centralised state sensors fails to capture.

3.1.3 Transect walks: Mapping Bio-indicators in Situ

To contextualise this knowledge within the physical environment, the study employed Transect Walks: Researcher walked the terrain with community elders to facilitate the in-situ Identification of ecological and Zoosemiotic indicators. This method utilises the landscape itself to trigger "spatial memory", allowing participants to identify historical hazard extents and paleo-channels that do not appear on official topographical surveys to be given a required set back from these channels.

During these walks (e.g., MVI_1546), the research documented Biosocial Indicators of ground instability. Survivors reported that domestic animals, participatory dogs, displays extreme distress and "ranging behaviour" hours before the primary landslide. So in this methodology the animals are treated as "bio-sentinels" or biological sensors capable of detecting the high frequency ground vibrations (P-waves) preceding a rupture. Mapping these behaviours in situ validates the community's "Anticipatory Intelligence," proving that biological sensors remain functional when electronic technological grid collapse.

3.1.4 Validation: Triangulation and Epistemic Pluralism

The final stage of the methodology is validation through triangulation. This involves cross-referencing oral traditions (such as the "Chandappan" snout) with physical geological Evidence found at the site, such as boulders exceeding 2 metres in diameter. By comparing the "muddy water" observation of residents with the geotechnical mechanism of soil piping, (Geological Survey of India, 2020) [**?**] the study achieves a hybrid form of validation.

Visual Preamble: The Hydrological Risk Landscape

Prior to delineating the specific socio-ecological characteristics of Chooralmala, it is requisite to visualize the escalating hazard profile that frames the case study. The following progression establishes the "Deep Uncertainty" referenced in the theoretical framework.

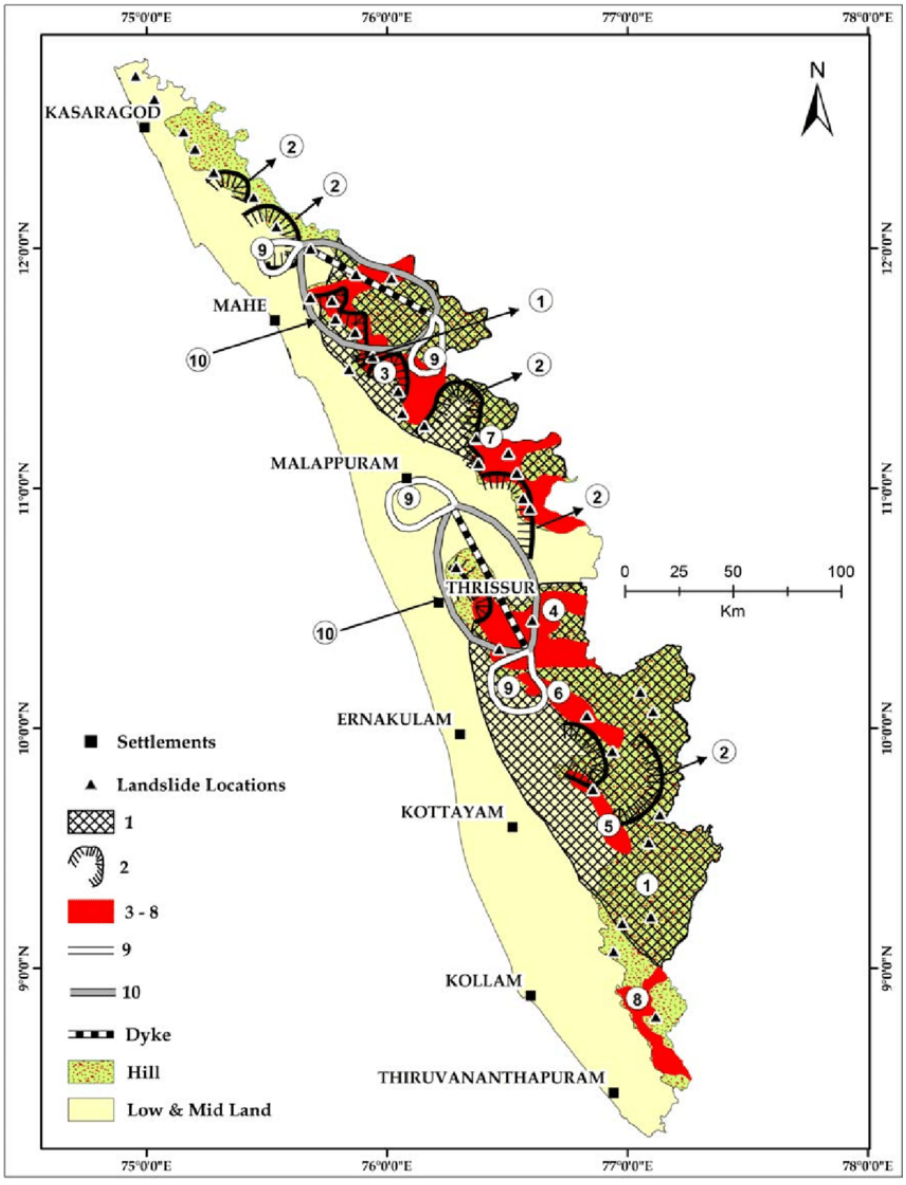


Figure 3.1: **Macro-Level Landslide Susceptibility Zonation of Kerala.** The map highlights the high-risk zones along the Western Ghats, contextualizing the study area within the broader regional hazard profile. **Source: Geological Survey of India (2022)** [23].

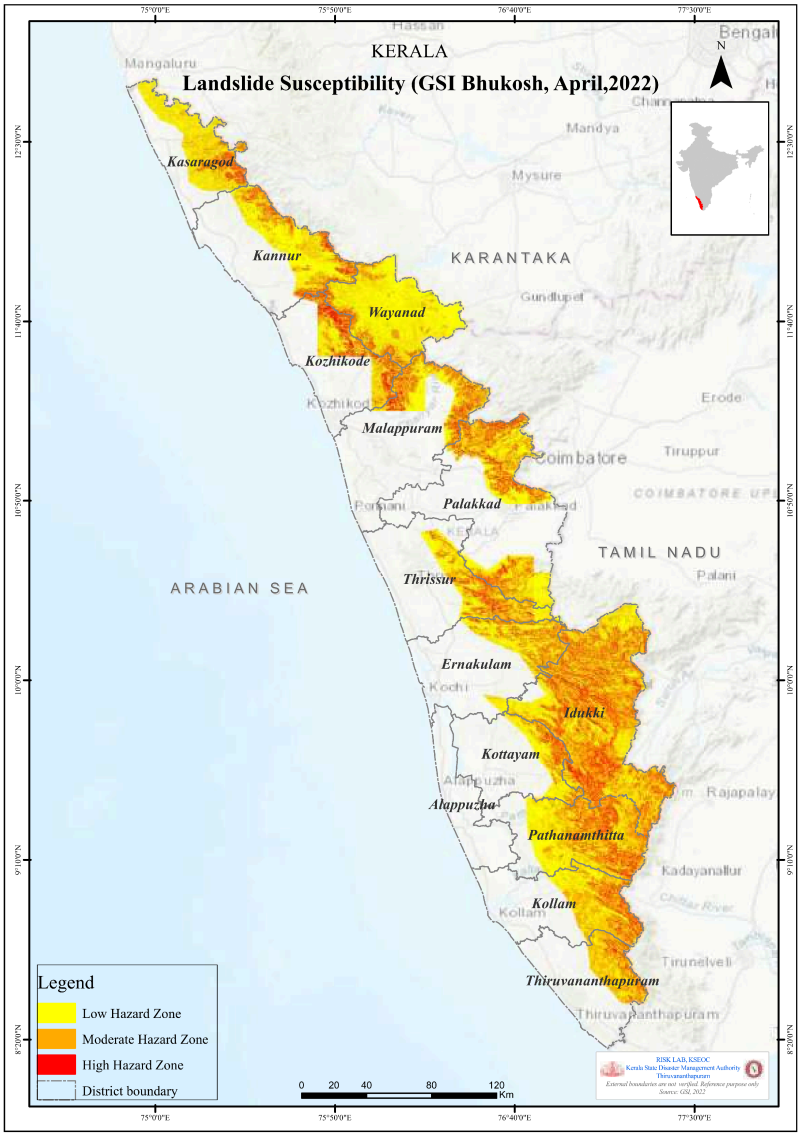


Figure 3.2: Macro-Level Landslide Susceptibility: Kerala State (Source: GSI, 2022) [47]

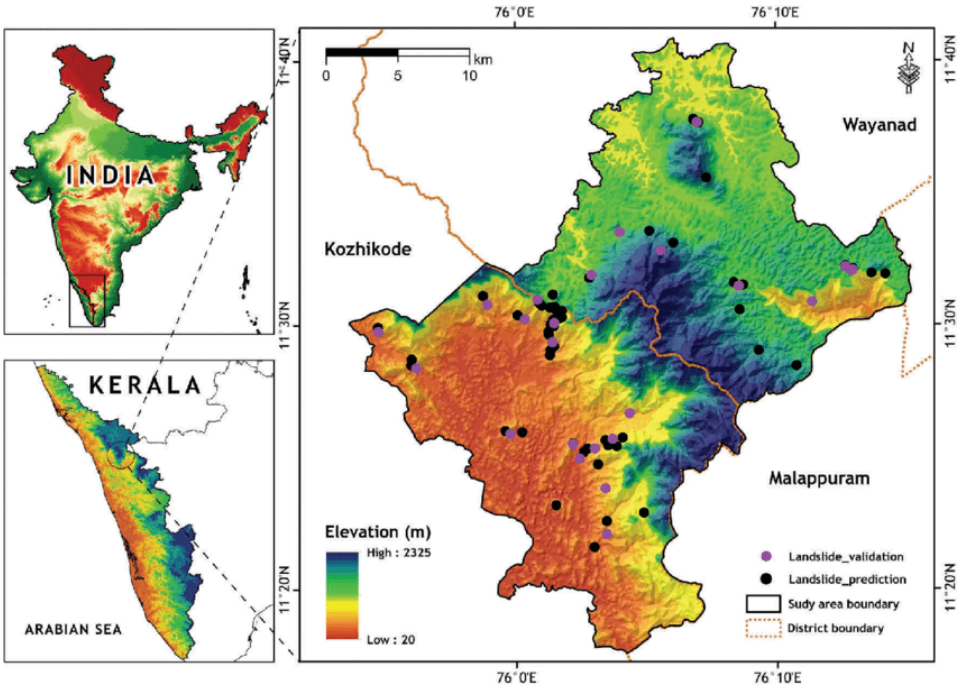


Figure 3.3: **Micro-Level Landslide Susceptibility (Model).** Prediction vs. Validation points overlaid on elevation. **Source: GSI (2022)** [24].

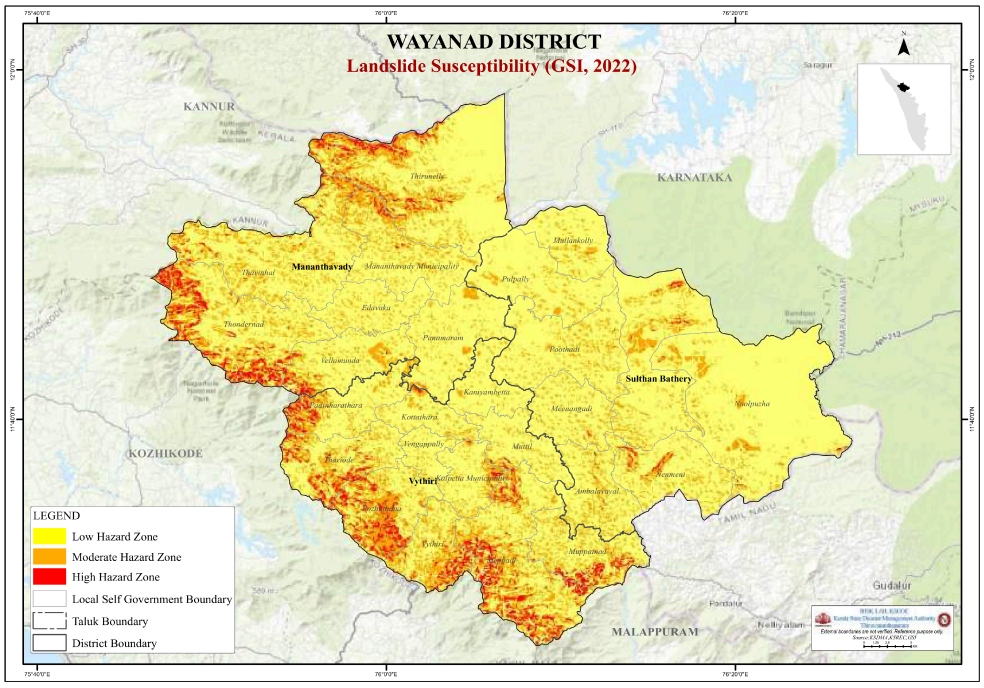
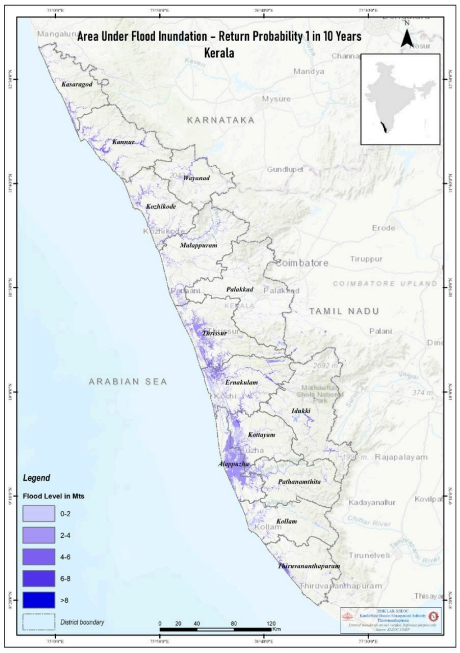
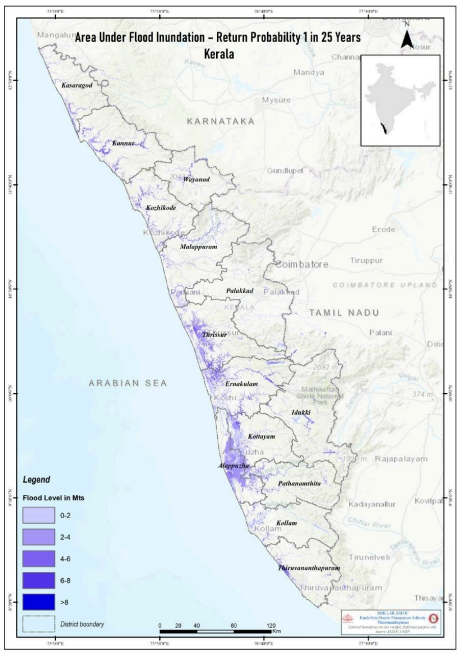


Figure 3.4: **Wayanad District Landslide Susceptibility.** District-level zonation context. **Source: GSI (2022)**.

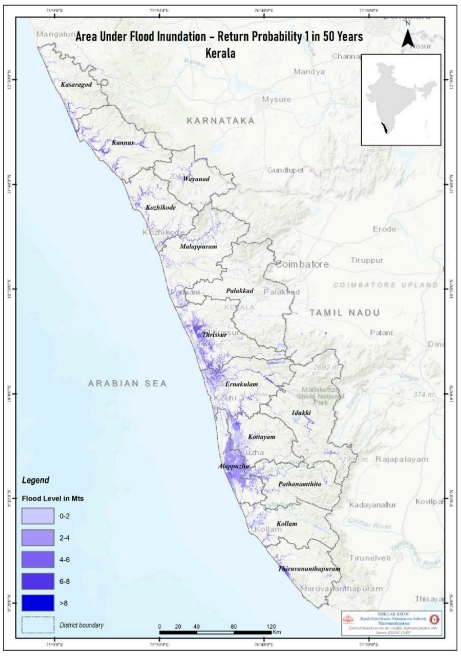


(a) 1-in-10 Year Return Probability

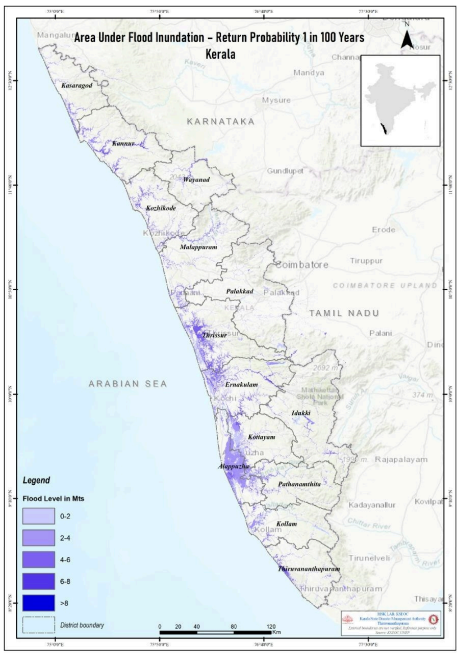


(b) 1-in-25 Year Return Probability

Figure 3.5: Flood inundation comparison: short-term return periods. Source:KSDMA [47]

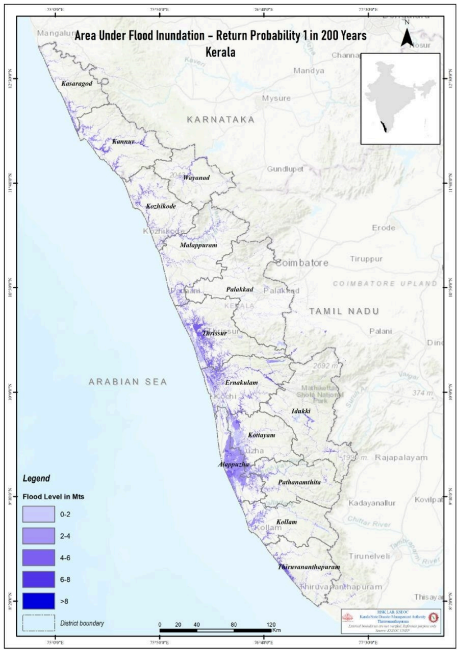


(a) 1-in-50 Year Return Probability

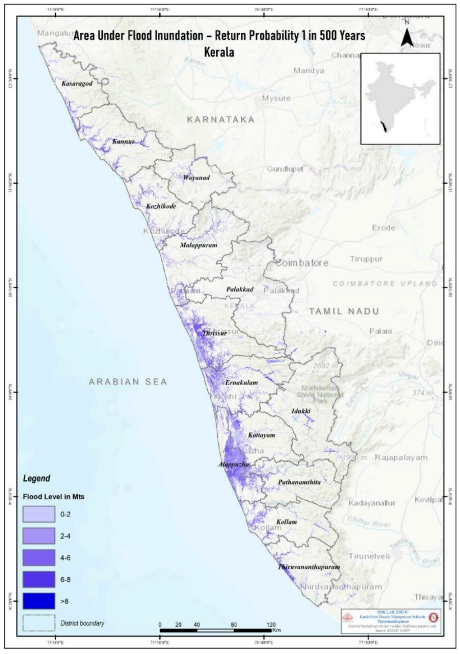


(b) 1-in-100 Year Return Probability

Figure 3.6: Flood inundation comparison: mid-term return periods. Source:KSDMA [47]



(a) 1-in-200 Year Return Probability



(b) 1-in-500 Year (Extreme Scenario)

Figure 3.7: Extreme scenario analysis showing maximum projected inundation. Source:KSDMA [47]

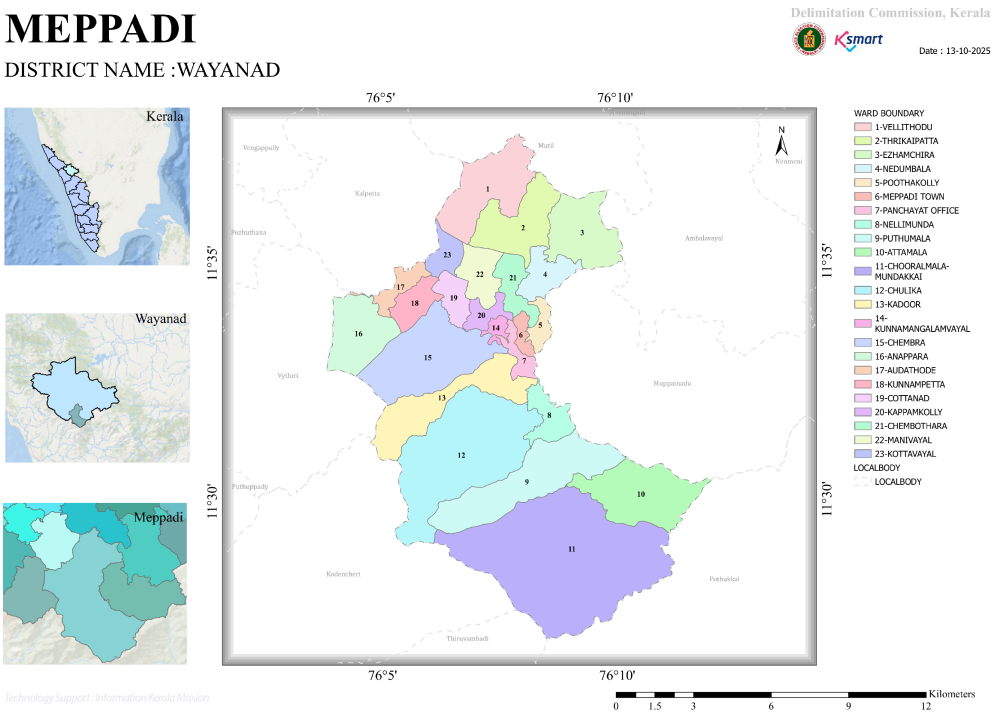


Figure 3.8: Administrative Ward Boundary Map of Meppadi, Wayanad District. Source: [47]

3.2 Introduction to the site of Chooralmala

While the Hyogo and Sendai Frameworks provide the global scaffolding for Disaster Risk Reduction (DRR), the efficacy of these paradigms is ultimately tested at the local scale, particularly in the ecologically fragile zone where human development and geological instability intersect. To understand the practical challenges of implementing a "culture of prevention", this research focuses on Chooralmala, a critical site within Wayanad district of Kerala, India.

