



TOWARDS A SAFER BAJHANG

A Magnitude 7.8 Earthquake Scenario and Steps to Build Disaster Resilience

REPORT BY

GEOHAZARDS  INTERNATIONAL

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Disclaimer

The scenario described in this document is not a prediction. Rather, it is a hypothetical narrative describing what may happen if a major earthquake strikes Dadeldhura in the near future. A real event could be similar or may be different.

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December 15, 2018

The 2015 Gorkha earthquake was a stark reminder that people across Nepal face great risk from strong earthquakes, and that communities should prepare. The Main Himalayan Thrust fault underlies much of the country and will continue to be the source for potentially very damaging earthquakes. GeoHazards International has been working to help communities in Nepal prepare for more than 25 years. Our approach is to strengthen local leaders with awareness, solid science and engineering, technical advice, and mentoring so they can build resilience. By taking action in advance to mitigate consequences of an earthquake disaster, they can save lives and reduce losses.

The work summarized in this report resulted from GeoHazards International's intensive collaboration with local decision makers and officials in westernmost Nepal. It presents the best-available evidence-based information on the specific effects of a strong earthquake affecting their district, in a story format that engages readers by making the earthquake's consequences tangible and personal. Most important, the work also outlines practical steps that can be taken to reduce damages and suffering from a future earthquake. It brings together the concerns and hopes of people who want their district to thrive.

I am happy to introduce "Towards a Safer Bajhang: A Magnitude 7.8 Earthquake Scenario and Steps to Build Disaster Resilience." GeoHazards International is grateful for the time and effort of contributors from many sectors and technical backgrounds.



Brian E. Tucker, Ph.D.
Founder, President



Towards a Safer Bajhang

A Magnitude 7.8 Earthquake Scenario and Steps to Build Disaster Resilience

Report by

**GeoHazards International
GeoHazards Society**

December 21, 2018

As part of our partnership with Bajhang District and Jayaprithivi Municipality, GeoHazards International (GHI) and GeoHazards Society (GHS) worked together with local professionals to develop the scenario and recommendations to improve resilience. We worked together for more than a year to identify the range of local consequences presented in the scenario. Local partners and technical contributors include:

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Our work in Bajhang is a component of Promoting Agriculture, Health & Alternative Livelihoods (PAHAL), a USAID funded initiative in Nepal. PAHAL is being implemented by three international partner organizations: Mercy Corps Nepal (lead), Plan International, and GeoHazards International; and three national partner organizations: Rupantaran, Support Activities for Poor Producers in Nepal (SAPPROS), and Resource Identification and Management Society (RIMS).

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GHI would like to acknowledge the following reviewers: Dr. Ian Buckle, University of Nevada, Reno; Jitendra Bothara, Structural Engineer, New Zealand; Dr. Bishnu Pandey, British Columbia Institute of Technology; L. Thomas Tobin, Senior Advisor, GHI; and Dr. Brian Tucker, President and Founder, GHI.

Towards a Safer Bajhang

Executive Summary

The pages that follow present an earthquake scenario for the district of Bajhang, Nepal. It tells the story of three people, and what happens to them and their families during a plausible but hypothetical earthquake. **This is not a prediction. This story, and the study upon which it is based, are intended as an example of what may happen if a major earthquake strikes Bajhang in the near future.**

Bajhang will always face a risk of earthquakes. The Main Himalayan Thrust fault, which underlies much of Nepal, is the source for potentially very damaging earthquakes. The last very large earthquake in this region occurred in BS 1562 / 1505 AD.¹ Another earthquake could occur any time, because strain has been increasing on the fault ever since.

This scenario shows the consequences of such an event, and the knowledge can be used to plan for safer outcomes. The story incorporates insights from professionals around the world who study earthquake effects, research on historic earthquakes, and documented experiences from the 2015 Gorkha earthquake. The consequences are based on standard methods that engineers and scientists use to estimate the shaking, damage and human impact a given earthquake may cause.

