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Wayanad landslides: When nature rewrote the map

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Wayanad's Mundakkai village, or what was left of it, days after the landslide in the region. | Photo Credit: Jino Jose P.

The devastating landslides that wiped out two villages show that climate change is here to stay and the need for adaptation is clear and present.

“This was Mundakkai,” murmurs a rescue volunteer, pointing towards his right. From where we stand, atop a destroyed house, the view is frightening. A huge expanse of land lies in front of a tall mountain, the earth raw and wounded, like a vast, long scar. The soil is a muddy palette—ochre, russet, and umber mashed up by nature’s rough hand. The terrain is chaos itself—churned and pitted, studded with rocks torn from sleep. Ripped open, the land’s guts spilling over for all to see, and a newly enlarged river gleaming like fresh gashes as a bunch of excavators claw deep, leaving grooves and furrows that snake across the site.

This *is* Mundakkai, a small, serene village in Kerala's Wayanad district that, along with the nearby villages of Punjirimattom, Chooralmala, and Attamala, was ravaged by three consecutive landslides in the wee hours of July 30, 2024. Heavy rains triggered the landslides whose source was later discovered to be at Punjirimattam. In the 48 hours leading up to the morning of July 30, the Mundakkai region saw a staggering 572 mm of rainfall. Hillsides collapsed as a result, sending a torrent of mud, water, and boulders crashing down. The debris flowed into the affected areas below the mountains, which lay as much as 5-6 km away from the source of the landslide. At least 250 people died in the natural calamity. Unofficial estimates put the death toll at over 400 as there were more than a hundred people yet to be found and several body parts yet to be identified when this writer visited the site.

Kerala woke up to a panic-hit morning on July 30 as news channels started airing shocking stories of hundreds of people trapped in the mud and even more missing or already presumed dead. Mundakkai was isolated for hours as the sole bridge that connected the village to nearby Chooralmala and the rest of the world was destroyed in the landslide that had set off a fresh, furious river stream. The “new” river of debris gobbled up everything that stood in its way, including the Vellarmala Government Vocational Higher Secondary School (GVHSS) in Chooralmala.



Remains of human habitations in Mundakkai village. | Photo Credit: Jinoy Jose P.

It was a frantic SOS call from Neethu Jojo, an executive at the Wayanad Institute of Medical Sciences (WIMS) in Meppadi, that first alerted the authorities of the massive landslide around 1:30 am. “Our houses are flooded. There has been a landslide. We won’t survive if another one breaks. Please save us,” Neethu could be heard pleading with WIMS personnel in a widely televised audio clip that went viral following the disaster.

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Rescue workers recovered Neethu's dead body on August 3. By then the astonishing magnitude of the catastrophe, one of Kerala's largest and most impactful natural calamities, had unravelled through media reports, social media posts, and the urgent testimonies of survivors.

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Vellarmala GVHSS alone lost 32 students. The teachers said 22 bodies were recovered and 10 were still missing. "We are yet to come to terms with the shock. This was a beautiful school, and a peaceful village populated with such lovely people and their children. One night of natural fury wiped out all the happiness we had amassed over the years," Unnikrishnan, the school's headmaster, told *Frontline*. "I don't know how I will face my children when they ask about their friends."

How it happened and what can be done to prevent such calamities

In the 48 hours leading up to the morning of July 30, the Mundakkai region in Kerala's Wayanad district saw a staggering 572 mm of rainfall. Hillsides collapsed as a result, sending a torrent of mud, water, and boulders crashing down.

At least 250 people died in the landslide. Unofficial estimates put the death toll as scores remained missing a week after the calamity. An estimated 5,000 people are affected.

The tragedy has triggered a debate around the way climate change impacts have been ravaging Kerala in particular and the Western Ghats in general. A focal point is the report of the Western Ghats Ecology Expert Panel, popularly known as the Gadgil committee report.

But the government faces criticism for not doing enough on climate mitigation and adaptation measures, especially the way it treated the Gadgil report.

The report proposed stricter regulation of development activities in these zones, including restrictions on building and infrastructure development.

Another committee, headed by K. Kasturirangan, was formed to examine the report and suggest a way forward as the proposal to curb development activities was found problematic.