Chooralmala serves as a representative microcosm of the "socio natural risk landscape defined in the theoretical framework. Located in the western ghats one of the world's eight "hot 'spots" of biological diversity (Meyers et al., 2000) the site exemplifies the complex friction between the expanding Bull's eye effect of urbanization (Ashley & Strader, 2016) and the non-stationary nature of climate hazards (Milly et al.) [56].

The study centres on the Mundakkai, Chooralmala region, in the geographical and Ecological context Chooralmala is situated in the Meppadi panchayat of the Wayanad district, nestled within the high ranges of western ghats, specifically within the critical catchment area of the Chaliyar river basin. The topography is characterized by steep slopes, with elevations ranging significantly, creating a landscape defined by high relief and deep valleys. Geologically, the region forms part of the Charnokite-Kondalite belt, consisting of metamorphic rocks that are heavily weathered, leading to the formation of

thick latosol soil covers (Geological Survey of India, 2020) [23]. This geological profile renders the slopes naturally susceptible to mass movements, particularly during the south-western monsoon.

The terrain is characterized by steep and deep valleys, dominated by the Vellarimala peaks (often referred to as the "camel's hump" complex). The topography is highly undulating, ranging from high-altitude shola-grassland ecosystems at peak to mid-land plantations in the valley floor. The specific site of disaster lies downstream of the Soochipaara waterfalls, a region historically shaped by intense fluvial activity.

However, the Hazard profile of Chooralmala cannot be understood through geological determinism alone. Following the "Socio-natural" definition of Hazard, the site's instability is deeply entwined with anthropogenic modification. The Western Ghats Ecology Expert Panel (WGEEP) [21], chaired by Madhav Gadgil, classified significant portions of this region as Ecologically sensitive zones (ESZ) (Gadgil et al.) [21]. The report highlighted that unscientific land use changes specifically the conversion of natural shola forests into monoculture plantations and the proliferation of infrastructure have severely compromised the natural drainage and slope stability of the region.

Socio-economic landscape and exposure: the vulnerability of Chooralmala is rooted in the colonial and post-colonial history. The transformation of Wayanad began extensively in the 19th century with the establishment of tea and coffee plantations by the British administration, which necessitated the migration of labour and the clearing of the forest cover (George) [25]. Today, Chooralmala is a hub of the plantation economy, heavily populated by labourers living in layams" (row houses) often situated on the toe of unstable slopes.

In the recent decades, the "Expanding Bull's eye effect "has intensified due to surge in tourism. The demand for resorts and homestays has pushed construction into steeper, and more precarious terrains, increasing the physical Exposure of assets and people. This development pattern ignores the Knightian Uncertainty of slope failure, treating the land as static rather than dynamic. Consequently, the site illustrates the Pressure and Release (PAR) Model [93], where the root causes of economic pressure (need for livelihood/tourism revenue) drive "dynamic pressure" (rapid urbanization, deforestation), resulting in "unsafe conditions" (settlements in high -hazard zones).

The climate interface contextualizing Chooralmala within the Anthropocene, the region is witnessing a shift in meteorological patterns. Kerala has experienced a marked increase in high intensity, short-duration rainfall events, a deviation from historical monsoon consistency (Hunt & Menon,) [33]. This climate volatility acts as a trigger mechanism on the already destabilized slopes of Chooralmala. The interactions between these "Deep Uncertainty" climate events and the modified landscape create a volatile risk scenario that traditional engineering (resistance -based) approaches struggle to manage.

Demographic and economic profile: The affected area primarily spans wards 10,11 and 12 of the Mepppadi panchayat, home to a population of approximately 4000 residents. The demographic composition is heavily influenced by the colonial and post – colonial plantation economy.

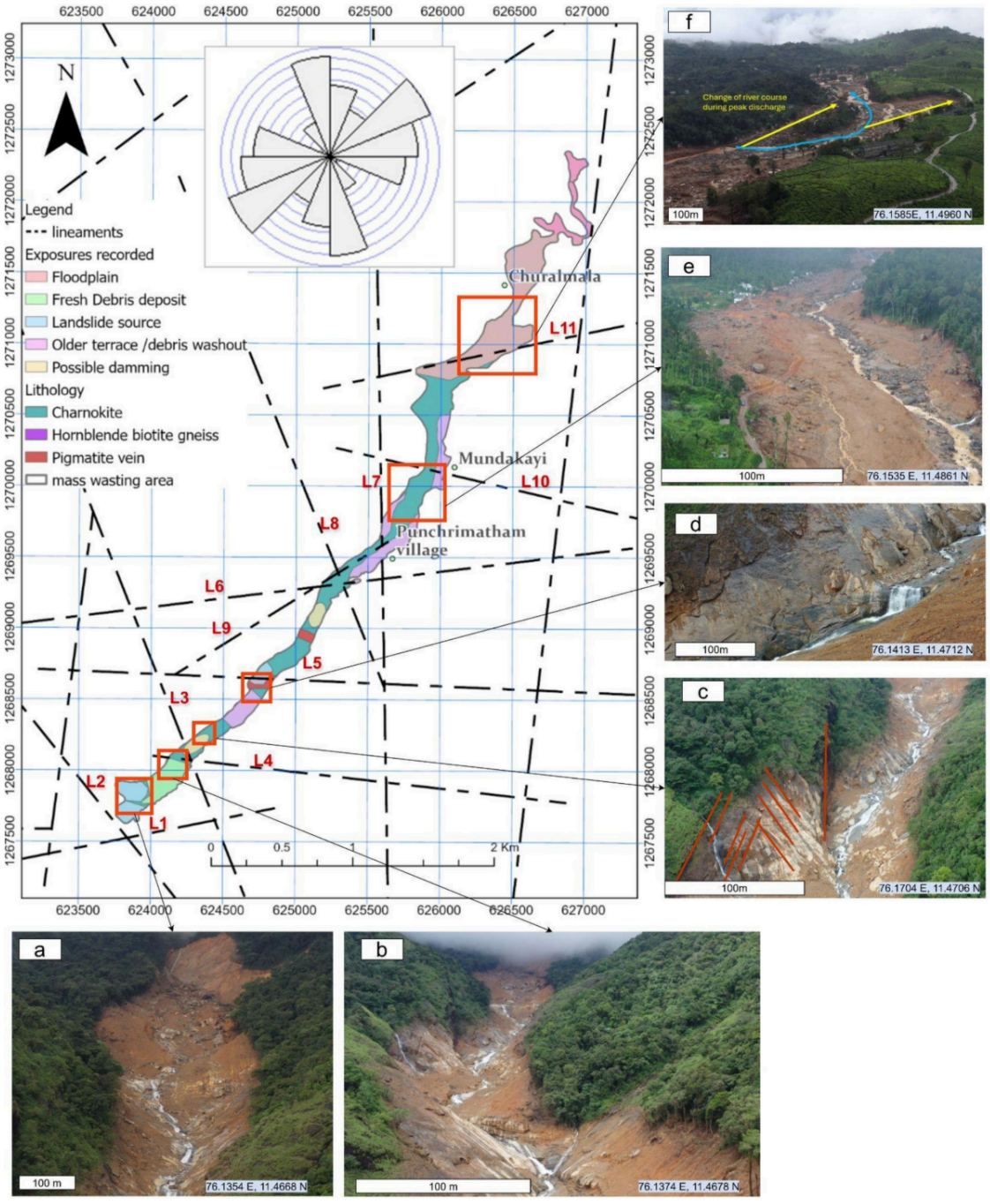


Figure 3.9: **Geological and Structural Controls of the Mundakkai Slope Failure.** Detailed lithological mapping reveals the dominance of Charnockite and Hornblende-biotite gneiss. The overlay of lineaments (L1–L11) demonstrates a strong correlation between structural discontinuities and the debris flow path. **Source: Maneesha et al.,** [75].

- **Settlement patterns:** the population is clustered in "Estate lanes" (labour quarters) and small commercial centres that have developed linearity along the riverbanks.

- **Livelihoods:** the primary economic drivers are tea and coffee plantations(estates) which employ the majority of the workforce. recently, a surge in tourism has led to the rapid construction of home stays and resorts, often encroaching into ecologically sensitive zones.

3.2.1 Landslide vulnerability

In the context of the core risk equation, the Hazard profile of Chooralmala is not a static geological probability but a dynamic "socio natural "process. While the region's topography presents inherent instability, the vulnerability if the site is defined by the convergence of specific geological mechanics, hydrological changes driven by the Anthropocene, and anthropogenic alterations to the landscape.

The mechanics of failure (Debris Flows and soil piping): Unlike simple slope failures, the primary hazard in Chooralmala is the "Debris flow" a rapid, fluid -like movements of saturated soil, rock, and organic matter (Sankar) [77]. This distinction is critical because debris flows possess high kinetic energy and can travel long distances, extending the risk zone far beyond the source of the slip (Martha et al.) [52]. The susceptibility is exacerbated by the phenomenon of "soil Piping" (tunnel erosion), a subsurface erosion process prevalent in the western ghats. Heavy monsoonal rains wash away fine clay particles beneath the laterite crust, creating hollow tunnels that eventually collapse under the weight of the overburden (Sankar) [77]. This creates a form of deep uncertainty in risk assessment: the surface may appear stable (safe) while the subsurface integrity is compromised, rendering traditional visual inspection insufficient. The hydrological pressure within the hill is locally understood through the concept of 'Orava'(natural channels or springs).Indigenous resident asserts that slope stability is maintained only when these natural conduits remain unblocked.Forensic interviews indicate that ' that blasting '(slope failure) is an inevitable consequence of obstructing these flow paths during construction. []

The Climate trigger (The death of stationarity): Applying Milly et al.'s [56] concept that "stationarity" is dead," the vulnerability of Choorlamala cannot be calculated using historical rainfall averages. The region has witnessed a shift toward short-duration, high intensity rainfall events (cloud bursts). Saturation Excess: the Lateric soil of Wayanad has high porosity but limited permeability. When rainfall intensity exceeds the soil's infiltration capacity, pore water pressure rises rapidly, reducing the shear strength of the slope material (Kuriakose et al.) [48]. The trigger threshold: under previous climatic conditions, the slopes could withstand typical monsoons. However, current erratic rainfall patterns push these slopes past their "tripping points "without warning, aligning with the thesis argument that we are moving from calculable risk to unmeasurable uncertainty.

Anthropogenic Amplifications (Manufactured Hazard): The "socio natural" nature of the hazard is evident in how land use has modified the slope hydrology. The transition from deep-rooted native vegetation to shallow-rooted plantation crops (tea

and coffee) has reduced the mechanical cohesion of the soil. Furthermore, the construction of roads and contour bunds for agriculture often blocks natural drainage channels. While laboratory tests confirm low shear strengths, indigenous knowledge corroborates the mechanism of soil structure degradation .Local testimony explicitly connects the loss of soil cohesion-described locally as the soil turning to 'bran'(loose powder). [] Drainage

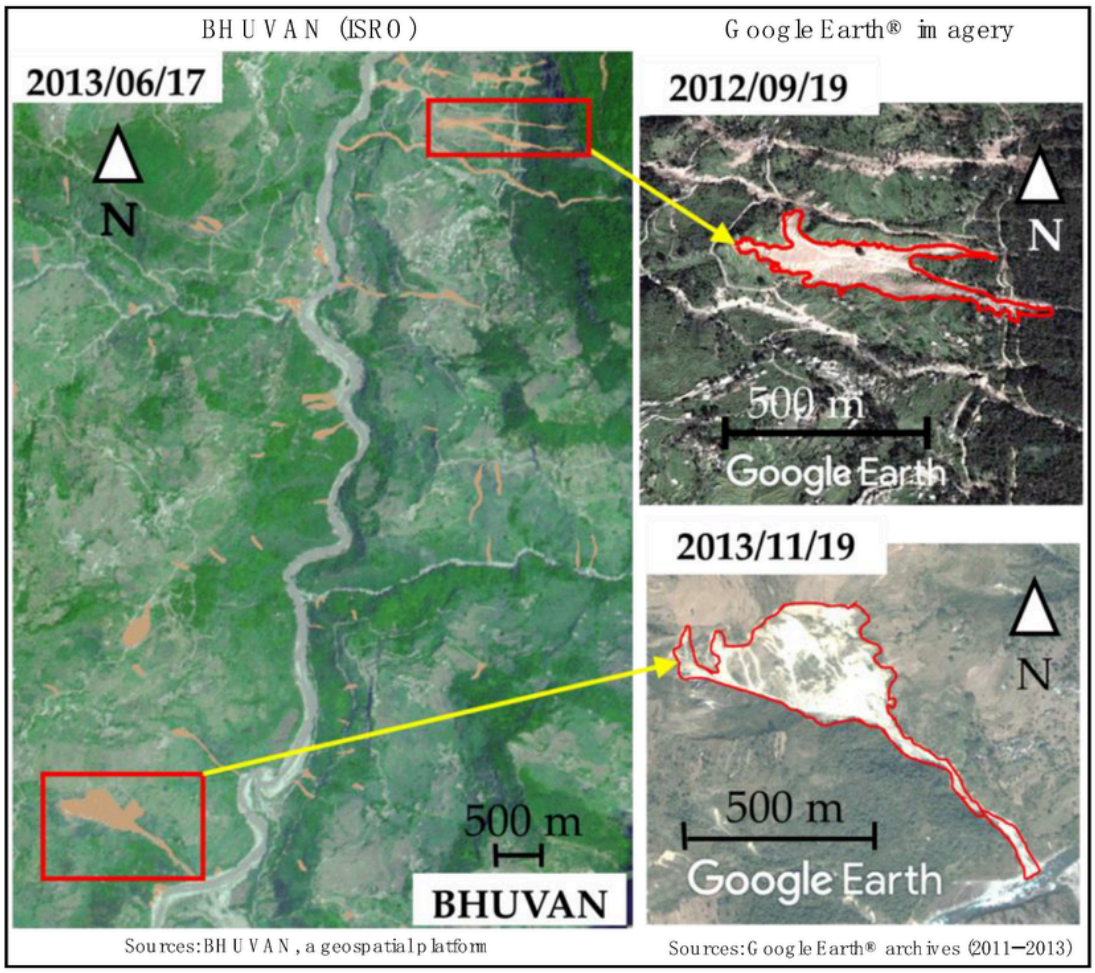


Figure 3.10: **Forensic Evidence of Antecedent Instability (2012-2013).** Comparing satellite archives from 2012 and 2013 reveals that significant slope failure events (red outlines) were active in the catchment area over a decade prior to the 2024 disaster. This contradicts the narrative of a sudden "Black Swan" event. **Source: Google Earth Archives & Bhuvan (ISRO)** [26] [67].

Obstruction: When natural streams (Thode) are diverted or blocked for construction, water accumulates in unstable pockets. During high -intensity rains, these blockages burst, triggering a cascading failure down the slopes. Natech implications: While not massive industrial site, the integration of infrastructure (roads, bridges, power lines) into this fragile ecosystem creates localized "Natech "(Natural-technological) failures, where

the failure of a retaining wall or road embankment can trigger a larger geological event (Krauasmann et.al.). [44]

Geomorphological vulnerability (the paleo channel): The fundamental vulnerability of Chooralmala was not just the rainfall, but the location of the settlements. The landslide debris on July 30th followed a specific path known as a "paleo-channel" an ancient, dormant riverbed that the "Iruvazhinji puzha" river had occupied in geological history.

The trap: over decades of "risk normalization," this paleo - channel was mistaken for solid land. Modern concrete infrastructure, including the main bridge, the school. And dense housing clusters, was constructed directly within this high velocity runout zone.

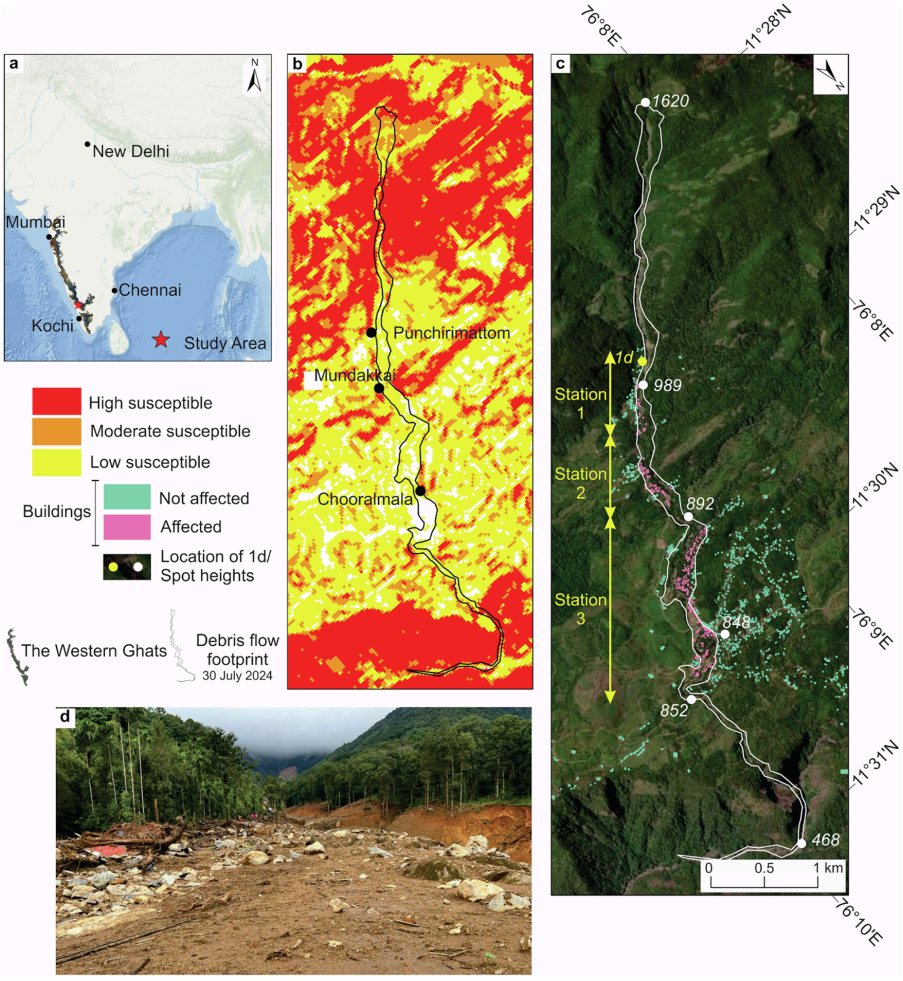


Figure 3.11: **Intersection of high-susceptibility landslide zones with affected building footprints.** This visual data validates the 'institutional blindness' regarding hazard zonation, showing dense construction (pink) within the high-susceptibility red zone. **Source: Springer Nature Scientific Data (2024)** [45].