The scenario earthquake strikes on a weekday in May at 1:35 PM. Across the district, adults are working, and children are on recess at school. Measuring magnitude 7.8, the earthquake originates approximately 100 kilometers northwest of Jayaprithivi on the Main Himalayan Thrust fault. It is not the worst earthquake that could happen, but it causes serious losses and suffering. Shaking throughout Bajhang and most of Sudurpashchim Pradesh is very strong, causing the consequences explained in this narrative: casualties, damaged buildings, landslides, fire, isolation, loss of power and water, and economic hardship.

Summary of Consequences from the Scenario Earthquake



Buildings

Approximately 23,000 buildings collapse across the district. This is about two-thirds of all buildings. In Jayaprithivi Municipality, about 60% of buildings collapse; nearly 30% more are unsafe. In the rest of the district's municipalities and rural municipalities, the extent of damage and collapses is similar.

Unreinforced stone masonry buildings are particularly prone to collapse. Many poorly built reinforced concrete frame buildings collapse, and many more are damaged. Some buildings on steep slopes fall downhill. Timber buildings fare the best.

Although many people are outside at this time of day, about 4,000 people are killed in collapsed buildings or by debris falling inside and outside of buildings. More than 10,000 others suffer serious injuries. Many are trapped in the rubble. Homes, shops and offices are unsafe to occupy.

¹ Dates are shown in Bikram Sambat (BS), the official calendar of Nepal, and the western Gregorian calendar (AD).

Thousands of people must sleep and work outside or in temporary shelters for months until permanent buildings are reconstructed. People are afraid to go back into buildings as there are numerous aftershocks (smaller earthquakes that follow the main earthquake).

To Be Safer: Train builders in earthquake-resistant construction. Strengthen or replace key buildings to make them earthquake resistant. Construct new buildings to be earthquake resistant, according to the building code.

Estimated building damage and impacts, by municipality or rural municipality

Jurisdiction	Building Collapses	Additional Unsafe Buildings	Serious Injuries	Deaths
Biththadchir Rural Municipality	1,850	800	700	300
Bungal Municipality	3,700	1,550	2,700	1,020
Chabbis Pathibhara Rural Municipality	2,000	800	700	290
Durgathali Rural Municipality	1,600	700	500	230
Jayaprithivi Municipality	2,650	1,300	1,600	660
Kanda Rural Municipality	250	100	90	30
Khaptad Channa Rural Municipality	2,150	900	680	270
Kedarsyu Rural Municipality	2,500	1,000	900	380
Mashta Rural Municipality	1,700	700	600	260
Surma Rural Municipality	1,000	400	380	150
Talkot Rural Municipality	1,400	550	500	190
Thalara Rural Municipality	2,200	900	750	320
Total for District	23,000	9,700	10,100	4,100



Schools

Most school buildings in Bajhang district (including the 458 government schools) suffer damage during the main earthquake and aftershocks. Some unreinforced masonry school buildings collapse, and stones fall both inside classrooms and into the school yards. Fortunately, many children are outside when the scenario earthquake occurs. Some of those inside, including teachers and classmates, are injured or killed. The casualties devastate and anger families. School repairs and rebuilding will take months to years, reducing education opportunities for a whole generation.

To Be Safer: Make schools earthquake resistant. Train teachers and students what to do in a disaster. Prepare plans and test them with drills.



Health Facilities

All 49 health facilities in the district suffer moderate to serious damage. Some may not be repairable. Surviving doctors and nurses must care for patients outside because the buildings are unsafe. Some risk their lives going into damaged buildings to retrieve medicines. Medical supplies quickly run low. Pain relief medicines, bandages, and saline drips run out after the first few hours in many rural health posts. At the District Hospital in Jayaprithivi, electricity fails, and generator fuel will not last long. The old hospital building is badly damaged and unusable, including the operation theater. Water supply is very limited. The large number of injured people overwhelms doctors and nurses. Relatives push and shout for treatment for their loved ones. Seriously injured patients need to be moved to a larger hospital for surgery, but the availability of helicopters is limited and delayed. Conditions at the hospital remain difficult for an extended period.