Climate change is turning costly for Kerala in terms of human lives and economic loss. The 2018 floods alone cost the State over Rs.40,000 crore.

Fast-tracking climate adaptation and mitigation efforts is, therefore, crucial, and early warning systems are thought to be crucial to such efforts.

Entire families have been washed away, and there are many families with only one person left alive. Bodies and body parts were being unearthed throughout the week following the disaster, and the search and rescue operations continued as the magazine went to press. More than 200 bodies were recovered from the Chaliyar river in the low-lying areas of Pothukallu in the nearby Malappuram district, which lies on the other side of the mountains. The Chaliyar flows 30-40 km away from Mundakkai and Chooralmala.



The mosque in the background was spared to an extent but not much around it. The giant rock, yet to be cleared away by rehabilitation teams, stands silent testimony to nature's fury. | Photo Credit: Jinoy Jose P.

An estimated 5,000 people are affected. Even that is a ballpark. Mundakkai alone is home to more than 1,200 people, including 200 children, in more than 400 houses. Chooralmala had over 2,100 people. The Kerala government has not finalised an estimate of loss to property and human lives yet, but Revenue Minister K. Rajan says that the region is roughly estimated to have incurred a loss of Rs.1,200 crore. The State government has asked for an assistance of Rs.2,000 crore from the Centre.

Brilliantly coordinated and swift rescue effort

The Wayanad landslides witnessed one of the most dedicated, swift, and brilliantly coordinated rescue operations in the history of the State. The rescue efforts were anchored on the strategic planning and execution capabilities of the Army, ably aided by the State forces and a Cabinet subcommittee that was constituted by Chief Minister Pinarayi Vijayan. The ministerial panel to oversee the rehabilitation and resettlement efforts includes Revenue Minister K. Rajan, Public Works Minister P.A. Mohamed Riyas, Forests Minister A.K. Saseendran, and Welfare of Scheduled Castes, Scheduled Tribes and Backward Classes Minister O.R. Kelu. S. Sambasiva Rao, a senior IAS officer, is supervising crisis management operations along with District Collector Meghashree DR. A total of

about 700 Army men, State police personnel, fire and rescue department personnel and forest officials, members of the National Disaster Response Force (NDRF), the State Disaster Response Force (SDRF), and local volunteers are engaged in the massive rescue effort.

The Army response was swift. On August 1, two days after the landslides, the Madras Engineering Group of the Army was able to build a 190-ft-long Bailey bridge, linking Mundakkai and Chooralmala to the rest of the world. But even before the Central forces came onto the scene, the Kerala State Fire and Rescue Services personnel were able to create a temporary bridge with an extendable ladder which helped them rescue those who were trapped across the bridge in Mundakkai, bringing down the overall casualties significantly.

Chief Minister talks about climate change, but Gadgil report was ignored

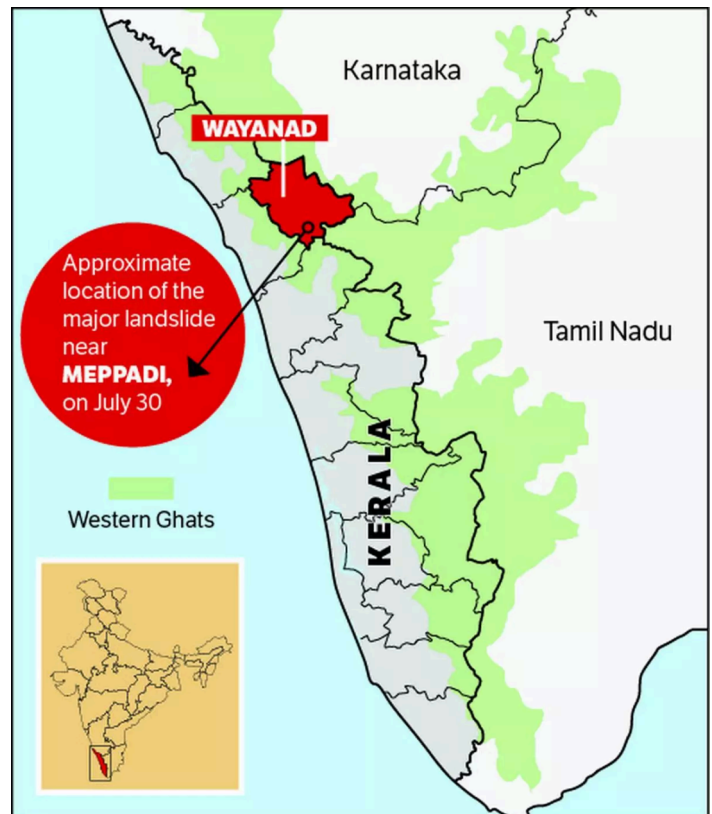
The tragedy has once again triggered an intense debate around the way climate change impacts have been ravaging Kerala in particular and the Western Ghats in general. A focal point is the Western Ghats Ecology Expert Panel; the WGEEP report is more popularly known as the Gadgil Committee report.