Meteorological trigger (The "Hyper-local" anomaly): The "hazards" component of the risk equation was severe meteorological anomaly that outpaced state prediction models. The prediction Gap: on the days leading up to the disaster, the India meteorological department (IMD) District-Level gauges issued orange alert, predicting rainfall in the range of 115-204 mm. The physical reality: In contrast, local rain gauges operated by the Hume centre for ecology and wildlife biology recorded a "cloudburst" event directly over the catchment area. The nearest Guage at Puthumala recorded approximately 572 mm of rainfall in 48 hours, with peak intensity bursts exceeding 372mm in 24hours. Systemic failure: this discrepancy highlights the failure of "grid – scale" science to capture "micro-climate" reality. The resulting debris flow carried massive boulders and slurry at velocities estimated between 10-15 m/obliterating the static infrastructure path.

Infrastructure vulnerability profile: The devastation revealed a critical failure in built environment's resilience. Brittle failure: the destruction of 1555 houses was largely driven by the use of unreinforced masonry (URM) and rigid reinforced concrete (RCC). these resistant structures, designed for static loads, suffered, to the dynamic impact of the debris flow.

Adaptive survival: preliminary visual forensic analysis indicates that wile rigid structures were pulverized, flexible ecological systems- specifically bamboo clumps and riparian vegetation on the channel fringes remained intact, demonstrating "Ecological Resilience" (bending without breaking) compared to engineering resilience" (attempting to resist and collapsing).

Summary of vulnerability: Ultimately, the landslide vulnerability in Chooralmala is a function of "unsafe conditions "generated by the pressure and release (PAR) Model [93]. The geological potential for debris flow (Root cause) is activated by climate change (Dynamic pressure) and realized through unscientific land modification (unsafe conditions), creating a landscape that is not merely prone to accidents, but structurally primed for disaster.

3.2.2 The Indigenous People of Wayanad

Wayanad is home to the concertation of tribal populations in Kerala, with distinct communities that co-evolved with the region's complex geomorphology. The primary groups relevant to study include the Paniya, Adiya, Kuruma and Kurichiya, along with the Muthuvan communities in the high ranges. Academically, these communities' functions as "high - reliability organizations "(HROs) unlike modern nuclear families, they operate through collective governance structures such as the 'panchayam' system of the Muthuvans where risk decisions are made communally. This social cohesion is not just cultural; it is a survival mechanism that allows for rapid information dissemination during crises, a feature often lacking in the fragmented social fabric of modern settler communities.

To understand the vulnerability and Exposure equations in Chooralmala, one must analyse the demographic stratification of Wayand. the district is unique in Kerala, hosting the largest population of Adivasis (indigenous tribal people), constituting approximately 17% of the total population (Census of India,) [68]. However, the region's current risk

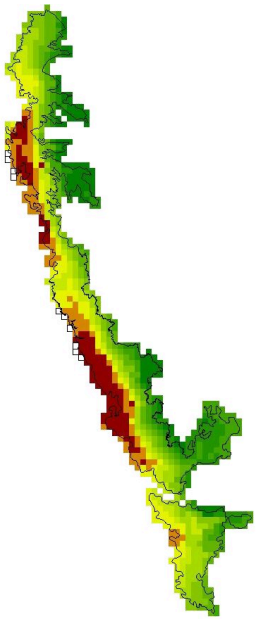


Figure 13: Digital Elevation Model (DEM) indicating high-gradient slopes.

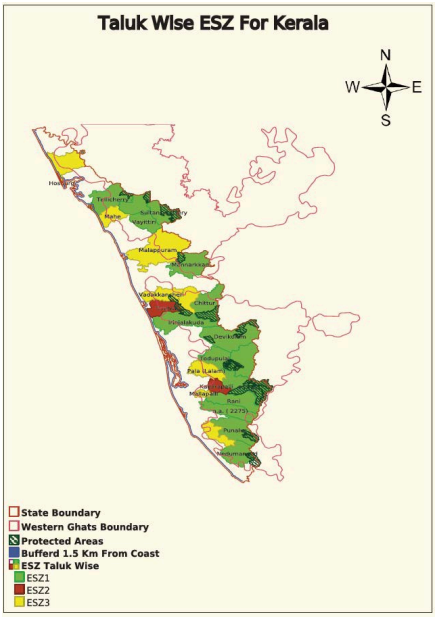


Figure 14: SRTM Derived Elevation Map highlighting orographic lift zones.

Figure 3.12: Topographical Vulnerability Analysis. The DEM (Top) and SRTM (Bottom) maps collectively visualize the high-relief topography. Since these maps are vertically oriented, they clearly show the north-south alignment of the steep gradients (greater than 1500m) responsible for the orographic lift. **Source: WGEEP Report.** [21]

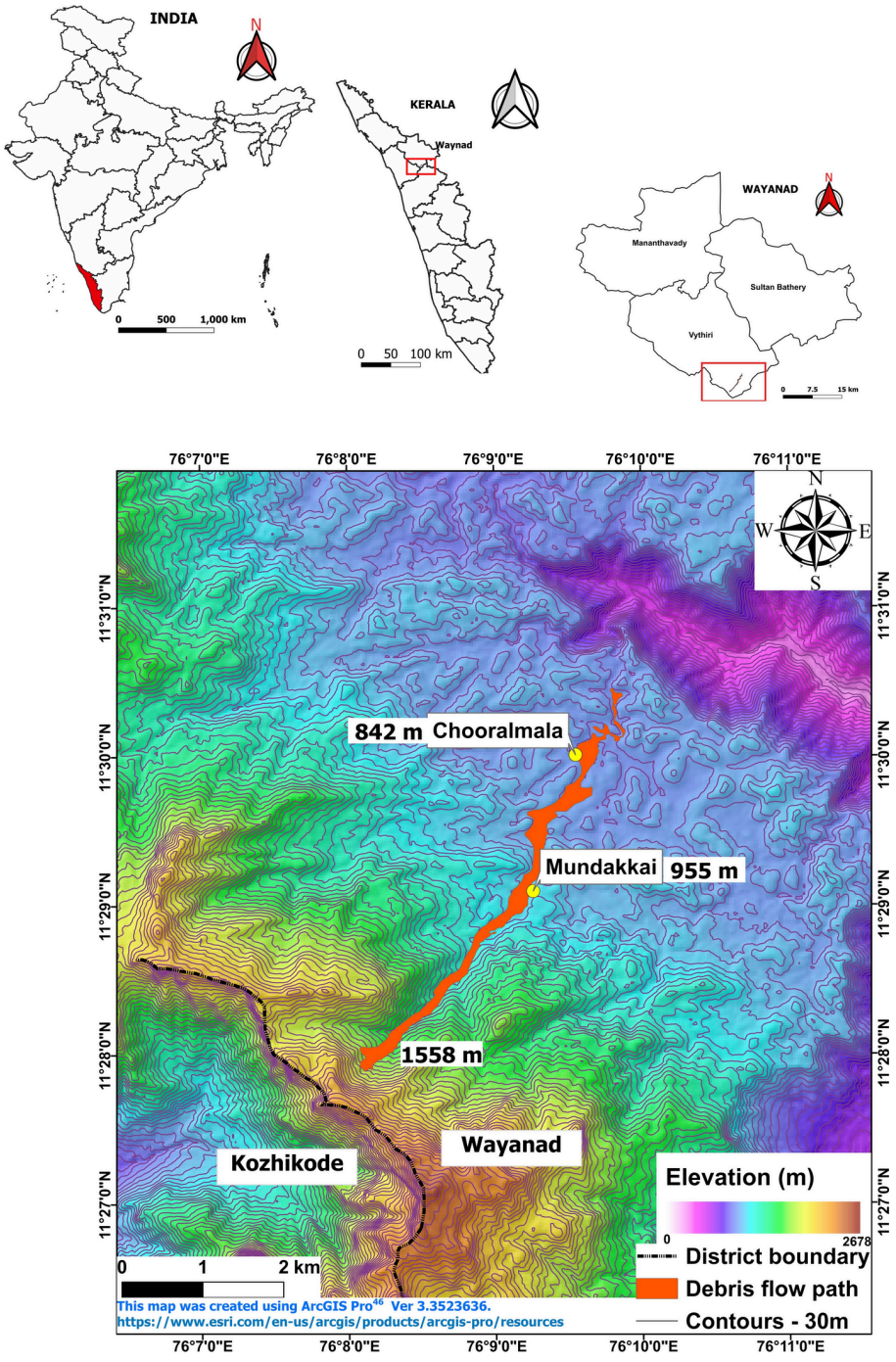


Figure 3.13: **Topographical Vulnerability Analysis.** Digital Elevation Model (DEM) tracing the debris flow trajectory from the crown (1558m) down to the settlements of Mundakkai (955m) and Chooralmala (842m), visualizing the steep gradient responsible for high-velocity flow. **Source:GIS Analysis Maneesha et al.,** [75] .

Figure 3.14: The Custodian of Oral History. Elderly residents possess "Spatial Memory" of previous flood events (e.g., 1984, 2018) that are missing from official digital maps. Their exclusion from the planning process represents a critical data gap in Disaster Risk Reduction. **Source: Author's Visual Log (MVI_1540)** [37].

landscape is defined by a sharp dichotomy between these indigenous inhabitants and the settler/plantation populations.

The indigenous groups: custodians of Tacit knowledge. Wayanad is home to several distinct tribal communities, each with specific historical relationship to the land:

- **Paniya:** Historically the most populous group, traditionally serving as agricultural labourers. Their history is marked by severe marginalization and displacements, often pushing them into ecologically fragile fringes.
- **Kuruma (Mullu Kuruma):** Traditionally settled agriculturalists who practiced distinct wet – rice cultivation and hunting. Their settlements, known as "Kudis", historically utilized vernacular architecture adapted to the local climate.
- **Kurichiya:** A matrilineal tribe often associated with martial traditions (historically linked to the guerrilla warfare of Pazhassi Raja against the British). Their "Tharavadus" (joint family homes) and land -management practices demonstrated a deep understanding of forest ecology.
- **Kattunaickan:** Traditionally Hunter gatherers living in the interior forests, possessing profound tacit knowledge of animal behaviour and weather patterns, often serving as early indicators of ecological shifts.

For these communities, the landscape was not a commodity but a "socio-natural" partner. Their traditional land- use-patterns, shifting cultivation (Punam) and bamboo-based

construction followed a safe to fail logic, ensuring that human dwellings accommodated, rather than resisted, the dynamic flows of the western Ghats.

The demographic shift: Migration and the plantation economy. The current demographic profile of Chooralmala is heavily influenced by two major waves of migrations that fundamentally altered the region's exposure profile: 1. The colonial plantation Era (19th century): The British introduction to tea and coffee plantations necessitated a massive labour force. This led to the influx of labourers from the plains of Tamil Nadu and Karnataka, as well as the dispossession of tribal lands.in Choorlmala today, a significant portion of the population consists of plantation workers living in "Layams" (row houses). These structures are often situated on the toe of unstable slopes to maximize land for cultivation, creating a high-concentration bull's-eye exposure.(Census of india) [68]. 2. The settler migration (1940s-1970s): Known as the "Kudiyettam" George [25], this period saw a mass influx of farmers (primarily Syrian Christians) from the Travancore region of southern Kerala. Driven by food insecurity and the "grow more food "campaign, these settlers introduced intensive agricultural practices (tapioca, rubber, pepper) and cleared vast tracts of canopy forest [25].

Current demographic complexity: Today, Chooralmala represents a complex mosaic:

- The "at risk" workforce: Low -income plantation labourers (both non tribal migrants and Paniya/Adiya tribes) who possess little agency over their housing location.

- The Tourism Sector: a growing transit population of tourists and resort owners who occupy the most scenic and often most geologically precarious cliff edges.

- The marginalized indigenous: Tribal communities who have been largely alienated from their ancestral "safe" zones and forced into sedentary settlements that may not align with their traditional knowledge systems.

Conclusions this demographic transition from low density indigenous stewardship to high – density plantation and settler economies has decoupled the population from the landscape's natural signals. The replacement of the indigenous "culture of prevention" has been the primary driver of vulnerability in the Anthropocene.

Figure 3.15: Spatial Analysis of Extractive Encroachment on Ecologically Sensitive Zones (ESZ). This GIS mapping illustrates the "institutional blindness" criticized in the Gadgil Report [21]. The visualization highlights the intersection of Mining Leases (Orange) and Active Mines (Yellow) with designated Wildlife Sanctuaries and Corridors (Green). While specifically depicting the Northern Western Ghats, this spatial data serves as a proxy for the systemic maladaptation and disregard for ESZ-1 protocols that characterize the administrative failure in the Chooralmala landslide zone. (Source: Western Ghats Ecology Expert Panel (WGEEP) Report (Gadgil et al., 2011)

Table 3.2: Compliance Matrix: WGEEP Guidelines vs. Site Reality. A forensic evaluation of how land-use in Chooralmala deviated from the recommendations of the Western Ghats Ecology Expert Panel [21].

WGEEP Guideline (ESZ-1)	**Observed Reality in Chooralmala**	**Forensic Status**
Slope Treatment	No disturbance on slopes $> 20°$.	Heavy contouring for tea plantations; resort construction on $> 30°$ gradients.
Critical Violation		
Construction	Ban on large scale infrastructure.	Construction of multi-storey concrete schools and resorts in high-hazard zones.
Critical Violation		
Hydrology	Protection of first-order streams.	Diversion of natural streams for irrigation; obstruction of paleo-channels.
Contributing Factor		
Quarrying	Complete ban in ESZ-1.	Active quarries observed within 5km radius of the slide initiation zone.
Trigger Factor		

3.2.3 Current Policies for Risk Reduction

The disaster management landscape in Chooralmala is governed by Kerala state disaster management plan (KSDMP) [47], which operates under the legal authority of the disaster management act (2005). Theoretically, this framework is robust and technologically advanced. Technological capacity: the state utilizes high -resolution satellite imagery from ISRO and the geological survey of India (GIS) to create "Macro-level" hazard zonation maps. Institutional strength: as evidenced during the rescue phase, the KSDMP Provides a unified command structure that allows for the rapid mobilization of the national disaster response force (NDRF).

Current policies for risk reduction: While the national and state level frameworks specifically the national disaster management plan (2019) [42]and the Kerala state disaster management plan (KSDMP) nominally align with Sendai framework's goals of 'risk reduction," the operational reality in Chooralmala reveals a significant gap between policy and practice. The current governance approach is characterized by a reliance in "Hard Engineering" solutions and a dilution of ecological regulation, leading to what the theoretical framework identifies as Maladaptation.

The technocratic failure ("fail-safe" vs "safe to fail"): Current risk reduction strategies in Wayanad predominantly employ a "Command and Control" approach to nature (Holling & Meffe, 1996) [32]. the focus is on resistance building retaining walls, concrete embankments, and channelizing streams attempting to make the landscape "fail safe". Engineering stability: These measures treat the hazard (landslide/flood) as a static force that can be contained. However, in the era where stationarity is dead (Milly et al.) [56], climate parameters frequently exceeded the design parameters of these structures. False sense of security: The construction of such infrastructures creates a "Levee effect ", encouraging further settlement in high-risk zones under the assumption of safety. When these rigid defences inevitably fail against "deep uncertainty" events, the resulting catastrophe is far greater than if the system had remained flexible (safe to fail).

The regulatory dilution (Gadgil vs KasturiRangan): The most critical policy failure in the region is the non-implementation of the western ghats ecology expert panel (WGEEP)report, authored by Madhav Gadgil in [21] The Gadgil report (scientific approach): proposed designating the entire western ghats as an ecologically sensitive area (ESA), with a graded system (ESZ 1,2,3) that would have strictly regulated construction, quarrying, and land use changes in zones like Chooralmala. The policy shift: Due to intense political and "settler pressure, the Gadgil report was sidelined in favour of the high – level working group (HLWG)report (Kasturirangan committee), which significantly reduced the area under protection and diluted the regulatory constraints (Ramachandra et al.) [74]. Consequences: This regulatory retreat prioritized short – term economic gains over long term ecological security, effectively legalizing the root causes of vulnerability defined in the pressure and release (PAR). model

Reactive governance and the adaptation gap: Despite the recurring disasters (notably the 2018 and 2019 Kerala floods/landslides), the local governance model remains reactive. Disaster management as relief: the administration machinery excels at post – disaster response (rescue, relief camps, compensation) but lags in pre-disaster mitigation. Risk reduction is often reduced to issuing warnings (orange /red alerts) rather than

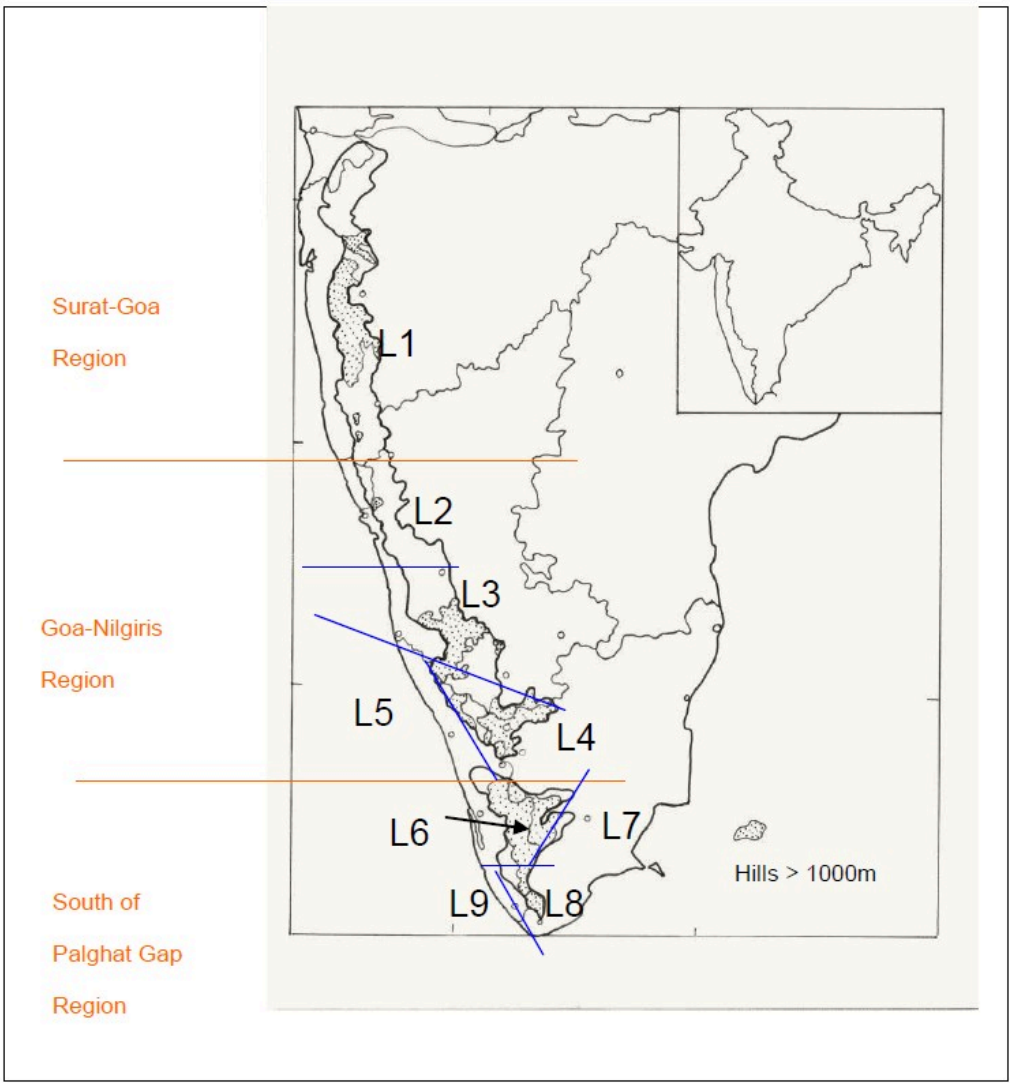


Figure 3.16: Zonation of Wayanad District showing Ecologically Sensitive Zones (ESZ). Note that the Chooralmala region falls within ESZ-1, where major construction was explicitly recommended against. **Source: Gadgil Report** [21].

addressing the underlying exposure caused by unscientific land use. Soiled approaches: there is a disconnect between the disaster management authority (focused on safety) and the town and country planning department (focused on development). This lack of integration leads to approved construction in areas that hazard maps identify as critical, creating a cycle of "sanctioned risk". Current policies in Chooralmala are fighting a 21st -century climate battle with 20th -century tools. By ignoring deep uncertainty and sidelining ecological science (Gadgil report) [21] , the state inadvertently fosters maladaptation increasing the system's rigidity just as the environment demands greater flexibility.