To Be Safer: Locate essential medical services in new earthquake-resistant buildings. Develop emergency plans to help keep the hospital functional after emergencies. Practice—with preparedness exercises, simulations and drills. Maintain sufficient backups for water, power, medical gas and communications. Anchor equipment to protect it from falling and breaking.



Communications

Communications fail in the district due to damaged towers. A few of the towers collapse because they were installed on weak buildings. The antennas require power, which is out, and there is little solar battery backup. Mobile phone services fail in Jayaprithivi. In small areas of the district where mobile phone service remains, the large number of people trying to make calls overload the system. It may take months to restore the cellular network, depending on how quickly the road system is opened. Telephone landlines are also down. Families are disconnected. The three satellite phones will be critical for communications. Without direct radio communications between local officials, Armed Police and the Army, there are major difficulties in understanding the extent of damage and coordinating response.

To Be Safer: Store parts and equipment locally for essential system repairs. Provide backup communications for key agencies and facilities. Develop an emergency communications plan for the district that includes all key agencies involved in the response phase. Encourage families to plan how they will reconnect after an earthquake.



Landslides and Rockfalls

Shaking triggers approximately 6,000 landslides all at once, throughout the district. Most landslides are on steeper slopes and where construction for roads or buildings has disturbed slopes. Areas where landslides have occurred during past monsoon rains have more slides, and many new slide areas emerge. Throughout the district, some people and livestock are rescued, but about 150 people and hundreds of livestock are killed by landslides. Landslides block road access to the district and within the district. In Jayaprithivi, the road from Chainpur Bazaar to the airport and hospital is blocked. Landslides may block rivers, causing flooding. Many agricultural fields are buried or damaged by landslides, affecting livelihoods. Cracks open on many slopes, and some will develop into landslides during aftershocks or rain. In future monsoon seasons, hillsides disturbed by the earthquake will have many more landslides than is typical, continuing to block roads and impact rural and city families for years.

To Be Safer: Limit activities that destabilize slopes. Strengthen slopes that threaten people, hospitals, schools, and government offices. In hill towns and along infrastructure corridors, prepare a landslide-hazard map that identifies landslide-susceptible locations. Avoid these locations when constructing important new infrastructure or buildings, such as schools and health facilities.

Estimated number of landslides by municipality or rural municipality

Jurisdiction	Number of Landslides	
	Dry Conditions (this scenario)	Monsoon Conditions
Biththadchir Rural Municipality	150	400
Bungal Municipality	800	2,000
Chabbis Pathibhara Rural Municipality	200	500
Durgathali Rural Municipality	100	300
Jayaprithivi Municipality	300	750
Kanda Rural Municipality	2,600	6,600
Khaptad Channa Rural Municipality	350	900
Kedarsyu Rural Municipality	200	500
Mashta Rural Municipality	200	500
Surma Rural Municipality	500	1,200
Talkot Rural Municipality	600	1,500
Thalara Rural Municipality	200	450
Total for District	6,200	15,600



Roads, Bridges, Airports

Road access to the district is completely cut off. Landslides in numerous locations block or erode the Khodpe-Chainpur road that leads to Chainpur Bazaar in Jayaprithivi. Some bridges are damaged and must be inspected before traffic is allowed across. Landslides block trails, and some trail bridges are damaged, which isolates rural families and villages from assistance and supplies. The airport in Jayaprithivi is a critical link, but road access is blocked and must be cleared before trucks can distribute supplies flown into the airport. The runway needs to be inspected for cracks and other damage, and to ensure that it is serviceable after years without regular use, before planes can land to bring in medical teams and relief supplies from Dhangadhi or Nepalgunj airports. The helipad in Jayaprithivi could also be useful, but road access to the helipad is blocked by landslides, which must be cleared before trucks can

get through. Relief efforts are drastically impeded, especially to rural areas. The normal flow of food and goods from other districts and the Terai is halted. Repairs to make the highway passable will take many weeks, and possibly months. Local roads and trail bridges may take even longer to open, with trail bridge repairs taking up to a year or more in remote areas. *To Be Safer: Develop landslide hazard maps along the Khodpe-Chainpur road, and plan for road clearance and reconstruction following earthquakes. Strengthen slopes along the highway that are most likely to fail. Test airplane and helicopter access periodically, before disasters happen. Pre-identify helicopter landing spaces, and protect access roads to these sites. Align new roads away from landslide-prone slopes. Store sufficient supplies, like fuel, locally.*