Chief Minister Pinarayi Vijayan, in his evening press meet following the tragedy, stressed Kerala's vulnerability to changes triggered by global warming and climate change. He highlighted this again when Prime Minister Narendra Modi visited Wayanad on August 10. Kerala's Leader of Opposition V.D. Satheesan also said the landslides in Wayanad and adjoining Kozhikode district showed that "climate change can no longer be ignored".

But the Kerala government faces criticism for not doing enough on climate mitigation and adaptation measures, especially the way it treated the Gadgil report that was submitted in 2011 by a panel headed by the renowned ecologist **Madhav Gadgil**.

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It had recommended that 64 per cent of the Western Ghats be declared an Ecologically Sensitive Area with varying degrees of protection. Gadgil suggested a ban on mining, quarrying, and sand mining in sensitive areas. The report proposed stricter regulation of development activities in these zones, including restrictions on building and infrastructure development. Many governments, including



Kerala's, and local communities opposed the report, citing concerns about its impact on development and livelihoods. Another committee, headed by K. Kasturirangan, was formed to examine the report and suggest a way forward.

After the July 30 landslide, Gadgil told the media that the disaster could have been avoided if the recommendations of his report were implemented. He noted that development activities and construction of resorts had taken place in the sensitive and extremely sensitive regions of the Western Ghats, and these have been triggering landslides. "Such activities should be prohibited," he noted, calling the tragedy "man-made".

Several studies have confirmed Kerala's susceptibility to climate change. As recently as August 14, a study by the World Weather Attribution, a reputed international research group that tracks how climate change triggers extreme weather events, linked human-induced climate change to the Wayanad landslides. Researchers from India, Sweden, the US, and the UK collaborated on this assessment, which found that extreme rainfall events triggering such landslides have become more intense due to global warming.

The study showed that heavy one-day rainfall events in the region have increased in intensity by about 17 per cent over the past 45 years. "The

Madhav Gadgil, who chaired the Western Ghats Ecology Expert Panel. | Photo Credit: LEJU KAMAL

Wayanad landslides are another catastrophic example of climate change playing out in real time," says Mariam Zachariah, a researcher at the Grantham Institute—Climate Change and the Environment, Imperial College London, and one of the authors of the study. Climate models indicate a 10 per cent increase in rainfall intensity attributable to human-caused climate change, the study says.

"In today's climate, which is 1.3°C warmer than pre-industrial levels, an event of this magnitude is expected about once every 50 years," the report states. The researchers warn that future warming can lead to even more extreme rainfall events. The report also highlights how land-use changes may have exacerbated the disaster. A 62 per cent reduction in forest cover and increased quarrying have likely made the slopes more susceptible to landslides. The Ministry of Earth Sciences said in the Lok Sabha that between 2014 and 2020, over 60 per cent of the 3,656 landslides that occurred in the country were in Kerala.

A one-size-fits-all approach may not work

But many fear that a one-size-fits-all approach may not work in tackling climate change and such extreme climatic events. “There’s a narrative being pushed that puts the blame entirely on human activity, specifically things like road-building, houses, and agricultural activity, for disasters like landslides,” says T. Jayaraman, Senior Fellow, Climate Change, M.S. Swaminathan Research Foundation. “While this might be true in some cases, it is not always accurate. The recent landslide broke out in an area some distance away from human interference. The landslide’s location and the way it occurred highlight the terrain’s susceptibility.”