3.2.4 Using traditional knowledge nowadays

In the contemporary landscape of Chooralmala, the operational use of traditional knowledge (TK) has undergone a precipitous decline. While the theoretical value of indigenous practices is increasingly recognized in academic discourse (Mercer et al.,) [55], their practical application in daily life has been largely displaced by "modern" standardization. This erosion represents a critical loss of social resilience, where the "software" of community coping mechanisms has been deleted in favour of the "hardware" of engineering.

The Architectural shift from breathable to burdened: The most visible decline of the TK is in the built environment. historically, the indigenous architecture of Wayanad utilized locally sourced materials bamboo, mud and thatch which possessed high elasticity and low thermal-mass. These structures were "light in the land", imposing minimal load on the unstable slopes. The concrete hegemony: Today, the aspiration for modernity has driven near -total shift to reinforced cement concrete (RCC) construction. In the local cultural lexicon, Concrete is synonymous with "development" and "safety". Structural maladaptation: this shift has introduced a dangerous geophysical contradiction. Heavy multi story concrete structures are now erected in slopes historically deemed suitable only for light dwellings. This increases the surcharge load on the soil, effectively destabilizing the slope mechanics described in section 3.2.1. Climate incompatibility: vernacular sloped roofs were designed to shed heavy monsoon water rapidly. Contemporary flat roofed concrete buildings often suffer from water stagnation and leakage, leading to structural fatigue and "sick building syndrome". Yet they remain the dominant typology due to social status.

Erosion of Ecological guardianship (the decline of "Kavu"): A pivotal component of traditional risk reduction was the Sarpa Kavu (sacred grove). these patches of untouched forest, maintained by traditional Hindu families and tribal communities, served as natural bio shields and hydraulic regulators. Ecological functions: The "Kavu" preserved deep rooted native vegetation that bound the soil and managed the water table, acting as natural "sponges" during extreme rainfall events (Ray et al.) [76]. Current status: Under the pressure of real estate and fragmentation, many sacred groves have been cleared or reduced to symbolic concrete shrines. this transformation strips the landscape of its natural green infrastructure, removing the biological buffers that once mitigated landslide risk.

Agriculture amnesia: The agricultural TK that once governed the "when and

Figure 3.17: Sacred Geography (Totemic Ecology). The worship of nature-totems creates a "Sacred Geography" where specific ecological zones are respected. This cultural belief functions as an informal conservation law, protecting root systems in sensitive areas. **Source: Author's Fieldwork** [37].

where" of planting has also faded. The traditional multi-tier cropping system (polyculture), which mimicked the forest structure and maintained soil integrity, has been largely replaced by intensive monoculture (tea, rubber). Water and Soil management: The 'Keni 'system: the Kurichiya community utilizes the Keni (a distinct method of well constructions using biological indicators to find water sources). while primarily for water security, this demonstrates a profound understanding of the sub-surface hydrology, preventing the random drilling of borewells that destabilizes slope shear strength in modern settlements. Bamboo windbreakers: as noted in the Muthuvan practice, planting bamboo/reeds acts as a windbreakers and soil blinder. this an "Eco- DRR" strategy that mechanically reinforces the soil matrix, preventing the shallow landslides that often trigger larger debris flows. Loss of signals: The older generations of the Kuruchiya and Kuruma tribes relied on bio-indicators (e.g., the flowering of specific plants or the behaviour of ants) to predict monsoon intensity. Today, this Tacit knowledge is failing to transfer to the younger generation, who increasingly rely on (often delayed) digital alerts from the state, severing the immediate feedback loop between the community and the environment.

Bio indicators (early warning): Indigenous elders utilize a "sensory science" that predates modern instrumentation. This includes: Acoustic Warnings: interpreting specific sounds from the upper catchment (often described as a "hum" or "groan") as indicators of debris shifts, distinct from thunder. Traditional Ecological knowledge (TEK) systems: The resilience of these communities is rooted in specific "Tacit" technologies

that manages environmental forces rather than resisting them. Visual proxies: Monitoring the turbidity of stream water. A sudden change to "muddy" water in dry spells or specific animal migrations (e.g., ants moving to canopy levels) serves as a proxy for slope instability upstream.

Historical settlement patterns: A critical analysis of historical land use reveals that indigenous settlements were rarely located in the "runout zones "where the 2024 disaster occurred. Zoning by taboo: The Kurichiya and Kuruma communities, historically agrarian landlords, established their settlements on their settlements on the mid-slopes or raised plateaus, avoiding the deep V-shaped valleys which they identified as "water paths". The "Savadi "logic: the Muthuvan architecture features the Savadi (dormitory), which is typically elevated or situated on stable ground. this contrasts sharply with the modern "river-view" resorts built directly on the paleo-channel. The indigenous logic treats the river valley as a zone of transience (for fishing / agriculture) but not for permanent habitation.

The erosion of knowledge: The transition of way and from a tribal landscape to a "plantation Economy" (colonial era to present) has systematically marginalized this knowledge. The influx of settlers and the imposition of the scientific forestry replaced the diverse, root - heavy native vegetation with shallow – rooted tea and monoculture timber. this represents not just an ecological shift, but an "Epistemic violence" where the local knowledge that kept the slopes stable was erased in favour of economic utility.

Conclusion (the modernity trap): Currently, traditional knowledge in Chooralmala is viewed through a lens of nostalgia rather than utility. it is often dismissed as backward or primitive by the mainstream settler population. This cultural marginalization of TK has created a "resilience void", where the community has abandoned the Safe-to-fail methods of the past but has not yet achieved the failsafe promises of the modern engineering, leaving them dangerously exposed to the deep uncertainty of the Anthropocene.

3.3 Using traditional knowledge for DRR in Chooralmala

Having established the "socio natural" vulnerability of Choorlmala and the progressive erosion of indigenous practices, this section shifts focus from diagnosis to potential solutions.it investigates the operational viability of reintegrating traditional knowledges (TK) into modern Disaster Risk Reduction strategies. The central premise is that TK offers a repository of "time-tested" adaptation strategies that are inherently aligned with the safe-to fail resilience model needed in the Anthropocene. While modern technocratic approaches often struggle with the "deep uncertainty" of local climatic shifts, local knowledge systems possess high - resolution, site specific data accumulated over generations. this section explores how these vernacular insights ranging from slope management techniques to biological early warning systems can be decoded and validated. The subsequent analysis aims to bridge the "adaptation gap" identified in the theoretical framework. It posits that a hybrid approach, which synthesizes the explicit precision of modern science with the tacit wisdom of traditional practice, is essential for navigating the complex risk landscape of the western ghats.

Investigating vernacular resilience: This section investigates the specific mechanism of traditional know (TK) that have historically allowed indigenous communities in Wayanad to navigates the region's volatile Geograpghy. the inquiry focuses on decoding the "vernacular logic" that aligns with the safe-to-fail resilience model. The investigation targets 2 primary domains of knowledge: 1. Ecological early warning systems (Bio indicators): Exploring the resilience on tacit biological signals such as the mitigation patterns of ants, changes in groundwater turbidity, or the flowering cycles of specific flora (e.g., Neelakurinji) which have traditionally served as precursors to slope failure. the objective is to assess how these "soft" sensors complement "hard" meteorological data in an era of deep Uncertainty. 2. Vernacular structural adaptation: Examining the material and structural choices in traditional dwelling (e.g., the Muthuvan use of bamboo and mud). The analysis seeks to understand how these lightweight, flexible structures manage kinetic energy and soil saturation differently than rigid concrete forms. by treating these traditional forms not as "primitive" but as "technologically appropriate" response to local hazards, this section aims to validate their potential role in reducing physical vulnerability. Ultimately in this section seeks to document weather these indigenous practices function merely as cultural artifacts or as viable, low -cost technologies for modern Disaster Risk Reduction.

Figure 3.18: Comparative Structural Analysis. A forensic comparison showing the rigid concrete house (left) suffering foundation scouring, while the flexible vernacular extension (right) deformed but did not shatter. This illustrates the resilience principle of "ductility" over "resistance".

3.3.1 Policy integration: How the traditional knowledge can be implemented in the current DRR policies.

This subsection will explore pathways for formalizing these informal practices, proposing how "vernacular wisdom "can be updated and embedded into the official state disaster management plans.

3.3.2 Challenges and obstacles to including traditional knowledge

While the potential of TK for reduction is theoretically evident, its integration into formal policy faces significant systemic barriers. this section analyses the friction between the "state "(technocratic governance) and the "community" (vernacular). **The Epistemological gap:** The primary obstacle is the fundamental disconnect between quantitative nature of modern bureaucracy and the qualitative nature of traditional knowledge. state DRR policies rely on "measurable" data, standardized building codes, rainfall millimetres, and return periods. in contrast, TK is often anecdotal, context -dependent, and transmitted through oral tradition methods within the rigid frameworks of the national disaster management authority. **The stigma of backwardness:** A profound sociological barrier is the cultural perception of TK as "regressive". in the current socio – economic landscape of Kerala, aspirational modernity is closely tied to the rejection of traditional practices. Mud and bamboo are often associated with poverty, while concrete

is associated with wealth and security. this cultural bias creates a demand for maladaptation where communities actively reject safer, sustainable traditional methods in favour of high-risk modern structures to signal social mobility. **The challenge of standardization:** Finally, there is the logistical challenge of codification. Traditional practices are highly localized what works on the slope in Chooralmala may not work even in the neighbouring valley. modern policy, however, seeks "one size-fits all" solutions. developing a "TK update protocol" requires creating a flexible regulatory framework that can accommodate this local variation without succumbing to administrative chaos.

Chapter 4

Findings: Forensic Reconstruction of the Chooralmala Event

4.1 Introduction

This chapter presents the forensic reconstruction of the disaster, triangulating survivor testimony with physical artifacts. The research identifies a catastrophic disconnect between "Explicit" scientific models and the physical reality of the event. While engineering systems suffered from brittle failure, indigenous knowledge—often dismissed as folklore—offered high-resolution data on the event's geological mechanics.

4.2 The Chandappan Event: Decoding Folklore as Hydro-Physics

The analysis of field interview MVI_1536 provides a critical entry point into the vernacular science of the western ghats. The subject, a long-term resident, describes a visual precursor known as "Chandappan" [37]: a "black elephant–sized entity" moving upstream ("Keripoyi") [37] along the riverbed. While technocratic risk management dismissed such accounts as superstition, a forensic geological lens reveals this to be a precise description of high-viscosity debris flow mechanics.

4.2.1 Granular Segregation and the Debris Snout

In the rheology of fluid physics, the leading edge or "snout" of a debris flow is frequently composed of the largest, darkest boulders. Through the process of **granular segregation**, larger particles migrate to the front of the surge, creating a coherent, dark wall of mud and stone.

Forensic evidence at the site (Photo 000040) confirms the presence of boulders exceeding 3 metres in diameter. This validates the witness's comparison to a "black elephant" in terms of scale, colour, and mass.

Figure 4.1: High-Velocity Debris Flow Evidence. The presence of massive boulders (> 2 metres diameter) indicates flow velocities that exceeded standard hazard zonation predictions. This validates local legends of "Chandappan" (the black elephant) as accurate descriptions of high-energy sediment pulses. **Source: Author's Fieldwork**.
[37]

4.2.2 Retrogressive Failure and "Upstream" Dynamics

The witness's observation that the entity "climbed upstream" (Keripoyi) appears to contradict gravity but aligns with **retrogressive failure mechanics**. When hyper-concentrated sediment pulses encounter a constriction or a temporary debris dam, kinetic energy is converted into a hydraulic jump or a "black surge" that visually appears to propagate backwards or travel upstream.

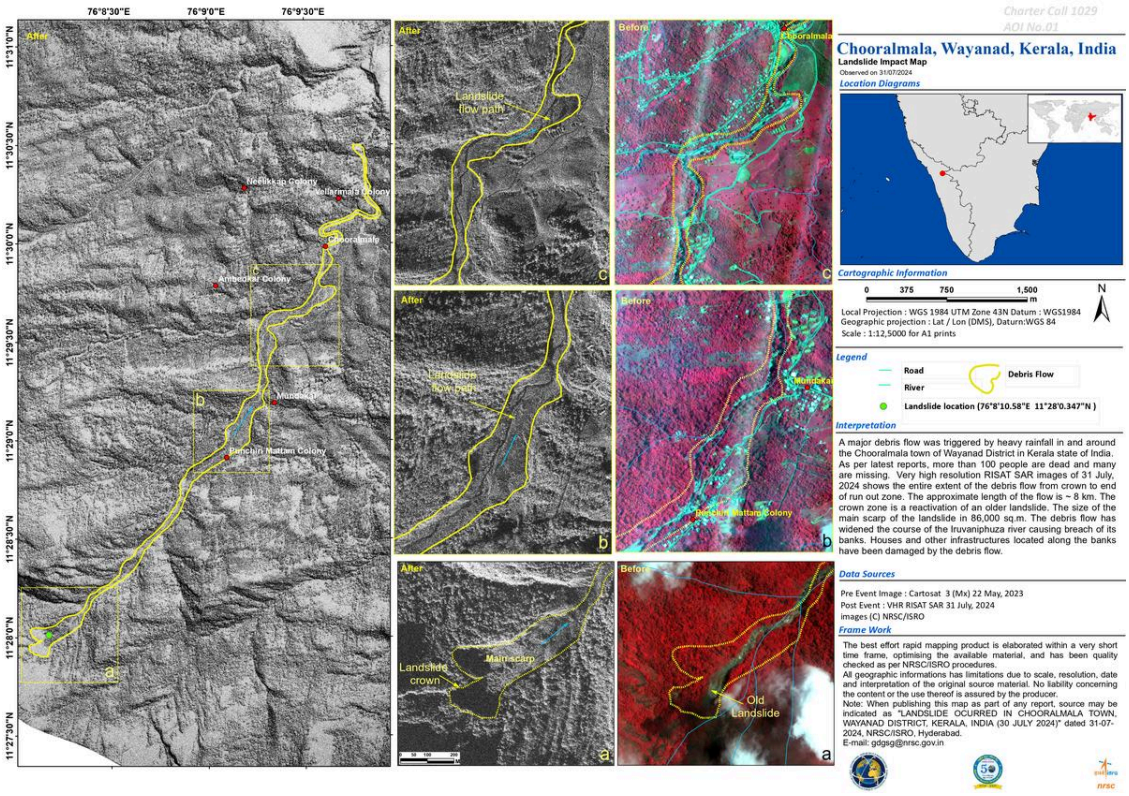


Figure 4.2: **Comparative Analysis of Hazard Zone Expansion.** Side-by-side comparison of the pre-event landscape versus the post-2024 event. The imagery highlights the reactivation of the main scarp and the significant widening of the river course, confirming the retrogressive failure. **Source: National Remote Sensing Centre (NRSC), ISRO (2024)** [63].

This "Chandappan" legend is, therefore, a codified community memory of a dam-break pulse—a data point that was invisible to centralised state sensors but served as a functional early warning for those who understood the sign.

Table 4.1: Forensic Chronology of the Event. This comparative timeline highlights the "Warning Gap" between indigenous bio-indicators and official state alerts.

Time Window	**Official State Alert (Scientific)**	**Local / Bio-Indicator (Tacit)**
T - 48 Hours	Orange Alert (Heavy Rainfall predicted). [36]	Elders notice change in river color (turbidity) upstream.
T - 12 Hours	Red Alert issued for Wayanad District.	Domestic animals (dogs, cattle) refuse food and show distress [37](Source: MVI_1546).
T - 2 Hours	No specific landslide warning for Chooralmala.	"Humming" sound reported from the earth; rapid disappearance of birds.
T - 0 (Event)	Seismographs register movement.	Catastrophic debris flow ("The Black Elephant") impacts the settlement.

4.3 The Zoosemiotic Sensor: The Domestic Dog as a Bio-Sentinel

The failure of the technological "grid" during the event—evidenced by power outages and signal loss mentioned in MVI_1536—meant that formal early warning systems (EWS) were non-functional at the moment of impact. However, findings from MVI_1546 and survivor testimony identify a functional, decentralised network: the domestic dog.

4.3.1 Ranging Behaviour and Seismic Precursors

Visual evidence from transect walks documents the "ranging behaviour" of local dogs, which run ahead to inspect terrain before returning to the group. Survivors in MVI_1537 [**?**]explicitly reported that animals displayed extreme distress and "howling" (*naayi oliyiduka*) hours before the primary landslide.

From a forensic perspective, this indicates that the animals acted as **bio-sentinels** capable of detecting P-waves (primary waves) or high-frequency ground vibrations that precede the destructive S-waves of a geological rupture.

4.3.2 The Institutional "Sensing Gap"

The dismissal of these zoosemiotic signals represents a critical "blind spot" in official disaster risk reduction (DRR). While the state's coarse digital models failed to capture the hyper-local slope instability, the biological sensory capacity of the community remained operational. The separation of these animals from their owners during evacuation—treating them as luggage rather than survival partners—further illustrates a maladaptive policy that ignores the biosocial anchors of indigenous resilience.

4.4 Material Forensics: Brittle Failure vs Ecological Resilience

The most damning evidence of maladaptation in Chooralmala is the forensic contrast between modern construction and native biological systems. The investigation utilised the PAR Model to analyse why modern "resistant" structures became lethal traps while vernacular systems showed superior persistence.

4.4.1 Brittle Failure of the "Concrete Trap"

Forensic inspection of the ruins (Figure 4.4) reveals a phenomenon of **Brittle Failure**. The modern reinforced concrete (RCC) columns snapped cleanly at the base [16] rather than bending. These structures were designed under the philosophy of "Engineering Resilience," a "Fail-Safe" mentality that attempts to resist natural forces through rigid mass.

When the high-velocity debris flow (estimated at 10-15 m/s) exceeded the static load design, the failure was sudden and catastrophic, offering no "Safe-to-Fail" windows for the occupants.

Figure 4.3: Bio-Indicators and Interspecies Resilience. A domestic dog exhibiting "ranging behaviour" prior to the slide. Residents reported animals displaying distress hours before the event, serving as a functional "Bio-sentinel" for ground instability. **Source: Author's Visual Log (MVI_1546)**. [37]

4.4.2 Ecological Resilience of the "Thayu" (Root) System

In contrast, testimony from elders in MVI_1532 [37]emphasises the role of the "Thayu" (root) systems in maintaining slope integrity. Indigenous knowledge holds that native vegetation and bamboo clumps provide essential tensile strength to the soil; as the witness states, *"if you don't have roots, the soil won't stand."*

The visual forensics of the landslide zone fringes confirm that while rigid concrete walls were pulverised, the native bamboo did not break; it deformed and absorbed energy, a principle known as **ductility**. The rhizome network of the bamboo acts as a "soil nail", allowing water to drain and dissipating pore-water pressure that would otherwise trigger a blowout behind a solid concrete wall.

4.4.3 The Natech Reality of Resort Construction

The findings further link the landslide to the Natural-Technological (Natech) triggers of recent resort development. In MVI_1532 [37], residents describe how engineers "break the rocks to put beams deep inside," a practice that disrupts the natural subsurface hydrology and triggers **soil piping** [21]. This unscientific land use, specifically the addition of heavy concrete weight to unstable colluvium slopes, is a clear instance of maladaptation that

Table 4.2: Comparative Root Mechanics: Monoculture vs. Native Ecology. Analyzing the soil-binding capacity of different vegetation types found at the landslide site.

Vegetation Type	**Root Architecture**	**Hydrological Function**	**Performance in Slide**
Tea Plantation	Shallow tap root (trimmed).	Low absorption; creates shear plane between soil and rock.	**Failed:** Slid explicitly along the bedrock interface.
Areca Nut	Fibrous but shallow.	Minimal soil binding depth.	**Failed:** Toppled easily by debris flow impact.
Native Bamboo	Dense Rhizome Network (Mat-like).	High absorption; acts as a "Soil Nail" anchoring deep layers.	**Resilient:** Clumps remained intact, diverting flow.
Riparian Trees	Deep buttress roots.	Hydraulic pump (lowers pore water pressure).	**Resilient:** Protected river banks from scouring.