Water

Earthquake damage to the water systems in Chainpur Bazaar and nearby areas leaves residents without clean water. The supply pipes, from the spring sources kilometers away, have been disrupted by landslides. The intake tanks crack and leak. They may need to be completely rebuilt. Many of the pipes in the distribution network are ductile and suffer little damage, though some leaks and breaks at valves and connections mean that little or no water reaches households. People in Chainpur Bazaar typically store water in household tanks and have some reserve, but some of these tanks have fallen or leaked due to the shaking. People must now collect water from the river or local spring sources, but river water is contaminated and must be boiled or treated. In other parts of Bajhang, local water supply systems are similarly affected, meaning many more people must now collect their own water. Some spring sources may be disrupted by the shaking. Assessing where and how to make repairs will take days, or longer in rural areas. Making repairs will take weeks to months, depending on availability of materials. Bringing repair materials by road will not be possible until roads are cleared.

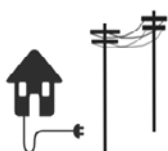
To Be Safer: Stockpile supplies locally to repair the water system. Secure household water tanks. Plan how to ensure clean drinking water until the water system is repaired. Over time, make the system less vulnerable to damage.



Fires

Fires start in buildings because gas cylinders fall and cooking fires spread during the shaking. With several of these fires occurring at once and a dwindling water supply, the fires are difficult to extinguish. Shop buildings constructed with timber and corrugated galvanized iron (CGI) sheets, though much safer during earthquake shaking, are at risk from fires.

To Be Safer: Make the water supply system more robust, so that water is available to fight fires. Take steps that will limit ignition and spread of fire.



Electrical Power

New transmission lines that will supply power from the national grid to the district, and existing lines from micro-hydro stations are disrupted by landslides. The micro-hydro station that serves Jayaprithivi stops working and

needs to be inspected. Rivers are full of landslide debris, and the intake canal and turbines are choked with sediment. Assessment will take days to weeks, and communication will be difficult with mobile phones out of service. Transformers, attached to poles and rails without any seismic protection, have moved or fallen in several locations. Locally, there are not enough replacement parts. New supplies can arrive once roads are cleared. Minor repairs should take days, but major repairs will take weeks to months. There is a heavy reliance on generators for power, but fuel is in very short supply due to blocked roadways. Solar panels provide a small amount of power for lights, or to charge mobile phones once phone service is restored.

To Be Safer: Secure generators and fuel tanks to prevent shaking damage. Store additional backup fuel. Increase solar power systems. Seismically protect transformers. Develop preparedness and service recovery plans for transmission lines.



Emergency Management and Response

Communication failures and power outages limit emergency responders' ability to coordinate response and collect district-wide reports. Until communications are re-established, police and military communications, along with runners, are the only way to learn about extent of deaths, injuries, damage, and road blockages. Critical information cannot be relayed to officials quickly. The lack of a District Emergency Operations Center (DEOC) makes coordinating response even more difficult. Responders at the municipality and district offices, search and rescue teams, and the hospital have to make difficult choices. Where will help be sent first? Whom do they try to save? With limited resources, how can they help the most people? Where do they direct aid that comes in? How do they coordinate its arrival? What should be repaired first? How best can food, water and medical supplies be distributed? In such a major disaster, communications will fail. Demands will be intense on emergency responders and officials.

To Be Safer: Practice disaster roles and responsibilities using this scenario as an example of what will happen. Set up the DEOC. Develop and practice inter- and intra-agency communication plans for disasters with tabletop exercises and drills. Ensure that responders and officials can focus on the response by making pre-disaster emergency plans with their families.