An aerial picture of tea plantations in Wayanad after the landslide. | Photo Credit: Humane Society International, India/Handout/AFP

Jayaraman says this points to the need for a comprehensive landslide monitoring and early warning system. Even a short warning time could be crucial. (Parliament discussed the Wayanad landslide, with Home Minister Amit Shah claiming early warnings were issued. But a closer examination of

IMD data shows that warnings were not specific or timely enough to prevent the tragedy.) While some are dismissive of such systems, the rainfall levels preceding the landslide suggest that even a brief warning could make a difference, he notes, adding that the focus of our efforts should include paying adequate attention to engineering solutions and early warning systems, empowering local communities to take action. A 2019 report commissioned by the Kerala State Planning Board addressed flooding and landslides and could serve as a foundation for further action, recalls Jayaraman.

“We need long-term solutions to such a crisis,” says Sekhar Lukose Kuriakose, who is the Member Secretary (ex officio) of the Kerala State Disaster Management Authority (KSDMA). “The baseline is land use,” explains Kuriakose. “In 1984, a similar landslide hit the same area, and the debris flow reached Chooralmala, but the human casualty was far less, about 14 people, because habitation was sparse and the land-use pattern was different.”

Given Kerala’s high-density population, disaster preparedness, political response, and reception by people should all be in sync with the ground realities, and these measures should be done in a democratic way, in coordination with all parties concerned, policymakers, scientists, civil society, and other stakeholders, notes Kuriakose. “It’s not an easy battle.”

Mundakkai and Chooralmala: Villages ravaged in the Wayanad landslides

Mundakkai and Chooralmala are beautiful, small villages located in Meppadi panchayat in North Kerala’s Wayanad district. Meppadi is known for its hilly terrain and agricultural land, most of which belongs to Harrison’s Malayalam Limited (HML) tea plantations. Mundakkai borders Kozhikode and Malappuram districts. Beyond the tall mountains that border the area lie the famed Nilambur forests and the Chaliyar river.

The area has a tropical climate. These villages are primarily agricultural communities. Many residents work as farmers or plantation workers. Common crops include coffee, tea, pepper, and various spices. Some families also engage in small-scale livestock rearing. The villages have a mix of traditional and modern housing. Many homes are built on or near hillsides. There are basic roads, small shops, and a few community buildings. Healthcare and education facilities are likely limited.

The population is predominantly rural, with many residents having lived in the area for generations. The surrounding landscape features dense vegetation, streams, and steep slopes. This terrain makes the area prone to landslides during heavy rains.

Climate change is turning out costly for Kerala in terms of human lives and economic loss. The 2018 floods alone cost the State over Rs.40,000 crore. Fast-tracking climate adaptation and mitigation efforts is, therefore, crucial. According to Kerala’s State Action Plan on Climate Change (2023-2030), the combined cost for both mitigation and adaptation efforts to combat climate change in Kerala is roughly over Rs.90,000 crore.

Given the challenge, prioritising engineering solutions, early warning systems, and adaptation strategies makes sense, say experts. “Wayanad highlights the importance of adaptation and the mistake of conflating mitigation with adaptation. Both have their place, but we need to focus on the immediate challenges at hand, which for India is overwhelmingly that of adaptation,” says Jayaraman.

“Climate adaptation strategies must incorporate early warning systems to enhance preparedness,” says Minu Treesa Abraham, a geotechnical research engineer with the Norwegian Geotechnical Institute, who hails from Kerala’s Kottayam district. “An effective early warning system comprises four key components: setting, modelling, warning, and response,” she says. Setting involves determining organisational structure, stakeholders, responsibilities, and hazard types. It guides the choice of monitoring methods, which may range from local sensors to satellite systems, depending on the type of landslides, and the area and assets to be protected. The warning stage establishes alert levels and notification protocols. The response mechanism outlines evacuation procedures, relocation plans, media engagement, and public awareness strategies. Successful implementation requires systematic coordination of all these elements, according to Minu.