Figure 4.4: The "Island Effect" (scouring). Flood waters eroded the soil around the rigid concrete structure, leaving it isolated. This highlights the failure of shallow foundations in liquefaction zones. **Source: Author's Fieldwork**.

has anchored people to the ground at the exact moment the ground has started to move.

Chapter 5

Discussion

5.1 The "Natech" Reality: Analysing the Failure of the Built Environment

The forensic evidence from Chooralmala (Source: Primary Data specifically Video MVI_1607) [37] confirms that the disaster was not a purely "natural" event but a "Natech" disaster—a natural hazard triggering a technological failure. The collapse of the modern concrete home illustrates the "Expanding Bull's-Eye Effect" [9]. Development has pushed rigid, heavy infrastructure into high-velocity flow zones previously reserved for light, vernacular dwellings.

The discussion here is critical: modern engineering attempted a "Fail-Safe" strategy (resistance), which failed catastrophically when the debris threshold was exceeded. In contrast, the traditional "Thayu" (root) systems described by elders (Subject MVI_1532) (Source: Primary Data [37])represent a "Safe-to-Fail" strategy [3], where the landscape is managed to absorb, rather than resist, the energy of the flow.

Table 5.1: Structural Resilience Comparison

Typology	**Response to Flow**	**Failure Mode**	**Outcome**
Modern RCC	Resists flow until yield point	Brittle Failure (Snapping)	Maladaptive / High Fatality
Vernacular (Bamboo)	Deforms and bends	Ductile Response	Damaged but slope held
Hybrid Proposal	Concrete Core + Bio-periphery	Composite	Adaptive Safety

5.2 Decoding the "Chandappan" Myth: Folklore as Hydro-Physics

A significant finding of this study is the validation of the "Chandappan" phenomenon. While modern policy dismisses such narratives as folklore, this discussion argues that they represent "Encoded Science." The description of the "black elephant" moving upstream is a precise vernacular articulation of Retrogressive Failure Mechanics. In fluid dynamics, the "snout" of a debris flow is often composed of large boulders (granular segregation), creating a visual "head" that matches the "elephant" description. By dismissing this myth, authorities missed a critical, validated data point regarding the type of hazard (high-viscosity sediment surge) that radar could not detect. This confirms Polanyi's theory of Tacit Knowledge—wisdom [70] that is embodied and narrative rather than written and numerical.

5.3 The Trap of Sedentarization: From Mobility to Vulnerability

The application of the PAR Model reveals that the "Root Cause" of vulnerability in Chooralmala is the forced sedentarisation of Indigenous communities. Historically, resilience in the Western Ghats was predicated on mobility—the ability to move away from elephant corridors or unstable slopes. The transition to government-allotted concrete housing has created a "Maladaptation Lock-in" [9]. As seen in the case of the elderly survivor (MVI_1540) [37], the concrete house acts as an anchor, fixing the population in a hazard zone. The protection offered by the state (a permanent roof) has paradoxically stripped the community of its primary adaptive mechanism: mobility.

5.4 The Biosocial Gap: Re-evaluating the "Siren"

The behaviour of the domestic dog—"ranging behaviour"—provided a clear, binary signal of ground instability long before the landslide occurred. However, the rescue operation's treatment of the animal as "luggage" highlights the "Socionatural Gap" in policy. Effective DRR requires recognizing that for forest-dwelling communities, the "sensing network" includes non-human actors. The anxiety of the animal was a valid data point. By ignoring this zoosemiotic signal, the formal warning system failed to utilize the only sensor that remained functional when the electricity grid collapsed.

5.5 Erosion of Memory: The Failure of Explicit Warnings

A final pillar of this discussion addresses the "Epistemic Violence" inherent in modern early warning systems (EWS). In Chooralmala, the state relied exclusively on "Explicit Knowledge"—codified, digital data from satellite imagery and district-level rain

gauges—which failed when the technological grid collapsed due to signal loss. This technological dependency resulted in "spatial amnesia," where official hazard maps were unable to render the landscape's historical memory of water paths and previous flood lines.

This research highlights that the older generation possessed "Tacit Knowledge" through a "Sensory Triad" that modern science dismissed as anecdote. This included:

1. **Auditory Cues:** The "Vambicha" humming of debris energy.
2. **Bio-sentinels:** The ranging behaviour of domestic dogs.
3. **Olfactory Precursors:** Specifically, the "smell of the soil" (*Manninte Manam*). While typically associated with petrichor, an intense release of geosmin in this context signaled deep soil shearing and the exposure of subterranean layers preceding mass failure.

The erosion of this memory has left the younger generation and recent settlers uniquely vulnerable.

Chapter 6

Conclusion and Recommendations

6.1 Summary: The Crisis of Explicit Science and the Triumph of Tacit Wisdom

The landslide disaster at Chooralmala has fundamentally demonstrated that "stationarity is dead" [56], and with it, the reliability of our current technocratic disaster management framework. For decades, disaster planning in Wayanad has relied on the assumption that natural systems fluctuate within an unchanging envelope of variability. However, the Anthropocene has introduced "deep uncertainty," where climate-amplified "Black Swan" events fall entirely outside the "bell curve" of state prediction models.

Our forensic reconstructions reveal that "Explicit" scientific systems failed because they were too coarse to capture micro-climatic realities. While the state's digital zonation maps failed to render the landscape's historical memory, "Tacit" traditional knowledge remained operational. The local "Chandappan" legend, dismissed by technocrats as mere folklore, was forensically validated as a precise vernacular encoding of retrogressive failure mechanics. Furthermore, while modern concrete infrastructure suffered catastrophic "brittle failure," trapping residents in fixed hazard zones, the biological and cognitive systems of indigenous resilience provided the only functioning early warning signals. We must acknowledge that "Epistemic Violence"—the systemic exclusion of local wisdom—is a primary driver of the "blind spot" that led to this tragedy.

6.2 Recommendations

6.2.1 Recommendation 1: Formal Integration of Bio-Indicators into the SDMP

To address the "Sensing Gap" exposed when the technological grid fails, it is proposed that the Kerala State Disaster Management Plan (KSDMP) be updated to include "Epistemic Pluralism." We must move beyond a purely mechanical Early Warning System (EWS) toward a "Hybrid EWS" that formally integrates biological and sensory precursors as valid data points.

- **Recognition of Zoosemiotic Precursors:** The SDMP should formally recognise animal behaviour (Bio-sentinels) as a critical "last-mile" warning signal. Forensic evidence confirms that domestic animals detect P-waves hours before a major rupture.
- **The Sensory Triad Protocol:** Training local First Responders to identify the auditory ("Vambicha" sound), olfactory (intense soil smell), and visual (stream turbidity) precursors.

6.2.2 Recommendation 2: Transitioning from Rigid Engineering to Bio-Engineering

The catastrophic failure of reinforced concrete (RCC) in Chooralmala provides a clear case of maladaptation. By prioritising "Fail-Safe" resistance, we have created a "concrete trap." We recommend a radical shift toward "Safe-to-Fail" bio-engineering that utilises the traditional "Thayu" (root) systems.

- **Vegetative Slope Stabilisation:** Mandating the use of native deep-rooted vegetation (bamboo and riparian flora) for slope anchoring. Unlike rigid concrete, the rhizome network acts as a "soil nail," dissipating pore-water pressure.
- **Ductility over Resistance:** Future infrastructure in Ecologically Sensitive Zones (ESZ) must be designed for ductility—the ability to deform without shattering.
- **Mandatory Cumulative Impact Assessments (CIA):** Following the Gadgil Report [21], an immediate moratorium on "Hard" infrastructure development (like resort construction involving rock-breaking) is recommended.

6.3 Closing Statement: Restoring the Ecological Contract

The transition from a "command and control" approach to one of "Adaptive Co-management" is no longer a choice but a survival necessity in the Western Ghats. The Ecological Contract with the Western Ghats shall be restored by empowering local governments and indigenous communities to act as the primary custodians of the land. By synthesising scientific precision with the tacit wisdom of those who have co-evolved with these slopes, we can build a truly transformative resilience. Resilience in the Anthropocene is not about building higher walls, but about listening to the land.

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Appendix A

Visual Forensic Transcripts

Overview of Site Interviews

This appendix provides the full textual reconstruction of semi-structured interviews and situated verbal evidence collected during the field investigation in Chooralmala (August 2024). These transcripts serve as the raw data for the "Verbal Forensics" methodology discussed in Chapter 3. Vernacular terms and local idioms have been preserved to maintain the epistemic integrity of the survivors' accounts.

No.	Timestamp	Forensic Transcript / Translation
1	00:00:24,880	**Came to Vellaramala school many people.**
2	00:00:28,320	**Swept away! They were swept away in water!**
3	00:00:30,119	**Then they caught up and came back.**
4	00:00:34,599	**They were from Mudakkai, then Channa all of them were swept half way.**
5	00:00:41,039	**After they were swept away, they came back then itself. In the first water run off! While we were at the school.**
6	00:00:45,320	**Then they in the night and then the next one came in high velocity "over".**
7	00:00:49,880	**Next landslide "Urul pottal".**
8	00:00:51,320	**When that came itself they ran, they came outside right! To run away.**
9	00:00:54,719	**Then itself water took, Half from here about 10 metres, they would have gone!**

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Table A.1 – continued from previous page

No.	Timestamp	Forensic Transcript / Translation (cont.)
10	00:00:59,719	**From there we went straight to top of the hill! Stayed there in the night till morning along with everyone.**
11	00:01:08,039	**Not just us, The outsiders also. Everyone were scattered on the top of the hill, or inside the forest the whole night.**
12	00:01:12,840	**That day nothing was there, no light, no current nothing.**
13	00:01:16,199	**Nothing was there, the torch of the mobile! There was no charge in the mobile 2-3 days before had the electricity been gone.**
14	00:01:22,119	**So that day it was fully gone. NO current!**
15	00:01:25,280	**So light, if there was light, we could have gone to some other places.**
16	00:01:28,639	**Then the heavy Mist, and its night right..!**
17	00:01:32,119	**So we could not understand anything, unable to predict (disaster) where it will come from.**
18	00:01:36,119	**While we were running sometimes we had even hit on each other accidently.**
19	00:01:39,360	**Yeah, many things like that had happened.**
20	00:01:42,639	**Like that! They went straight the shelters like the camps.**
21	00:01:48,159	**Later in the morning was everyone taken to the shelters.**
22	00:01:50,679	**We were altogether taken in the morning.**
23	00:01:53,800	**Night they didn't come.**
24	00:01:56,079	**Night 4:00 am.....!**
25	00:01:57,480	**Night it did not reach 4:00 am, landslide happened around 3:30 - 3:45.**
26	00:02:00,639	**Like 3:45 am...! In between it broke. 3:00 - 3:45.**
27	00:02:04,960	**4:00 am it reached and it happened.**
28	00:02:08,480	**No one had informed us.**

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Table A.1 – continued from previous page

No.	Timestamp	Forensic Transcript / Translation (cont.)
29	00:02:10,480	**{Interviewer: Anyone informed if a disaster was about to happen?}**
30	00:02:12,719	**No..no nothing was informed.**
31	00:02:14,360	**We did not knew it as well....!**
32	00:02:15,760	**Then the ward members came, and in the evening the day before the disaster.**
33	00:02:18,760	**"People living near by the river side has to move."**
34	00:02:21,599	**This message was sent to the phone of my children.**
35	00:02:24,920	**We did not know the reason exactly..!**
36	00:02:27,039	**Because they, near the riverside it will break...!**
37	00:02:30,039	**That feeling had come.!**
38	00:02:31,119	**Water!!! Heavy rain!!! The river was fully covers.**
39	00:02:35,960	**So water level was rising up very fast.**
40	00:02:38,159	**So a message was sent to mobile phone that everyone near the riverside should be cautious.**
41	00:02:42,840	**Other than that, no other information from authorities or officials of sarkar had passed..!**
42	00:02:51,159	**We felt something...! When the dogs started Howling.**
43	00:02:54,880	**Dogs..! They started howling.**
44	00:02:57,519	**Kittens here were behaving strangely..! Walking and looking at the hill frequently..!**
45	00:02:02,239	**When they come and look, they understands it very well.**
46	00:03:05,360	**We think that they know about some thing about this or part of this,**
47	00:03:05,360	**At that time they were howling very loud.**
48	00:03:10,840	**That time the women (wife) will say, someone is going to die.**
49	00:03:15,719	**When dogs start to howl like this.....! Someone will die....!**

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Table A.1 – continued from previous page

No.	Timestamp	Forensic Transcript / Translation (cont.)
50	00:03:18,880	**For that dogs howling.! Something is going to happen...!**
51	00:03:22,519	**This we could forecast...!**
52	00:03:25,000	**We felt something is going to happen.**
53	00:03:27,320	**That time me... Heavy wind storm.**
54	00:03:30,320	**Morning..!**
55	00:03:31,000	**So, I tied the dog at a house near by.**
56	00:03:33,639	**Then I told surely the hill will blast today.**
57	00:03:36,280	**I had told it to my children.**
58	00:03:38,920	**My little girl, didn't you notice she came and stay by my side....she also told...**
59	00:03:41,559	**Today surely the hill may collapse. There is every signs for the collapse.**
60	00:03:45,079	**Otherwise the dogs won't howl like this. It was just told...**
61	00:03:48,880	**It was not finished saying this..**
62	00:03:52,599	**Till that it should be around 6:00 or 7:00, That the first water came from the partially collapsed.**
63	00:03:56,000	**Then at the night came the big ones....**
64	00:03:57,760	**Around 12:00 one....,**
65	00:04:00,760	**Then around 4:00...consequently itself....**
66	00:04:03,039	**In five minutes, ten minutes, Gap... It came along.**
67	00:04:07,039	**Even that time was not given. It was not even 5 minutes....**
68	00:04:10,840	**It may be 2 minutes or 3 minutes. After the first blast.**
69	00:04:14,159	**The next blast around.....**
70	00:04:15,639	**In about 5 minutes... both of that happened..**
71	00:04:18,639	**Yes ..(aah)**

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Table A.1 – continued from previous page

No.	Timestamp	Forensic Transcript / Translation (cont.)
72	00:04:20,800	**By then, hearing the blast of the first sound itself we altogether.**
73	00:04:23,159	**I was like fast asleep...**
74	00:04:26,079	**That time children and women(wife).. none had slept.**
75	00:04:28,480	**So I told... I will sleep a little.**
76	00:04:29,639	**Each of us will observe it one by one...**
77	00:04:31,519	**When it blast here... last year when the first collapse happened.**
78	00:04:34,599	**By then, first when it came rain like this.. close to this.**
79	00:04:37,760	**There was a blast.... also above there was a blast.**
80	00:04:39,719	**From above the resort also it blasted and came down.**
81	00:04:41,920	**The other part Kottumala it blasted.**
82	00:04:43,400	**Then "Karimuttam" it blasted some time before.**
83	00:04:45,760	**We used to go for work there.**
84	00:04:47,840	**At "Karimuttam" is where we had work. From our mother's time.**
85	00:04:50,920	**Every one was going for work that time.**
86	00:04:52,639	**That time "Karimuttam hill" also blasted in the same way.**
87	00:04:55,639	**That time no one was hurt and no one was gone luckily.**
88	00:05:01,079	**From there we came down before it happened.**
89	00:05:01,079	**It was luck that we came down. That time "Karimuttam" blasted....**
90	00:05:03,280	**Keeping those fears in the mind.. that something will happen was sure...**
91	00:05:07,719	**"We" when this water came..... mostly "our people".**
92	00:05:10,519	**This water when it overflows. We will say "Chandappan is coming".**
93	00:05:14,480	**There is something to be observed in the water like an elephant, through the water.**

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Table A.1 – continued from previous page

No.	**Timestamp**	**Forensic Transcript / Translation** (cont.)
94	00:05:17,480	**That we will know its a black coloured thing.**
95	00:05:20,280	**Its of enormous size.**
96	00:05:22,079	**That when it goes through the water like that we can understand...**
97	00:05:25,159	**We will say "Chandappan" is coming for that...**
98	00:05:26,679	**{Interviewer} Going the upstream..?**
99	00:05:27,840	**It will go up...! Down near my place "Maniyapuzha", the channel through my place is called Maniyapuzha.**
100	00:05:34,119	**The water channel through my place is called Maniyapuzha...**
101	00:05:37,920	**So this like this will climb up the steep.**
102	00:05:41,320	**This steep when it goes up this will happen...**
103	00:05:44,519	**That thing has come, that I saw in the past, not now..**
104	00:05:47,400	**In the past we..... there while we were grazing the cow.. our land near the Dam..**
105	00:05:53,760	**So when land and house was there, we can see the river also..**
106	00:06:57,480	**And while standing near our house we can see the river flowing... so like that it was seen...**
107	00:06:01,719	**Its a black thing, "large".**
108	00:06:03,760	**{Interviewer: This thing, did you see it here?}**
109	00:06:05,400	**Yes here we saw, down there at our land.... {Interviewer ahh down...}**
110	00:06:08,519	**Down..... recently, probably about 10-15 years back...**
111	00:06:13,039	**{Interviewer: Aah,, ok will it blast, right after it goes up itself..?}**
112	00:06:17,360	**Aah,, no it climbs up and by morning it will blast.**
113	00:06:20,880	**It was while the "Karimuttam" collapsed this thing happened.**

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Table A.1 – continued from previous page

No.	Timestamp	Forensic Transcript / Translation (cont.)
114	00:06:25,679	**So in the same condition, while this thing will go is when the incident really happens.**
115	00:06:30,239	**That thing when it directly goes up, an elephant sized entity in black color.**
116	00:06:33,800	**I don't think anyone has invented it either, but we have seen it... {Interviewer: what is it called again?} "Chandappan, Chandappan".**
117	00:06:41,239	**Folklore: "Chandappan" has gone up..! It will be like elephant in the appearance.**
118	00:06:44,599	**When that goes up we can see water differently.**
119	00:06:47,119	**This muddy water comes right?**
120	00:06:48,599	**When the muddy water comes, it usually goes down right?**
121	00:06:53,039	**So when it goes up we can clearly understand.**
122	00:06:55,760	**When something blocks the water flows differently right?**
123	00:06:59,480	**Like that when it goes up we can clearly understand.**
124	00:07:02,760	**We can see this thing clearly.**
125	00:07:04,639	**No body would have seen it. The people in past has seen it ....**
126	00:07:07,920	**My grand father and grand mother clearly knows.**
127	00:07:11,280	**They know all these things like this and they will also tell us these things..**
128	00:07:15,000	**If it comes like this, this will happen.**
129	00:07:17,440	**Then this charcoal, we either - bite it and hold it or keep it under the toes of the feet.**
130	00:07:23,159	**When this lightning and other things come..!**
131	00:07:26,320	**This charcoal we will keep it under the feet. It is said that lightning wont hit in the folklore...**
132	00:07:30,280	**The grand mothers and grandfathers had told us.**

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Table A.1 – continued from previous page

No.	Timestamp	Forensic Transcript / Translation (cont.)
133	00:07:32,599	**{Interviewer: Karikk.. what?} "Karikkatta" that we use to burn the stove.. right? "Kari".**
134	00:07:39,199	**Yeah that... we keep it under the feet..**
135	00:07:41,760	**Then scythe knife we will keep in the stove..**
136	00:07:41,760	**When there is heavy rain and storm..**
137	00:07:47,800	**Scythe knife should be kept in stove. In our customs there are these types of systemic ways.**
138	00:07:51,199	**When there is heavy storm and rain there must be a knife in the stove and it should be searing hot is told.**
139	00:07:56,039	**It will stay like that, that is how for us these are made.**
140	00:08:00,440	**There are so many like this... I'm not telling..., because now us...!**
141	00:08:02,840	**Many we have forgotten...! Not forgotten, I have in memory.**
142	00:08:08,280	**What we have learned we won't forget...!**
143	00:08:11,639	**{Interviewer: Any other customs like this?} Interviewee: Other..., only this is there importantly.**
144	00:08:17,119	**Importantly only this is there...**
145	00:08:18,760	**This Chandappan is what we have really...,! I have seen for real.**
146	00:08:22,800	**That is a black coloured thing... goes through water like that... when the muddy water comes.**
147	00:08:27,520	**It climbs up.., it won't go down..**
148	00:08:30,640	**{Interviewer: It is seen in one day or on the day of the blast (landslide) it is usually seen..?} Interviewee: No..**
149	00:08:33,239	**While this thing goes up the slope,, is when these things happens...**
150	00:08:38,239	**{Interviewer: This how much time will it take.. in how much time will it happen...?}**
151	00:08:40,800	**That, the time I have not watched (calculated), Not wanting this to happen...**