Economic and Social Setbacks

Many people throughout Bajhang are unable to make a living the way they did before the earthquake. The loss of income comes at a time when people need it the most to recover and rebuild. Farmers have lost their crops, animals, seed stores, and even fields. Shops do not have much to sell, and people do not have money to buy. With roads blocked, farmers are unable to transport their products, shopkeepers cannot resupply their goods, and relief supplies arrive slowly. Fuel and goods are increasingly scarce, and prices rise. Because communications are down, many men from Bajhang who had been working outside Nepal sacrifice their jobs and return home to find out about their loved ones.

With a number of trail bridges damaged, many rural villages are isolated. People cannot cross rivers with their goods, access health care receive relief supplies, or attend school. Others cannot access their fields, or their fields were damaged by landslides. Irrigation channels run

dry. Hundreds of goats, cows, and buffalo throughout Bajhang are killed by falling buildings and landslides. Without these animals, families have less milk and meat, for themselves and to sell.

Everywhere people grieve for lost family and friends. Aftershocks frequently shake the ground and reawaken fear. Sleeping and performing simple tasks are difficult for many. People help each other, but also argue due to stress. As time moves on, some people get angry, others cannot stop feeling sad. The loss of basic services adds to the stress, and women have to endure most of this.

This Need Not Happen

Such extensive damage and consequences need not happen. Bajhang can make changes that will reduce these impacts. The following key recommendations emerged from discussions during the local earthquake scenario development process. They address significant threats to people's physical safety and services they rely upon. More detailed technical recommendations, organized by topic, are located in the Recommendations section of this report. Additional perspectives are critical, and a local action planning process will further clarify high priority actions, identify responsible parties and resources, and set timelines for completing the actions. Listed in suggested priority order, the key recommendations are:

- Prepare for roads within the district and important access roads outside of the district to be blocked by earthquake-induced landslides for a month. Revise response plans to address how to meet urgent human needs without road access, and how to rapidly reopen roads. Store sufficient fuel and supplies, as well as parts for emergency repairs to water, power and communications systems.
- Ensure all new buildings are constructed to be earthquake resistant. Accelerate local mason training; improve building bye-law adoption and enforcement capacity in municipalities by training and supporting municipal staff; build capacity of local engineers and architects to follow building bye-laws, and educate owners and builders about the importance of earthquake-resistant construction to improve compliance with bye-laws.
- Identify the five most critical buildings or services in the district that will be needed for post-disaster response, create a plan to assess them, and seismically retrofit or replace facilities likely to perform poorly in an earthquake, or provide redundancy.
- Create municipality Master Plans that focus growth in areas with a lower level of hazard. Provide resilient, redundant infrastructure for water, electrical power, and communications. Investing in resilient new development is an important way to make people safer in the long term.
- Develop a health facilities plan in which each hospital has at least one building designed to have minimal damage in strong shaking, so that it can continue to function. House all critical medical services (such as operation theatres) in this building. Seismically protect the backup water and power systems serving this building.
- Store sufficient medical supplies to last up to a week during a major disaster, especially supplies for treating earthquake-related injuries.
- Plan and construct all new roads in a manner that minimizes the risk of causing landslides on slopes. Locate new road alignments in areas less susceptible to landslides, because development grows along roads. Dispose of excavated soil and rock in safe, designated

areas rather than dumping it downhill of the excavation, which can add to slope instability. Road construction can be very difficult in this area, which is a function of geology, meaning that investments in construction should be made even more carefully so they are not lost in subsequent monsoons or an earthquake.