Minu says Kerala can learn from the best practices adopted by landslide-prone countries such as Switzerland, Italy, Japan, and Norway. These are some of the geographies that have successfully implemented operational solutions in predicting landslides.

“When Pettimudi [Munnar] landslides happened in 2020, we were facing a shortage of rainfall data. But the situation is definitely improving, with strong efforts from KSDMA and other institutes. So things are changing,” says Minu, pointing towards the work private research agencies like the HUME Centre for Ecology and Wildlife Biology and the District Disaster Management Authority in Wayanad have done.

‘No one was able to predict the scale of the flow’

Established in 2005 and located in Kalpetta, HUME monitors rainfall patterns in Wayanad and adjoining areas. This time as well, they had shared the data with the authorities. “People who were living very close to the mountains were asked to leave the place or were evacuated, but no one was able to predict the scale of the flow. Nor were we able to forecast the drastic change in the river’s flow path,” says C.K. Vishnudas, HUME’s director. According to Vishnudas, the focus should be on early warning. “The primary triggering factor is climate change-induced changes in monsoon weather, which causes exceedingly heavy rainfall. Wayanad falls in this region, which sees what is technically called a mesoscale cloudburst.”

Warmer seas and cloudbursts

In recent years, meteorologists and climate scientists have observed an alarming increase in the frequency and intensity of cloudbursts in the regions surrounding the Arabian Sea. These extreme

weather events, characterised by sudden and intense rainfall, have been linked to the excess heating of the Arabian Sea's surface.

As global temperatures rise, the Arabian Sea absorbs more heat. This excess heating is particularly pronounced in the months leading up to the monsoon season. The warmer sea surface enhances evaporation, leading to a significant increase in moisture content in the lower atmosphere.

The warm, moisture-laden air rises rapidly through the atmosphere. As it ascends, it cools and condenses, forming towering cumulonimbus clouds that can reach heights of up to 15 km. In many cases, multiple cumulonimbus clouds organise into larger, more complex structures known as mesoscale convective systems. When these massive systems encounter topographic barriers, such as the Western Ghats, they can result in intense, localised rainfall, a phenomenon that is called a cloudburst.

While cloudbursts are not a new phenomenon, their increased frequency and intensity have been linked to climate change. As global temperatures continue to rise, the Arabian Sea is likely to experience more frequent periods of excess heating, potentially leading to more frequent and severe cloudburst events.

Understanding the connection between Arabian Sea heating and mesoscale cloudbursts is crucial for improving weather prediction models and developing effective disaster management strategies.

As we continue to grapple with the effects of climate change, ongoing research in this area will be vital for protecting vulnerable communities and mitigating the impact of these extreme weather events.

People in these regions stay in the valleys that lie between the mountains. The rest of the area is used for plantations (the tea gardens of RPSG Group's Harrison Malayalam Plantations occupy a major chunk of Mundakkai and Chooralmala), and the unused swamps are used for building shelters for workers. So, eventually, these swamps, which in a way form the drainage system of the mountains, become heavily populated. But this also means that the people here are not safe, says Vishnudas. In 2020, the same region saw an intense landslide event, but people were evacuated following alerts from HUME agencies. "We need to expect such events during the monsoons now," says Vishnudas.

His observations are corroborated by the fact that there was heavy rain in the Mundakkai-Chooralmala area and minor landslides were reported in the last week of July. People were aware that something was bound to happen. "But they were not clear or sure about how far the landslide debris would flow down or how powerful it would be," says K.K. Sahad, former president of Meppadi Panchayat. The same thing happened in the [Puthumala \(August 8, 2019\) landslide disaster](#). "But people were evacuated before the major event, thus saving precious lives," recalls Sahad. Recently, there was a landslide with a 3-km runout in the nearby Kurichiyarmala area, but the Forest Department was able to evacuate people. But that didn't happen in Mundakkai-Chooralmala because of many factors, including the absence of a proper forecast on the potential distance the debris would travel.