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Table A.1 – continued from previous page

No.	Timestamp	Forensic Transcript / Translation (cont.)
152	00:08:44,560	**When this goes itself.. sometimes that day itself it will blast.**
153	00:08:47,720	**It will climbs and reach half way or somewhere and there it blasts the thing.**
154	00:08:52,479	**That kind of power is there in it..... it is told.**
155	00:08:55,880	**This in the past... they like this.**
156	00:08:59,359	**They only had this.... we all later, while I was studying in the 1st standard, it is 1975.**
157	00:09:05,399	**My date,..... myn,... old times it was very scary.. this head will be chopped and stealed.**
158	00:09:11,039	**These thief... will come and so the mothers won't let the children's study in schools..**
159	00:09:16,159	**In the house they will be kept hidden....**
160	00:09:19,880	**I have gone till 1st standard only. Then my grand mother took me from school.**
161	00:09:23,520	**I was in Attamala, I studied in Attamala school..**
162	00:09:27,640	**Now im about 50-55 years old...**
163	00:09:31,319	**So.. it was like this.**
164	00:09:34,840	**So I could not go to school that time. Like that now.**
165	00:09:38,439	**Then, we ourself.. like that...**
166	00:09:41,760	**Whatever we had studied is only there..**
167	00:09:45,920	**Children were here, one of my girl was struggling for the breath....**
168	00:09:49,479	**One girl was struggling to breath.. I was also sleeping.**
169	00:09:52,159	**Children where the one's who woke me up.. when they heard the sound of the blast..**
170	00:09:56,159	**When one blast(landslide) came itself.. when the first blast came itself children woke up....**
171	00:10:00,119	**And no one has slept and all... I was then.... having a high fever...**

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Table A.1 – continued from previous page

No.	Timestamp	Forensic Transcript / Translation (cont.)
172	00:10:03,840	**For dogs also... all not feeling well.. due to heavy rain.**
173	00:10:07,079	**Then so that it won shiver we took it to the house down the valley.**
174	00:10:11,239	**We where doing small setup, those were very tiring times.**
175	00:10:15,079	**It was that day I told the girl, it is sure, there is every possibility that the hill will blast.**
176	00:10:20,119	**The rain is not the kind of rain that is going to stop.**
177	00:10:23,319	**That I had only told, and they now tell me you have something,**
178	00:10:26,960	**You have "Karinaavu" (the folklore of 'prophetic tongue'). Don't talk with your tongue... etc..**
179	00:10:30,840	**I had told that day, so they tell like this now.**
180	00:10:35,760	**For Them... and for us... we anyways... the next blast will come from above us, it was dark right...?**
181	00:10:42,920	**So from here, it will come and we were sure that we will also go.....**
182	00:10:48,319	**Anyways we will go..! Many people down the valley all called.**
183	00:10:51,840	**They ran, telling that the blast (landslide) happened in Ambedkar Colony and it is coming from there.....**
184	00:10:56,239	**It is coming from here, that was the sound. In the other part... it was huge and booming sound.**
185	00:11:00,079	**It was heard from here till the "Kotthumala"-the sound.**
186	00:11:03,600	**That kind of sound, now if we see there, that is it, but that day it was huge booming sound.**
187	00:11:09,239	**And the intense smell... the smell of mud. Yeah.**
188	00:11:13,439	**The dog was very restless. It was barking non stop and coming to us.**
189	00:11:17,119	**I hurried and untied them, and let go.**

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Table A.1 – continued from previous page

No.	Timestamp	Forensic Transcript / Translation (cont.)
190	00:11:21,840	**It was a terrible situation that day.**
191	00:11:24,520	**Then the people who went for rescue. Pradeesh and many others went for the rescue.**
192	00:11:29,039	**To rescue.**
193	00:11:30,720	**Then only his one hand was visible, told the people.**
194	00:11:33,479	**We could not go there.. then them our workers, Naseer they all were swept away.**
195	00:11:40,560	**From there we all went to phone them, me with Bibin brother and all.. Told "go via there" "go via there".. me.**
196	00:11:46,720	**Me like that was calling from minute to minute, then charge also went off.**
197	00:11:51,319	**Putting the light also...**
198	00:11:52,840	**Then also it was not ringing... untill that then.**
199	00:11:54,560	**I called so many people and let them know.**
200	00:11:57,680	**Yes, during the night.. during the blast also we where saying... climb there fast, run and climb there fast. It is better to go this way.**
201	00:12:02,439	**But they will go the other way...! They don't know.**
202	00:12:06,479	**Where to go, is it from here or from there. Don't know right..?**
203	00:12:09,520	**Running like that only so many people went missing. Otherwise so many lives might have been saved.**
204	00:12:13,760	**"If we go to Chooralmala we will get vehicles" and "we can go in the vehicle" in this run only this happened to many of them.**
205	00:12:19,840	**About half was lost from their homes.**
206	00:12:22,520	**Half of them while running in half of their way they were gone.**
207	00:12:26,079	**I told Bibin brother "go up the hill..!" Bibin brother and his mother. Mother is not well.**

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Table A.1 – continued from previous page

No.	Timestamp	Forensic Transcript / Translation (cont.)
208	00:12:30,800	**So, told Bibin brother, "go up the hill with mother, nothing will come that way".**
209	00:12:35,880	**"From this part we climb the hill" then through that way will go down together to the other part.**
210	00:12:39,720	**It will not blast fully we know, with courage, without fear we climbed that way. A small child was also there.**
211	00:12:45,479	**With this child we climbed and went up the hill.**
212	00:12:50,800	**Yeah they survived like that... I called everyone I know...**
213	00:12:54,960	**That is how it is...**
214	00:12:57,680	**{Interviewer: Everything was in at the night right?..}**
215	00:12:57,680	**Interviewee: Everything was at the night... all by before 4:00 am.**
216	00:13:09,840	**Yeah, 4:00 am then little light came and then some courage started to come.**
217	00:13:13,239	**Until then, everyone was at the top. Near the 'Kavu'.**
218	00:13:15,880	**There hurrying to light the lamp, doing the rituals and all.**
219	00:13:22,439	**It was all this.**
220	00:13:25,720	**It was horrible, out of fear...!**
221	00:13:30,079	**The fear came and it was very tensed and anxious situation.**
222	00:13:34,039	**The elders..! Some say let the elders go, the younger ones are still there. And find comfort.**
223	00:13:44,560	**16 days in Meppadi high school. In the camp.**
224	00:13:48,159	**{Interviewer: How much time after the disaster did it take.. to shift to the camp...?}**
225	00:13:51,720	**On the day after the landslide itself we were taken, and we stayed for 16 days there itself.**
226	00:13:57,760	**Then we came only to give food for the dogs.**

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Table A.1 – continued from previous page

No.	Timestamp	Forensic Transcript / Translation (cont.)
227	00:14:01,720	**One guy came and gave, the rest none was let in to here.**
228	00:14:05,279	**This is the situation we could not come here, we, with the help of that H&H India's, vehicle.**
229	00:14:10,119	**Vehicles are also not there right..! Bus and nothing was there.!**
230	00:14:13,479	**Jeep bus and nothing was there. In their vehicle came the food for dog and cat.**
231	00:14:17,319	**That is there now.! (dogs)**
232	00:14:20,520	**It is there...!**
233	00:14:25,159	**{Interviewer: The searching started then itself?}**
234	00:14:28,560	**Yes that day itself, the day the blast (landslide) happened itself..! After we were taken there setted up there.**
235	00:14:32,600	**That day itself we where ready and that day itself they gave us food also.**
236	00:14:36,279	**So The puppies... here like that.**
237	00:14:39,680	**Telling that the dogs are starving.**
238	00:14:43,079	**We did not eat anything, I told like that.**
239	00:14:46,800	**So they decided to give food to the puppies and the all came.**
240	00:14:50,399	**They came the H&H... came.**
241	00:14:54,279	**Helped a lot they come daily in the morning and give food, sometimes bread, biscuit and other things and medicines. All needed things where given.**
242	00:15:04,159	**Medicines where given to dog to get rid of the parasites. Then chains for the them.**
243	00:15:08,720	**They also bought this cage.**
244	00:15:20,640	**After the collapse (landslide) there is no job or anything now.**

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Table A.1 – continued from previous page

No.	Timestamp	Forensic Transcript / Translation (cont.)
245	00:15:23,319	**Now no jobs meaning, all the people here went, now only we are left here.**
246	00:15:27,319	**Like one, 2-3 families from outside and we now 18 families, like that 21 families are there.**
247	00:15:32,319	**That is 74 people in total, including children.**
248	00:15:37,399	**74 people are there in total. Here!**
249	00:15:40,800	**Then anganvady teacher will come. If it is raining heavily, by 1:00 - 2:00 pm they will come and go..**
250	00:15:45,439	**Then only we are here.**
251	00:15:47,439	**Remaining the neighbours all left from here.**
252	00:15:50,800	**{Interviewer: Is it also due to the natural Hazard as well. Yes that's right}**
253	00:15:54,560	**And now when in between the rain and storm came everyone left. All are staying for rent.**
254	00:15:58,800	**Now from the Sarkar (Government) house is built there, only the one's who has went there.**
255	00:16:03,239	**The ones who has lost completely. Only for them the houses are built, hearing that.**
256	00:16:06,760	**Half - three fourth of the people here left out of fear. Only we are left here. In reality.**
257	00:16:11,600	**Then down the valley, there is one Geetha Nair. Only they are there, nowhere to go..!**
258	00:16:17,800	**And when we talk about the rent, it is very high rent.**
259	00:16:21,239	**High rent in the sense - 6000, 8000, and first we have to give an amount.**
260	00:16:25,560	**Like that in every month they should be given the rent.**
261	00:16:28,640	**That in this time when there is no job...! How we can pay the rent.**
262	00:16:32,760	**{Interviewer: Is the relocation being done in the same place..?} Yes, All that are part of it...! There here only the blast happened.**

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Table A.1 – continued from previous page

No.	Timestamp	Forensic Transcript / Translation (cont.)
263	00:16:37,199	**There beyond this! Beyond that hill.**
264	00:16:40,199	**Through there..! With heavy sound. Heavy sound that scared us all..!**
265	00:16:45,520	**That time we all went there.**
266	00:16:48,640	**3-4 ambulance came and and we get in that and somehow reached the camp.**
267	00:16:53,239	**This all were shaking.. all of these places where shaking heavily....! Then that smell of the soil.**
268	00:17:01,000	**This and that and it was all a messed up situation.... howling and calling and crying ...and all.**
269	00:17:07,600	**It was a mess (chaos).**
270	00:17:09,720	**For 16 days there was no peace!**
271	00:17:13,279	**We can't eat food or anything,**
272	00:17:16,600	**In between that our puppies and kittens.**
273	00:17:20,159	**These all together. That on the other hand.**
274	00:17:23,319	**Then that H&H people came and they came and helped us.**
275	00:17:28,399	**They came each days in this 16 days period and gave food to these kittens in the neighbourhood.**
276	00:17:34,760	**Morning they will take us and come. Medicines for the Dogs.**
277	00:17:39,359	**Like that the injection....**
278	00:17:42,600	**They are the ones who helped H&H India, they told they are at Kochi.**

Transcript Part II: Socio-Economic Vulnerability & Anthropogenic Drivers

Forensic Context: The PAR (Pressure and Release) Index This section of the interview transitions from the immediate disaster event to the underlying **Progression of Vulnerability**. It provides primary evidentiary support for the **Pressure and Release (PAR) Model** discussed in Chapter 4.

The dialogue covers:

- **[VULN] Economic Fragility:** Loss of livelihood assets (sewing machines) and delay in government aid.
- **[ANTH] Anthropogenic Triggers:** Eyewitness testimony regarding unscientific **resort construction** (deep piling/boring) disrupting soil cohesion.
- **[RES] Resource Scarcity:** Collapse of water infrastructure due to wildlife conflict.

No.	Timestamp	Forensic Transcript / Translation (Part II)
1	01:00:04	**Come come ...**
2	01:00:14	**should we we turn oneby one**
3	01:00:16	**we will talk from there right..?**
4	01:00:19	**my daughter ..!**
5	01:00:22	**she is "fasion design"**
6	01:00:25	**She will stitch anything.. Untill now from sarkar (government)**
7	01:00:29	**[VULN] Other than everyone coming and writing things down, we haven't even recieved a machine**
8	01:00:33	**She studied privately, everything in this is stiched by her.**
9	01:00:37	**Stiching these ..„,,a machine or anything has been done for us....**
10	01:00:43	**people will come and they will write it down and go.!**
11	01:00:46	**"you will get.... you will get...you will get ..." tellig this , nothing has, we've been recieved.**
12	01:00:50	**for each page each ...she is stiching ..!**
13	01:00:55	**she knows everything of this...**

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Table A.2 – continued from previous page

No.	Timestamp	Forensic Transcript / Translation (cont.)
14	01:00:57	**TIll then, we dont have that machine...**
15	01:01:01	**If we get a stitching machine...it would have been a great favor.**
16	01:01:04	**for the girl**
17	01:01:12	**she stitches all these , she knows all the things , she nokws how to stitch "Udupp" (little children's dress)**
18	01:01:16	**Fashion designing, she draws well...**
19	01:01:19	**nothing we have recieved till now. "good dresses " ,dresses for the children..**
20	01:01:25	**she puts design for my wife..! she will stitch nighty(women's night dress)..**
21	01:01:29	**only thing is that we don't have a machine..!**
22	01:01:32	**one by one like this...will stitch "shimmees" little girl's dress.**
23	01:01:35	**then blouse , blouse of my wife.**
24	01:01:39	**all these she will do...**
25	01:01:45	**after writing an application at the office we haven't recieved even one thing.**
26	01:02:02	**There is another also..!**
27	01:02:04	**course is there but untill now, no one has called.**
28	01:02:10	**but if we get a machine here it would be good.**
29	01:02:13	**We can stich from here itself ,for the neighbours also**
30	01:02:17	**Ambedkar colony, 18 families, 7 acres of land.**
31	01:02:22	**Nilambur ITP bought us this, for each family 45 cent of land and...**
32	01:02:27	**in htis 45 cent land there is a home also..**
33	01:02:30	**so, we are 70...,74 people..**
34	01:02:34	**26 women, 25 women and 23 childrens are there,us.**

Continued on next page...

Table A.2 – continued from previous page

No.	Timestamp	Forensic Transcript / Translation (cont.)
35	01:02:39	**here when the rain and storm comes are what we are afraid , here since blast(landslide), this and that happens.**
36	01:02:46	**we altogether go and stay at a place ,"Kammittallo"or somwhere we go and stay , and**
37	01:02:52	**we, what we will do..? if some one comes in office or**
38	01:02:55	**if someone come ,to a camp or somewhere we will go.**
39	01:02:59	**we do like that ..huh...**
40	01:03:01	**[VULN] Untill now, form sarkar , the kit they promised we haven't recieved yet.**
41	01:03:06	**The 9000 INR we haven't recieved yet...**
42	01:03:10	**10000 INR we haven't recieved...**
43	01:03:12	**Like that only they "says"**
44	01:03:15	**now our village is changed from chooralmala**
45	01:03:18	**were in vellaramala school, we where near "Unni sir" we all! and**
46	01:03:21	**this lads all studied , now school is changed to meppadi.**
47	01:03:25	**high school is gone from here...it went to meppadi...**
48	01:03:28	**village went to 300, it is like that now**
49	01:03:31	**we , without leaving .... for us ...no facilities are available...**
50	01:03:35	**full, complete..for scanning and all..vythiri or there we have to go.**
51	01:03:40	**to see the village authority we have to go to "300"**
52	01:03:43	**for school we have to meppadi...like that it is very difficult...**
53	01:03:47	**[RES] we ..staying now...then we don't have drinking water..! utill now..**
54	01:03:52	**all the political party members will come and say..! they will make water for us**

Continued on next page...

Table A.2 – continued from previous page

No.	Timestamp	Forensic Transcript / Translation (cont.)
55	01:03:57	**in the past there was pipe line , that broken by elephant .**
56	01:04:00	**spoiled everything. everything is gone.**
57	01:04:02	**now we don't have water...! if it is rainy season, then in hte rainy season**
58	01:04:07	**in the estate garden there is a pipeline..**
59	01:04:10	**through this pipeline is how we ,take the water for now.**
60	01:04:14	**If they tell that they wont give..We..!**
61	01:04:17	**for everyone we take water in a bucket and bring it home....to the anganvadi there is no water...**
62	01:04:24	**none of us have water...for us nothing like ...the things are not there..! and exept ration shop , all other things have changed..**
63	01:04:30	**then in this blast , the hill blast, many of our friends are gone.**
64	01:04:36	**"pradeesh" them and these folks...! "Naseer"**
65	01:04:39	**all, ..all the people who helped us...! many of them are gone..! "chand brother"**
66	01:04:43	**for them , the people who had put stores and all there.**
67	01:04:46	**many people has gone.....all of them died.**
68	01:04:49	**many of them were caught at "nilambur", in this and all , got ..(80 km far away village"**
69	01:04:52	**after going..., "soochippaara" (water falls)**
70	01:04:56	**then my place collapsed everything below...**
71	01:04:59	**the mud ,stones and everything came and left like that there..**
72	01:05:03	**in the land , untill now for that land we haven't recieved any money. other than Jhon and "matthayi" put there some stone...!**
73	01:05:09	**there is nothing of that land ... and untill now we haven't recieved cash as well...**

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Table A.2 – continued from previous page

No.	Timestamp	Forensic Transcript / Translation (cont.)
74	01:05:12	**form the agriculture office also its like that. we all went there and this ... had written and gave ..!**
75	01:05:17	**corrieander , coffee nad coconut sapling . areca...for going for all of these we haven't recieved any cash..**
76	01:05:25	**just 7500 INR .....was priced for that**
77	01:05:30	**that we haven't recieved till now**
78	01:05:32	**that is how we like this here , going through hardships...**
79	01:05:35	**Then for me its , three girls, i got one married after thee 10th, now two more are remaining.**
80	01:05:42	**so , me giving land and all...land is with "title deed" and "Tax", bought at the time of the grandfather...**
81	01:05:50	**we bought it with money itself. from a preson named "KC muthalali" (Capitalist KC), was bought with money**
82	01:05:55	**During that time it was less value for a cent,there is about 10-40 cents of land...in that ,ia had thought of selling 10 cents and marry...**
83	01:06:03	**now it won't happen also here, now the mud and dirt have come over and its lying over there...**
84	01:06:09	**so it is like that how ours situations are..**
[gray]0.95[**Topic: Forensic Evidence of Anthropogenic Triggers**]		
85	01:06:14	**[Interviewer]: you told earlier ,about the construction works of resort and all...**
85	01:06:19	**[ANTH] Interviewee: yes when we talk about the resort...**
86	01:06:20	**[ANTH] that they break the rocks and all, then the beams are put down...**
87	01:06:24	**[ANTH] with the lintel and all..beam is going inside the mud,**
88	01:06:28	**[ANTH] when this is put down..that makes a complaint for the soil.**

Continued on next page...

Table A.2 – continued from previous page

No.	Timestamp	Forensic Transcript / Translation (cont.)
89	01:06:31	**[ANTH] it deep below with machine and bore well and everything**
90	01:06:35	**[ANTH] all these goes inside that itself...so the earth gets cold and cold ...**
91	01:06:40	**[ANTH] this is collapsing .water going inside! in the mud!**
92	01:06:43	**[ANTH] the water from the rain goes inside , it is collapsing is the matter.**
93	01:06:47	**[ANTH] this , nowadays is the biggest problem, at the top of hill and all,are these being built.**
94	01:06:53	**[ANTH] like that if we were in that other place an all, we could hear blasting sound, on the top of huge cliffs and huge hills ...**
95	01:06:58	**[ANTH] they are building this, that is the reason why all these happens.!**
96	01:07:02	**[ANTH] now if see near the blast ("chooralmala landslides") there are resorts... intesively.**
97	01:07:05	**so all theese are the things that are happening**
98	01:07:08	**then cutting of the trees, trees... [Interviewer: as a part of this (resort constructions) right..?**
99	01:07:11	**yes, so anyways , in the where it has collapsed. as soon as possible,, plants are planted and grown only this will stay longer...**
100	01:07:17	**other wise it will be completely lost...**
101	01:07:18	**if we keep collapsed places like that itself , it will be gone !**
102	01:07:21	**other wise some plants ..some tree saplings should be grown there..**
103	01:07:26	**Yeah for agriculture, we do ginger, now nothing is there.!**
104	01:07:30	**coffee , pepper, tamirind, all the crops like this we does...**

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Table A.2 – continued from previous page

No.	Timestamp	Forensic Transcript / Translation (cont.)
105	01:07:35	**but now nothing is there, now this collapsed and all, and now nothing is there, last year and all we did...**
106	01:07:40	**with this ginger pulses and other things..!**
107	01:07:44	**then every one goes (****) this and that .**
108	01:07:47	**that evening it will be crowded. when they (****) go to hill and come**
109	01:07:51	**That evening it will be very crowded. [Interviewer: then will you get meat or something...?]**
110	01:07:55	**Ehh..? if we get meat and all.. that there this foxex might caught and thrown**
111	01:07:59	**now no one takes that .Now, what "poisen will enter" , "desease will be caught" being said, no body takes that now**
112	01:08:07	**it will be caught and put aside...in the past we used to eat that a lot..**
113	01:08:11	**while , father and mother was there...! now no one goes to the forest that much...**
114	01:08:15	**no some old people will go , but the childrens and kids usually won't go .... because of fear..!**
115	01:08:19	**TIger, elephant these all are there being said...**
116	01:08:23	**won't go , won't go alone**
117	01:08:26	**otherwise in groups we go.. altogether like that..**
118	01:08:29	**if we get forest meat , we usually. here ..we..like...!**
119	01:08:32	**here the fox and all, run and catch.**
120	01:08:36	**then it can be given in the shops...!**
121	01:08:39	**orelse all these we will pick it up and used to eat...**
122	01:08:42	**removing the bitten spot...! rest we make as meat and eat...**
123	01:08:47	**now its not there..!**

Continued on next page...

Table A.2 – continued from previous page

No.	**Timestamp**	**Forensic Transcript / Translation** (cont.)
124	01:08:49	**[Interviewer: now, it diffifult for water, you brother had said...!] [Interviewer: like that now, so do you do any alternative methods for that.]**
126	01:08:57	**no that we have written and given to the government**
127	01:09:00	**for water to be , recieved, the panchayat , now next election must come, last election...then..**
128	01:09:06	**our member, told drniking water , from the well here ,will be given putting a motor ...**
129	01:09:10	**untill now its not done...**
130	01:09:13	**then, its written and given to the chief minister. we had send a request letter.**
131	01:09:16	**untill now nothing has come ...! nothing has been passed.**
132	01:09:20	**without water no work is going on.**

End of Transcript Log: MVI_1532 (Part II)
Status: Verified Fieldwork Evidence

Appendix B

Forensic Visual Inventory

B.1 Digital Video Archive (Primary Field Data)

The following digital archive lists the raw video footage collected during the fieldwork. These files document the transect walks, ritual practices, and survivor testimonies.

B.2 Digital Video Archive (Primary Field Data)

The following digital archive lists the raw video footage collected during the fieldwork.

Category	File Series (ID)	Description of Content
Group A: Rituals & Culture	MVI_1508 – MVI_1513	Documentation of local shrines and 'Kavu' (Sacred Groves).
	MVI_1518 – MVI_1520	Recording of ritual offerings and community gatherings.
	MVI_1525 – MVI_1530	Interviews explaining the ecological significance of totemic worship.
Group B: Livelihood	MVI_1514 – MVI_1517	Documentation of daily agricultural labor and plantation life.
	MVI_1521 – MVI_1524	Interviews regarding economic dependence on cash crops.
	MVI_1531 – MVI_1533	Visuals of housing conditions ('Layams') and domestic resilience.
Group C: Disaster Narrative	MVI_1534	Primary interview: Pre-disaster context.

Category	**File Series (ID)**	**Description of Content**
	MVI_1536 – MVI_1537	**Critical Testimony:** Account of the "Chandappan" phenomenon and dog behavior (Bio-sentinels).
Group D: Transect Walk	MVI_1538 – MVI_1543	Geomorphological observation of the slope and river path.
	MVI_1546	Documentation of vegetation root structures (Thayu).
	MVI_1607	**Forensic Walk:** Post-disaster debris field and structural failure analysis.

Appendix C

Forensic Visual Inventory

Overview of Site Documentation

The following visual inventory compiles the primary photographic evidence collected during the field investigation in Chooralmala (August 2024). This comprehensive dataset (18 Plates) documents the geomorphological, structural, and socio-ecological dimensions of the event.

Figure B.1: Upstream view of the runout zone showing massive boulder deposition (> 2m diameter) in the paleo-channel.

Figure B.2: The widened river corridor post-event, illustrating the volume of mobilized debris.

Figure B.3: Structural displacement of a residential unit. Note the intact roof structure despite foundation failure.

Figure B.4: Catastrophic collapse of an unreinforced masonry wall, indicating the high-velocity impact force.

Figure B.5: Detail of ‘Brittle Failure’ in a reinforced concrete column. The rebar is exposed due to shear stress.

Figure B.6: Foundation scouring. The floodwaters eroded the soil matrix beneath the footing, leaving the structure suspended.

Figure B.7: Heavy sediment accumulation inside a semi-collapsed structure, reaching a depth of approx. 1.5 meters.

Figure B.8: Large granite boulders lodged against residential infrastructure, confirming the granular segregation of the flow.

Figure B.9: Contextual view of the slide margins. Note the surviving vegetation on the periphery compared to the central scour zone.

Figure B.10: Remains of a vernacular extension. Unlike the concrete main block, lighter materials were washed away but did not shatter.

Figure B.11: Post-disaster site clearing operations. The scale of the machinery provides a reference for the debris depth.

Figure B.12: Panoramic view of the affected valley, looking downstream from the initiation zone.

Figure B.13: Contextual landscape of the high-range catchment area, illustrating the steep gradients prone to rapid runoff.

Figure B.14: Atmospheric conditions in the upper reaches. The dense mist/fog highlights the visibility challenges for visual early warning.

Figure B.15: Community mobility patterns. Residents navigating the forest paths, highlighting the importance of pedestrian evacuation routes.

Figure B.16: Zoosemiotic Indicator. A domestic animal in the debris field, representative of the "Bio-sentinels" discussed in Chapter 4.

Figure B.17: Sacred Geography. A surviving shrine (Kavu) within the landscape, representing the intersection of faith and ecological conservation.

Figure B.18: The Human Dimension. An elderly resident and custodian of oral history, whose testimony provided key data on historical flood paths.

Figure B.19: Evidence of 'Dynamic Pressures' (PAR Model). A resident presents documentation of his daughter's livelihood. The struggle to validate this work highlights a lack of institutional safety nets, a key dynamic pressure leading to economic insecurity.

Figure B.20: Unrecognized Assets. The inventory book showing lost work materials. The absence of government assistance for these specific losses illustrates how macro-level policy gaps translate into local vulnerability.

Figure B.21: Indigenous Community Coherence. An intergenerational family group pictured at their settlement. The image captures a moment of communal peace, representing the intrinsic strength and happiness of the indigenous family unit within their environment.

Appendix D

Verbal Forensic Evidence: Site II (Full Transcript)

Transcript Log: VFE_Kurumbalakkotta_Unabridged

Overview: This appendix contains the complete,verbatim transcript of the field interview recorded at kurumbalakkotta hill of Western ghats.To assist forensic analysis, critical passages have been **higlighted in bold**.These highlighted sections corresponds to the following key research themes:

- **[HYD]Hydrology:** Indigenous knowledge of *"Orava"*
- **[SOIL]Soil Mechanics:** Observations on soil cohesion loss due to the chemical herbicides (**"Roundup"**).
- **[ANTH]Anthropogenic Factors:** community resistance to unscientific road construction and infrastructure.
- **[HIST]Social History:**Settlement timeline, political history, and housing evolution.

ID	Role
R1	Respondent 1 (Lady Resident)
R2	Respondent 2 (Male Elder, 77 yrs) - Key Informant
L1/L2	Local Neighbors / Facilitators

Time	**Speaker**	**Transcript Dialogue**
01:00:05	R1	Here everyone in this circle comes to relief camp at the school..!
	Intr.	Everyone....?
01:00:09	Elder 1	Them the ones we have seen that day, they are from another place near by.
	Elder 2	That is due to floods (not landslide).
01:00:13	R1	Then from the hill there in other part, they didn't come here. They went there itself.
01:00:18	R2	Then the colony people near the temple. They went to the school near the temple.
01:00:22	L1	Yes , i recall .
01:00:24	R2	Then , from our side also , it has come to effect childerns, that childrens have to study right...?
01:00:27	R	So we went to there ...to (sarva***).
01:00:31	R1	Here childrens have to study right..?
01:00:33	R1	So, we went there and stayed there for 2 weeks. (Rescue camp).
01:00:36	R2	Then to come back here no one there took responsibility, leaving from here.
01:00:39	R2	Then we with , with a vehicle and all, we brought them and dropped here.
01:00:43	Intr.	Sarkar helped you to go to and fro..?
	R1	Yes, all them (after the stay at the camp.)
01:00:47	L1	A jeep.
01:00:48	R1	They will take us, and bring us back.
	L1	Food and all ..?
01:00:52	R1	Food and all is there..
01:00:54	R1	That night / morning ,anytime food is there.
01:00:57	R1	But hunger was not there.
	L1	Food is there enough and more.!
01:01:01	R1	It will be there enough and more.
01:01:04	Intr.	How is the situation for drinking water,
	R2	Its there above..!
	R1	You saw it there right..?

Continued...

Table D.1 – continued from previous page

Time	**Speaker**	**Transcript Dialogue** (cont.)
	L1	Yes ...Yes...
01:01:11	R2	Yes ,from there the water will come to top.
01:01:14	R1	There is a tank Down the valley right ..? it is pumped to here to the top after filtering.
01:01:19	Intr.	There is no scarcity issues..?
	R2	No, no scarcity.
01:01:22	R2	This water even goes to the hills near by as well.
	L1	Is it ?
	R2	Oh..yes..!
01:01:26	R2	This same water goes to the Hills near by that side.
	R1	That side as well.
	R2	Then goes that side as well.
01:01:30	L1	Yeah the area all over here is from there right.?
	R1	Yeah like that itself.
01:01:33	Intr.	Do you know almost how many families gets from there..
01:01:37	R2	How do we now , how much supply goes from here..? that side itself there are 10-65 colonies. All there this water only goes.
01:01:45	L1	In our place , vellarammala town ...every where this only goes.
01:01:50	L	Through different programs like Jalanidhi, this only goes.
01:01:54	R1	Here almost everywhere this water.
01:01:58	R2	This is now 3 Panchayaths right?
01:02:03	R1	Panamaram Panchayath, then one kottakkara panchatath..
01:02:06	R1	Here all goes this water.
01:02:09	Intr.	Then any agricultural activities are done ?
01:02:13	R2	Here only these things are there.., this year is gone..
01:02:20	R1	These things are only there for us.!
01:02:24	R2	We now don't do that much now.[.some people from outside now, our george ettan (bro) and all....that's it the rest ..none...]
01:02:31	R1	Our childrens go to the "Thottam" garden.
	R2	Yesterday only the eldest came and went.
01:02:37	R2	You know that store at the muttil..

Continued...

Table D.1 – continued from previous page

Time	**Speaker**	**Transcript Dialogue** (cont.)
01:02:40	R	From there , all these bricks where lifted.1 brick.....
01:02:44	R2	**Then what we did? unable to lift ... each 10 metres made a person stand.,**
01:02:50	R1	**He will take and keep on my head , and me the next one**
01:02:55	R1	Like that we built all these..
	Intr.	From where ..? how much distance it was lifted like that...?
01:02:58	R2	**From here ? from here about ..500m,..minimum half a kilometre till here ... it has to be lifted and brought here...!**
01:03:07	R2	Yeah...
	R1	[we bought people for labour]
	R2	isn't that why it is not completed yet..?
01:03:11	R2	And money , money also got over right..?
01:03:13	R2	Otherwise i would have finished this..!
01:03:16	R2	Then when the daughter's house came there,topside.....,road was given. since it (road) was given that was completed.
01:03:21	R1	This was brought here , head lifted..! Yeah...!
01:03:25	R2	stell, cement , matel and all...
01:03:26	R1	even that with many people...I dont know how to "echu kettan"tie knot for the roof.
01:03:30	R1	brought some people for tieing the knot.
01:03:34	R1	that one day , full we lifted many bricks till here
	R2	300 or 400..bricks was there..
01:03:38	R2	there
	R1	They didn't lift fully
01:03:42	R2	**i think those are "hindikkaru" North Indians.. "Hindikkaru" came and then only they lifted and kept it there.**
01:03:46	R2	do you know what my expense was then?, 10 kg tapiocca and some "kandhari"
01:03:51	R2	yeah , That time they told this was only needed ...
01:03:55	R2	even that , our "ettayi" (friend) there arranged for us.
01:04:01	Intr.	people form bengal also helped right...?

Continued...

Table D.1 – continued from previous page

Time	**Speaker**	**Transcript Dialogue** (cont.)
	R2	yeah that day them...
	R1	went back clearing all those things.
01:04:05	R	we have no choice but to go down...
01:04:08	L1	we itself knows it when we see right..?
01:04:10	R2	Nothing needed , this goerge "Ettan's "(friend), this area right..?
01:04:15	R2	you know the george ettan?
	L1	I know , i know..
01:04:17	R2	there was this muvh water near his house.. this much water flowed there , because of this much force
01:04:23	R2	even with that water nothing happened..! it did not went down, other wise for the hill also nothing Touched..
01:04:28	R2	Nothing happened to the hill...!
	R1	too much water goes there ...
01:04:31	R2	yeah that road..if you go....
	R1	not here , there you came up right..?
01:04:36	R2	its too much water..
01:04:39	R1	lot of water drains there....!
	R2	**This orava "paleo channels " is going without being blocked is the reason why nothing is happening here...**
01:04:44	R2	**if the "orava" is stopped it will blast.**
01:04:47	R2	**there is no other way than blasting (landslide), it will blast**
	R1	now if its heavy rains. many (Orava) will start to flow.
01:04:52	R1	down
	L1	" orava"
	R2	because the "orava" is flowing that's why its not blasting here...!
01:04:55	R2	otherwise it will blast. anyways it will go..
01:05:00	Intr.	has the govenment authorities has seen these and understood about the "orava" ?
01:05:04	R2	that after they have reasearched only this "kurumbalakkotta" hills are safe they told right..? that is what is heard ..
01:05:12	R1	but now we can't say about this right.

Continued...

Table D.1 – continued from previous page

Time	**Speaker**	**Transcript Dialogue** (cont.)
	R2	these are like some sort of unpredictable right?
01:05:19	R2	**if orava is blocked there is no othwer way than to blast. It will blast**
	L1	doue to what reasons the "orava" be stopped ?
	R2	**block meaning, if there is a blockage for the rocks , it shall blast.**
01:05:30	R2	**Not for rock if , "orava" is got it will blast.**
01:05:33	L1	it wont stop right? it will go in its way . if there is a blockage of some rocks are there...
	R2	it will blast
01:05:47	R2	**It is because orava is there that's why nothing is happening to this hill**
01:05:50	R2	**this hill has orava on hte both sides..., that's why nothing is happening to the hill...**
01:05:53	R2	other wise there is no other way than to blast, it will blast..!
01:05:58	Intr.	so if we keep houses or something in between , will also be a problem right..?
	R2	If we are trapped in that death is sure... death itself...
	Intr.	if orava is blocked and some house constructions are made it will be problem right..?
01:06:12	L1	would we build a house , blocking the orava...? no right?
	R2	no.
01:06:15	L1	It is a problem for the whole hill right!
01:06:18	R1	it is problem for the hill itself.
01:06:20	R1	for instance , that road .. comes till here..!
01:06:23	R2	**tried construct it to hte top also... towards the point. , we went and blocked them.**
01:06:30	R2	**It was blocked because , that if JCB goes there , and digs... collapse , the hill will collapse.**
01:06:33	R2	**here, in all 4 sides of the hills there are people living. In case some thing happens, only a little is enough.**
01:06:43	R2	for that not to happen only . the road is only built till here only.

Continued...

Table D.1 – continued from previous page

Time	**Speaker**	**Transcript Dialogue** (cont.)
01:06:46	R2	that which ever panchayath party comes , the colony will protest.!
01:06:49	L1	Now , we came till here right..? from there till the top , its steps.
01:06:52	R2	so people tried to dig the road till the top. and that they stopped, here they have their families right..!
01:06:57	R2	there are many houses right..! for them, in doing anything ,if something harmful happens to the hill.
01:07:05	L2	it might break ... right..?
	R2	anyways , that there..... if we start to level there.
01:07:11	R2	**There is no other way than to blast for the hill...This side there is a slope that way there is a slope...**
01:07:17	R2	**all these 3 sides there is "orava" going down. the "orava" is going down on these 3 sides is the reason, the hill is standing.**
01:07:23	R2	otherwsie this hill will blast.!
	R1	like the "Kurishu mala" (mount of crosses)
	R2	yeah , go and see there at "kurishu mala"
01:07:29	R2	if you can climb.
	R1	it is very steep... steep!
01:07:34	R2	there is nothing to worry in that hill also ... because there are too many "orava"
01:07:40	R2	once stopped ... thats it ...!
01:07:43	R2	helpless other than to blast..!
01:07:46	R2	If the water is stopped , it will blast.!
01:07:49	L1	so that's how it is ...!
01:07:51	R2	that means , i know that much to study that time...!
01:07:55	R2	i have also studied extensively...!
01:07:58	R2	i have passed 5th standard in five years ,each year i passed classes one by one ...!
01:08:04	L1	that too in the 55's
	R2	in 1955..
01:08:07	R2	**now i'am 77 years old...! but still even today you all will need 4 sticks, to climb and walk. even today i will walk..!**
01:08:15	L1	Yes, that's right , i came here holding a stick...!

Continued...

Table D.1 – continued from previous page

Time	**Speaker**	**Transcript Dialogue** (cont.)
01:08:18	R2	**it is due to the food in the past , standing today also..! that time we never used to mix this poisen and eat...!**
01:08:29	R2	**there is 100-101 years old , old chap down there , but hhe died ...alright ... died...! he died in 101th year...**
01:08:33	Intr.	i think now there is only achuthatnathan and all there..now...!
01:08:39	R2	of that day...! its all because of the food that time...!
01:08:42	R2	nowadays you guys..!? ,77 like me..!? are dieing in 66,or 55..?
01:08:49	R2	but even still today i don't have any problems.
01:08:53	R2	then sometimes when this desease of pressure comes i will drink medicine....!
01:08:56	R2	When sugar and pressure comes ...! i will see doctor ..every month i will go and and show me...
01:09:01	Intr.	here they come for health chek up and all ?
01:09:05	R2	**yes will come for check up ... when they come what...! who is going to come here for check up... Steep....This steep...!**
01:09:12	R2	here our children are there...! ours son's childrens.
01:09:17	R2	you might know them..!
01:09:24	R2	they ... are working for them selves..
01:09:27	R2	**They ,in a sense they and education and all... but giving application nothing got passed...! Jobs and all they did'nt get...!**
01:09:36	R2	**Then they started doing agriculture..went for that...! now they are doing that ...!**
01:09:41	R2	with their own banana tree...! taking the land for lease...!
01:09:45	Intr.	in this kind of climates, are we doing any kind of climate adaptation..?
01:09:51	R2	There is no that kind of problems...! there is nooo problem ...!
01:09:56	R2	here in this rain..! There has been bigger storms and rain than this...! in 1987 or1986 ...that time here was some tapiocca and all...
01:10:06	R2	that time i didn't had her and all for me... right...! this land was not passed ..
01:10:09	R2	**it was that "pulpora" (hut with grass tied in the roof). That had all gone in the wind..!**

Continued...