Chief Minister Pinarayi Vijayan with Narendra Modi at Kannur airport just before the Prime Minister left for Delhi after visiting the landslide-hit places on August 10. | Photo Credit: ANI

Geotechnical engineers like Minu point out that India did not have an operational early warning system for landslides until very recently. The National Landslide Forecasting Centre, set up by the Geological Survey of India, was launched only in July. The centre currently provides daily forecasts for Kalimpong, Darjeeling, and the Nilgiris. This is expected to be fully operational with coverage to other regions in a decade, with warnings issued via the “Bhooskhalan” app as well as the “Bhusanket” portal.

For local or site-specific warnings, sensor-based detection and early warning systems, like the prototype developed by IIT Indore for Kalimpong or Amrita University’s wireless sensor network system in Munnar, work better, despite their limitations. Experts say prediction models are indeed improving, but each model needs to be customised or tailored for the hydro-meteo-geological

conditions of the regions, and the type of landslides. “For instance, in the case of debris flows, we need to have a model that can calculate the runout distance [how far the debris flow can travel],” says Minu.

Also, the current susceptibility maps only identify the source areas of landslides. But the runout distance should be integrated into disaster management plans to make them more efficient. The practical challenges of permanently relocating everyone from such sensitive areas should be considered. If such systems come into place, casualties can be avoided using temporary shelters in safer locations.

Of course, there should be restrictions on future constructions and major infrastructure development in such areas, and eventually, long-term structural mitigation strategies must be planned, including flexible barriers, to reduce the impact of the flow by the time it reaches human environments. The debris flows in Wayanad are usually very deep due to the thick soil cover, and it is important to understand the phenomenon in detail in order to plan the measures to reduce the impact of flow.

The Geohazards Research Lab at IIT Indore, led by Professor Neelima Satyam, has attempted to model the runout of some recent events in Wayanad, and they are still working on physical model tests to understand the rheological behaviour of debris flows. More such studies are required in this direction, as the increased frequency of extreme rainfall events is likely to trigger more debris flows in future.

No consistently available shelters

Vishnudas points to another important issue: shelters. “People are hesitant to move out because they don’t know where to move and how. There are no proper shelters or consistently available shelters. Often, they are moved to makeshift places or schools, which they try to avoid” he says. “This must change. We need to ensure better, larger, and more efficient shelter facilities and build trust in the community.”

In the long run, the state must ensure that people living in such vulnerable areas move out on their own by sensitising them about the dangers and providing adequate support for their resettlement, says Vishnudas.

“The government is focussed on tackling climate change and strengthening alert mechanisms,” Revenue Minister K. Rajan told *Frontline* as he prepared for another urgent meeting on the evening of August 7 at the Wayanad Collectorate in Kalpetta. The downpour outside mirrored the heavy weight of the disaster.

Also Read | Landslides in Kerala more frequent due to climate change, deforestation

“Right now, our immediate priority is to ensure that rescue and rehabilitation efforts are executed flawlessly. We have identified rental homes for the displaced and are envisioning a long-term plan

that includes a new township for the victims; it could be far away from Mundakkai and Chooralmala,” he said.

Such a move would be a lifeline for many of the survivors *Frontline* met at the Meppadi camp. “We can’t go back. There’s nothing left for us there,” says Dinesh, a labourer, his voice hollow as he stands outside the relief camp. He has lost nearly 10 family members, including his parents, brother, sister-in-law, and their children, in the landslide.

As the sun dips below the horizon, blanketing Meppadi, Chooralmala, and Mundakkai in a subdued yellow, an ambulance siren pierces the quiet. Faces, both of survivors and volunteers turn towards the sound with a mixture of dread and hope. The vehicle might be carrying a familiar face, a lost loved one.

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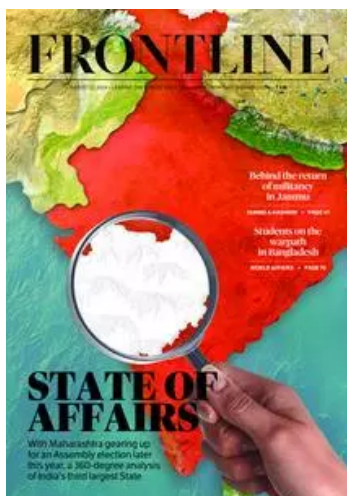
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