Table D.1 – continued from previous page

Time	**Speaker**	**Transcript Dialogue** (cont.)
01:10:13	R2	That went in the wind in the old times itself...! then i went to the village and made... these
	R1	look ! that is my home..!
01:10:20	R2	brought the village officer here and all and showed the !
01:10:24	R2	**he was like that one, and he also passed the money..! so passed that money and then we built a "chetta pura" hut .**
01:10:32	R2	it is like that and all here..!
01:10:35	R2	In those times , if these kimd of storms and rains comes..! no body,no people will stay here..!
01:10:39	L1	They will go ..!
	R2	didn't everyone went down and left..!
01:10:42	R2	we are still here..! then i felt it will not be good if i stay here.
	R1	yeah this thing's(house's) construction is not over yet..
01:10:46	R2	It will not be right if we stay here..! "we go up after the storm and rain stops ..!"
01:10:50	R2	left straight to the other part .
	L1	this time thte rain came earlier for us right...?
01:10:54	R2	this time its laready early..!
	L1	lasr year was'nt it almost june..!
01:10:57	R2	no ..june was almost over...!
01:11:00	R2	it was june almost 10-15, hte heavy rain and storm started.!
01:11:03	R2	this time its earlly ...! [unpredictable climate..]
	R1	this time early.
01:11:07	L1	climate is not happening like what we imagine right..?
01:11:10	R2	that cannot be said right..?
01:11:13	R2	regarding this we can't say right..?
	R1	we can't say regarding this..
01:11:17	L1	when it comes we percieve it ..
	R1	yes..!
	R2	when it comes we percieve it!
01:11:19	R2	like this it will happen , we van make sure then!

Continued...

Table D.1 – continued from previous page

Time	**Speaker**	**Transcript Dialogue** (cont.)
01:11:21	R2	if its heavy storm and rain we shall go any way..
01:11:25	Intr.	was it old home ?, which home was better for you to stay .?
01:11:32	Intr.	you had a home with grass roof right , was that house more comfortable for you..?
01:11:38	R2	That was here only .
01:11:42	R2	For that i went to the panchayat .!
01:11:45	R2	There are small babies right? for that reason , people took us to the camp.
01:11:52	R1	there is house below your house. right?
01:11:54	R2	they were staying in a " chettapora" and even staying in there nothing happened to them.!
01:12:00	R1	we all went to the school. poeple come form there right?
01:12:05	R1	at 10 o clock people will come like that to watch this right..!
01:12:08	R1	then they will go ...!
	R2	that time the officials come , they will go away.
01:12:11	R1	then after this rain and storm goes they are still here..!
01:12:14	Intr.	this the government officials come here to inform , in a situation of heavy rain or storm right...?
01:12:22	R2	when they informs you know they will will og away.!
01:12:26	L1	they are lazy to go to the camp..
	R2	they hesitate to go to the camp.
01:12:29	R1	then the rain became less..1
01:12:33	R2	**EMS, AKG,(famous left political leaders of left democratic front in india)... i have gone for all their conferences and had talked to them.**
01:12:44	R2	for instance when "nayanar" died...we had gone there...!
01:12:50	R2	**you all might haven't seen EMS but i have gone to the "mana" (upper class house in kerala in the past.) of EMS.**
01:12:56	R2	at "chavakkadu" it was how i was now i've become like this..!
01:13:00	R2	its not that i don't know , everyone almost a little , i do know...
01:13:05	Intr.	what is the difficulty that you face here now...!
01:13:08	R2	the difficulty is only when this rain and storm...!

Continued...

Table D.1 – continued from previous page

Time	**Speaker**	**Transcript Dialogue** (cont.)
01:13:11	R2	other than that during the summer we dont have any no difficulties.!
	L1	no problem..! comfortable.!
	R2	comfortable!
	L1	water will be there for us..!
	R2	water for water..!
01:13:18	R1	water will be there anytime..!
	L1	that is great comfort .!
01:13:21	R2	when the rainy season comes..! like this everything...!
01:13:24	R2	if the heavy rain and storm comes..! pachayath takes us down..(to shelters)..
01:13:28	R2	then there is no choice other than to go right...! whatever they tell us...that;s it right..?
01:13:32	R2	so we will do as they say..!
01:13:35	Intr.	still now there is nothing , has come danger to house right..?
	R2	for house there has no issues happened till today..!
01:13:41	Intr.	weathter its storm..!
	R2	there is nothing to worry even of its storm as well..
01:13:45	R2	all those hit the wind and gone..!
01:13:50	R2	down there i have to go to kuttan and buy 6 kg cement*
01:13:55	L1	Did you bought the ration?
	R1	yes we have bought rice and all now are the difficulties yet to come.
01:13:59	R1	now is the difficulties..!
01:14:02	L1	there is no road right..?
	R2	not road, from there till here vehicle won't come..!
	R2	so from there we have to lift it till here.
	R1	"chettay's" car will come till here...
01:14:10	R2	it will come till the the shed.
	L1	from there how is it brought here?
	R2	from there we have to load it till here.
01:14:14	L1	oh, that is difficult in rain right.?

Continued...

Table D.1 – continued from previous page

Time	**Speaker**	**Transcript Dialogue** (cont.)
	R2	its in rain and its difficult as well..!
01:14:17	L1	it will come till here..?
	R2	in the summmer the will come here and unload everything.
01:14:22	R1	nest montht is the difficulty of bringing rice .
01:14:24	R2	this mont's is almost over!
	L1	this month's is bought right?
01:14:28	L1	now ofhte june's right..?
	R2	of the june's (ration rice)
01:14:33	R2	next month is not yet..! can we get it..?*
	L1	there is 5-6 days more.
01:14:41	R2	if it was me , this house wouldn't have been completed.
01:14:44	L1	now we have the courage right..?
	R2	even if storm and wind comes..!
01:14:48	R2	like that only the work did completed almost..! otherwise i would have finished..
01:14:52	R2	That not only my home , there is also many homes of all these people.
01:14:56	R1	form that side and all.
01:14:59	R2	there are many people like that .
01:15:01	Intr.	how was the old house built..?
	R2	wasn't that house a small one?
01:15:04	R2	**yeah , it will have almost this hieght.! if it is made too tall the , the wind will take it ..**
01:15:11	R2	**for that we make it smaller.., that's how we used to live..!**
01:15:14	R2	then until now nothing has happened..!
01:15:17	Intr.	that time also there was this storm and an..
	R2	that time's rain and storm..
01:15:21	R2	it was like tornado's
01:15:25	R2	it was heavy storms and rain..! that time here was some tappiocca and all.
01:15:29	R2	the house was already taken by the wind ! then tapiocca was there.. , tapiocca is none here at all none!

Continued...

Table D.1 – continued from previous page

Time	**Speaker**	**Transcript Dialogue** (cont.)
01:15:33	R2	it was all taken by the wind. all of it..
01:15:37	Intr.	so the house was changed due to the challenging winds right..?
	R2	yeah, with that we went to the panchayath "apeksha",
01:15:44	R2	3-4 times we, we had go and return, for this to get passed..!
01:15:48	R2	that's how this got passed..!
01:15:50	R2	begging to the panchayath member here nothing has , then i wnet there myself.!
01:15:54	R2	went there and asked the panchayath..!
01:16:00	R2	daughter's house and my house.
01:16:03	Intr.	so even though the fund was passed , we had to run for things to get done , ouselves right..?
01:16:07	R2	now, the current member's thing is better not to say.
01:16:11	R1	now there is no member right..!
01:16:15	R2	now she is not there..?
01:16:18	R1	then when it became morning, everyone came right ?, to take us down.!
01:16:22	L1	even there, in the one's those who had died , most of them where outsiders right..?
01:16:26	R2	more in number is them rright..!
	L1	our people somehow , in the night . (managed to suvive)
01:16:33	L1	then not just that ..when the "urul pottal" (landscape happens) wherever, there should be kept alarm , have been used to hear...
01:16:37	R2	untill now , in between the blast..! if some alarm is kept, it will be known
01:16:43	R2	that like when the alarm cries "we should go down " was there used to be rule..!
01:16:48	R2	with that untill today no one has come. it has'nt happened yet.!
01:16:52	R2	like in 3-4 hills , one in vellamunda hill, one here , one in chooral-mala...like that.
01:16:58	R2	different sarkars only says these..!
01:17:02	R2	but did you feel that , there how they went to the forest..?
01:17:06	R2	that how it was ,who could know.!

Continued...

Table D.1 – continued from previous page

Time	**Speaker**	**Transcript Dialogue** (cont.)
	L2	no , some kind of insticts will come right?
01:17:09	R2	instincts means , they will know ! that is not only that, the reason for the blast (Landslide), not like that it blasted..
01:17:18	R2	**this pestisides round ups are there right, when the round ups are hitted , in three consecutive years , the soil is comletely damaged.**
01:17:25	R2	**it will go inside, if rain comes , then it will , hit , collapse and goes off...**
01:17:29	R2	all of these are mostly that.
01:17:33	R2	you guys in this rain, if you do the smae here for a 3 years , hte situation is the same..! with this rain and storm.
01:17:40	L1	you where informed you told right.. where you informed in the night itself..the chooralmala's ?
01:17:44	R2	yes, that day night, for us we got to know in the morning..!
01:17:47	Intr.	people informed or , where you informed through phone..?
	L1	where informed through phone..?
01:17:53	R1	then from here, the people went and got to know, and passes the information.!
01:17:57	R1	They all goes right?
	R2	this is how many years ? year 55 or 56 , i'am now 77 years old. after coming here
01:18:05	R1	like almost in '86 we came her and settled,untill today , here anything like that, "here had happened."
01:18:11	R1	then all of us went down and left.! look ther that home..!
	R2	then you know what..!
01:18:15	L1	Fearin the monsoon..! yeah fear.!
	R1	all of us went down..!
01:18:19	R2	then all of htem from panchayath and all comes and tessl us right..!
01:18:21	R2	Then the police people came..! police took down many people.
01:18:26	R1	even then 2-3 chaps are still there..!
	R2	still some of them where here only.
01:18:29	L1	they did not go down..?

Continued...

Table D.1 – continued from previous page

Time	**Speaker**	**Transcript Dialogue** (cont.)
	R2	they did not go down.! they are here itself..
01:18:33	R2	when they come to shift , they will move before that..!
01:18:36	R1	then they...
	R2	they used to stay here itself all those days..!
01:18:39	L1	its our house only , we might have a courage...right..
	R2	then here..!
01:18:42	L1	after this rain and water goes., if the soil's thing is gone..!
	R2	yeah the soil.
01:18:45	R2	yeah that's how all these are happening..!
01:18:48	Intr.	that might also catalyses the landslifes..?
	R2	yeah all these itself..!thes soil being wsahed away and all these are only the reasons...!
01:18:57	R2	**this mud is like bran, it will become like bran , if round up is sprayed..!**
01:19:02	R2	**after the pesticides are sprayed , this mud right? becomes almost like bran..!**
01:19:06	R2	**when this has become like bran right, in the intense storm and rain ,will get pierced and washed away..! then it has become "Urul pottal"..**
01:19:12	R2	that's it nothing else
01:19:16	R2	**if it is sprayed in the tea plantations.! for 10 peoples job , now one is enough..(shortage of work)**
01:19:19	R2	to hit this and go..!
01:19:23	R2	see how many' people's work is it , should look at the profit..! when it is looked that way is how all these happens..!
01:19:26	L1	yes, yes..! so to reduce people, this...!
	R2	yah to reduce the labour only this round up is being sprayed right.! pestisides being sprayed..!
01:19:35	R2	**because of that what hapened , the plant is gone , below the plant its gone..!**
01:19:39	R2	**under the tree its gone..! all these will burn and go..**

Continued...

Table D.1 – continued from previous page

Time	**Speaker**	**Transcript Dialogue** (cont.)
01:19:42	R2	**how powerful is this pesticides..! you know! the mud will become bran..!**
01:19:48	R2	you in the same time go and watch at the place where round up is being sprayed..! go and watch..
01:19:51	R2	then you will know , even if you go slowly down steep in this rainy season.!
01:19:54	R2	it will go under the mud till here..!
01:19:56	Intr.	so from sarkar, naything has been done to overcome this ..?
	R2	**they are the ones who invented this medicine..! it is the government..!**
01:20:04	R2	so we this rain right ..! then what we did..!
01:20:07	R2	like this only the next will come !
01:20:11	R2	that in the sense , from now the collector came and said to us, you should not let them spray pesticides..!
01:20:16	R2	pesticides should not be let sprayed..!
01:20:19	R2	in that time , the bamboo or these kind of things shall be planted...!
01:20:22	L1	is that good? yes..! it will hold the soil ..!
01:20:27	R1	yeah they came and told that , this bamboo can be planted over all the sides..!
01:20:32	R2	here and there all we where told to plant bamboo..!
01:20:38	L2	bamboo will hold the soil right..?
	R2	it will hold the soil.
01:20:42	R1	that's why they came and said like that ..!
	R2	the collector came and told this ..!
01:20:47	Intr.	so that, anyone had followed it here .. the bamboo to hold the soil?
	R2	it's being planted through all there..!
01:20:56	L2	where on the way till here right?
	R1	near that house,*
	R2	there is no doubtin that ..!
01:21:02	R2	we cannot say that form the stand..!
01:21:05	R2	otherwise that balavady and all won't be there..

Continued...

Table D.1 – continued from previous page

Time	**Speaker**	**Transcript Dialogue** (cont.)
01:21:08	R2	it will slip and go..!
	L2	yeah that's right..
01:21:12	R2	to know regarding this exactly , hte whatsapp should come..! from whatsapp only we can know the thing about this...!
01:21:19	R2	if it comes in the summer nothing will be known.!!
01:21:22	L1	if we come in a time , while it is little more raining..
	R2	we should come at the time of rain..! to know which sides there is "orava" which sides its not there"
01:21:29	R2	that time only this blast happens..!
01:21:33	R2	if "orava" goes continuesly , nothing will happen to the hill..!
01:21:36	R2	if the "orava" is stopped the centre itself shall blast..!
01:21:40	R2	full fledged straight up..!
01:21:52	Intr.	incase we build a house in such a place .
	R2	only if we are careful we do this , otherwise we won't do this right..?
01:22:00	L2	may be there it was not considered could also be a reason.
	R2	there will be houses which might not have been careful about these...
01:22:03	R2	all these are the reasons for it..
01:22:07	R2	then the disaster happens.. not only that , these 5-8 years...!
01:22:10	R2	this round up is being sprayed.! its tea plantations right..!
01:22:14	R2	for tea plantations , this 10 people's work..! 1 this if sprayed...!
01:22:20	R2	if there is one who spraye's in the forest , just one person is needed.right...!
01:22:24	R2	for 10 people's work , only one is needed for sparaying all these...!
01:22:28	R2	so , what this soil has become , burned and become like barn..!
01:22:32	R2	thiis coffee's ,these tress's bottom right,? that's all gone..
01:22:35	R2	it will be burned adn gone..
01:22:39	R2	when these happen's is how these trees and all falls and are gone..!
01:22:42	R2	nothing other than that ..!
01:22:45	L2	they at first itself , cut and cleared..here it was full of bushes..!
01:22:49	L2	all these have been cut and cleared and like that , each one taking an agricultrue...!

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Table D.1 – continued from previous page

Time	**Speaker**	**Transcript Dialogue** (cont.)
01:22:53	L2	then they also some to help...we help each other , like one house itself..!
01:22:58	Intr.	are you guys family or...
	L2	no , we are neighbours..!
	L1	they are like living together here..!
01:23:03	L2	**i'am a christhian.**
	Intr.	that how did you came into chrithianity?..
01:23:10	L2	**we , we came form ' pulpally ' and alll...! we came up here and settled here...**
01:23:14	L2	**from here , not an "aadivasi" (indigenious member) and became a christhian.!**
01:23:17	L2	**we are christhians from the beginning...!**
01:23:22	L1	here came and settled right..?
	L2	their people became "bandicose" later..!
	Intr.	ancestor's?
01:23:30	R2	**to be honest , in at that time when we came here , there was not even a fly. only monkeys where there .!**
	L2	while they where here..!
	Intr.	while you came here there was only one "kudi" you are saying..!
01:23:43	R1	**we are the first ones who came and settled here..! we cut this forest and brought lilght !**
	L2	the father of kunjiraman right..?
01:23:49	L1	ah, i know , i know , i know ...
	L2	its the father of kunjiraman, first brought.. ther like that...
01:23:53	R2	**we got the left over land..! 1 acre and 15 cents**
01:23:57	R2	so then.., this.at the other side ,people started to live crowded..!
01:24:02	R2	then we also thought..
	L2	you where at "veetikunnu" before right..?
01:24:06	R2	then i thought, now we shall change the place ...!
01:24:11	R2	like that we shifted to here and settled here..!
	L2	then our childrens and all followed tto htis circle

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Time	**Speaker**	**Transcript Dialogue** (cont.)
01:24:16	R2	then there is no own well right? there is an "oori"near your place right?
	L2	yes.
	R2	the water in that ;oori'
01:24:21	R2	people at the night , without sleeping will go with an utensil to there..
01:24:26	L2	there used to be a lot of people.
01:24:30	L2	there is a person names 'soman' in paper right..when he became , so many people came here.
01:24:34	L2	that time we had not came up...!
	L1	so after that you came...
	L2	we came long after that...
01:24:38	R1	we came first, followed by soman, after him... many people came..!
01:24:48	L2	a long after kannan, came only i came here...!
01:24:51	R2	a lot of people from 'pulpally' had come up here.
01:24:55	L2	**after tehy went down due to the storms went down, came us.!**
01:25:00	R2	there where so many people who went down because there were no drinking water...!
01:25:03	R2	now its like , there is an 'oori ' near her place and i myself dug a well here..!
01:25:09	R2	when water was found in that well all of them came here..!
01:25:13	R2	that water only...that got spoiled due to the wastes being dumped in it by the tourists coming to see the hill...spoiled it ..
01:25:19	L2	not waste, htey wash their feet and all in that..waste have'nt been dumbed..!
01:25:26	R2	not that well but this well..
	L2	oh this well..!the other well its because feet is washed outside..
01:25:30	L2	now we have our own , well water.
01:25:33	Intr.	what did they told..
	R2	they didn't say anything.
01:25:37	R2	it was told that the road should come up that was told..!
01:25:42	Intr.	so di they do this without studying about this

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Time	**Speaker**	**Transcript Dialogue** (cont.)
01:25:44	R2	they di nothing..! they jus t dug the soil and made hte road
01:25:48	R2	we had also co-operated with them...! we also need the road.
01:25:53	R2	if the road is being built till here
	L2	if its built till here its good right..?
01:25:57	R2	if we dig and make a road till The point..!, there it will be completely levelled...
01:26:05	R2	once its levelled , what happens..? danger comes ..!
01:26:09	R2	it will collapse..!
01:26:13	R2	the mud will slip and leave..like that! only because there are these rocks..!
01:26:17	R2	**there is a :karadikuzhi" right ..! , the amount of water that goes to the karadikuzhi you go and see now..**
01:26:23	Intr.	so you told the government this..?
01:26:28	R2	whithout telling the matter it won't be okay right..!
01:26:32	R2	there is no other way than to tell them the matter right?
01:26:36	R2	**once digged , if hte 4 sides the hill blasts, there are people liveing over there all the sides!**
01:26:41	Intr.	so when you told them what did they say..?
	R2	they did not object anything..they told it might be right and then they left.!
01:26:46	L1	we know better than them..right
01:26:49	R2	now there a palm has been cut and some water was seen..! the palm was cut and , rotten
01:26:54	R2	in that part little water stayed...!,everyone was saying it will blast and there where accusations ...when we all went where it was just some water in the cut palm tree.
01:27:05	R2	there cacophony telling water will burst and all..! so we went there and checked but ther was nothing...!
01:27:11	R2	in the cut part there..! inside was rotten.
01:27:15	R2	water settled inside..! the rain water stayed inside.telling that is 'orava'..blasted.. and this accusation raised.
01:27:21	R2	so when we all went there and checked there was nothing.

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Table D.1 – continued from previous page

Time	**Speaker**	**Transcript Dialogue** (cont.)
	L2	they know ..when they see they know..!
	R2	we know regarding this ..right..! we know when we see..!
01:27:28	R1	didn't you see, down there...?
	L2	yes..aah
01:27:30	R2	then they all sat together..!
01:27:34	R2	and now you know what..? i think its been 3 years right..? there as there was nothing now?
	L2	yes after it became very less
01:27:39	R2	it is full of rocks..! that's why its staying like that..! other wise you know..
01:27:44		there is the hill...!