- Control excavations for buildings and roads on ridges and hillsides to avoid destabilizing slopes as settlements grow. This can include regulations and monitoring for safer slope-cutting, enforcing the regulations, and educating owners and builders on the dangers and costs of unsafe excavations to themselves and neighbors.
- Develop an earthquake safety plan for schools that prioritizes which schools to address first, with the goal to seismically retrofit or replace all schools at risk of collapse during an earthquake in the next 30 years, and 10% in the next 5-8 years.
- Support efforts by local elected officials to increase their knowledge of disaster risk and resilience issues affecting their jurisdiction, so that they can make better-informed decisions to keep their constituents safe.
- Clarify the division of disaster management authority, roles, and responsibilities among district and municipal officials. Sensitize, orient, and train district and municipal stakeholders on the Disaster Management Act of 2017; the National Disaster Risk Reduction Strategic Plan and Policy, 2017-2030; and emergency management procedures to prepare them for the likely demands during a disaster.
- Government offices and departments with critical post-disaster roles should develop and maintain all-hazards emergency plans. Consider specific earthquake impacts such as those described in this scenario. Describe actions to take in the event that access roads are blocked and phone connectivity is lost for an extended period. Train staff and conduct exercises/drills to keep people aware of the plan and ready to carry it out.
- Identify and establish a District Emergency Operations Center (DEOC) in a location that is not hazard-prone.
- Develop an emergency communications plan to coordinate sharing information between urban municipalities, rural municipalities, the district, and the departments in charge of roads, electricity, water, and others essential for response. Provide backup communications other than mobile phones, where needed, and train multiple people to use them so that there is redundancy. Practice regularly to ensure all involved are ready to fulfil their roles.
- Electrical power, water, and communications providers should develop an emergency service restoration plan and standard operating procedures that identify personnel assignments and resources. Plan how to quickly communicate damage and repair information to response coordinators, assuming phone connectivity is lost for an extended period.
- Encourage household level backup utility systems. To improve emergency water availability, encourage households to harvest rainwater, to anchor water tanks to prevent toppling during shaking, and to be prepared to decontaminate river water for household use after an earthquake. Encourage people to continue to use and maintain rooftop solar panels.

- Strengthen community-level preparedness for all hazards including earthquakes. Initiate awareness programs. Assist urban and rural communities to develop preparedness plans at the family, neighborhood, and community levels, so people know what to do and what to have on hand during a disaster. Increase school disaster preparedness education programs.

The district is likely to grow rapidly in the coming years, particularly along roads. If communities choose to grow by building safely, by making improvements to infrastructure, by avoiding destabilizing the land, the district can reduce the risk presented in this scenario.

However, if the district allows development to proceed with building practices as they are now, or makes only marginal improvements, then risk will increase drastically. This report provides decision makers a roadmap to safety, an opportunity to take stock of the situation and take steps to turn things around. It brings together the concerns and hopes of community members who want to make Bajhang a safe, thriving district.

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Towards a Safer Bajhang

Introduction

Bajhang district lies in an area of high seismic hazard, meaning that a damaging earthquake could strike soon. How will it change life in urban and rural areas? How will buildings and infrastructure fare? Will there be many landslides? And most important, how can the community lessen the consequences of such an earthquake?

This scenario narrative and report tells the story of three people, and what happens to them and their families during a plausible but hypothetical earthquake. **This is not a prediction. This story, and the study upon which it is based, are intended as an example of what may happen if a major earthquake strikes Bajhang in the near future.** This scenario is not the worst earthquake that could happen. In reality, the next major earthquake in Bajhang could be less damaging or much worse, like the massive BS 1562 / 1505 AD earthquake that devastated much of western Nepal.

The scenario shows how people in both cities and rural areas are vulnerable to harm from earthquakes. It focuses on potential earthquake consequences to Jayaprithivi Municipality including Chainpur Bazaar, and to certain roads, infrastructure and rural villages throughout the district. The consequences are based on standard methods that engineers and scientists use to estimate the shaking, damage, and human impact a given earthquake may cause. The picture is enhanced by insights from professionals around the world who study earthquakes and their effects, research of historic earthquakes, and documented experiences from the 2015 Gorkha earthquake.

This knowledge can be used to plan for safer outcomes *before* a real earthquake strikes. The report also explains specific actions that will improve Bajhang's disaster resilience. These include improvements in building design and construction, land use, the transportation network, utilities, and emergency response. Appendices provide additional technical information and describe the assumptions and methods used.

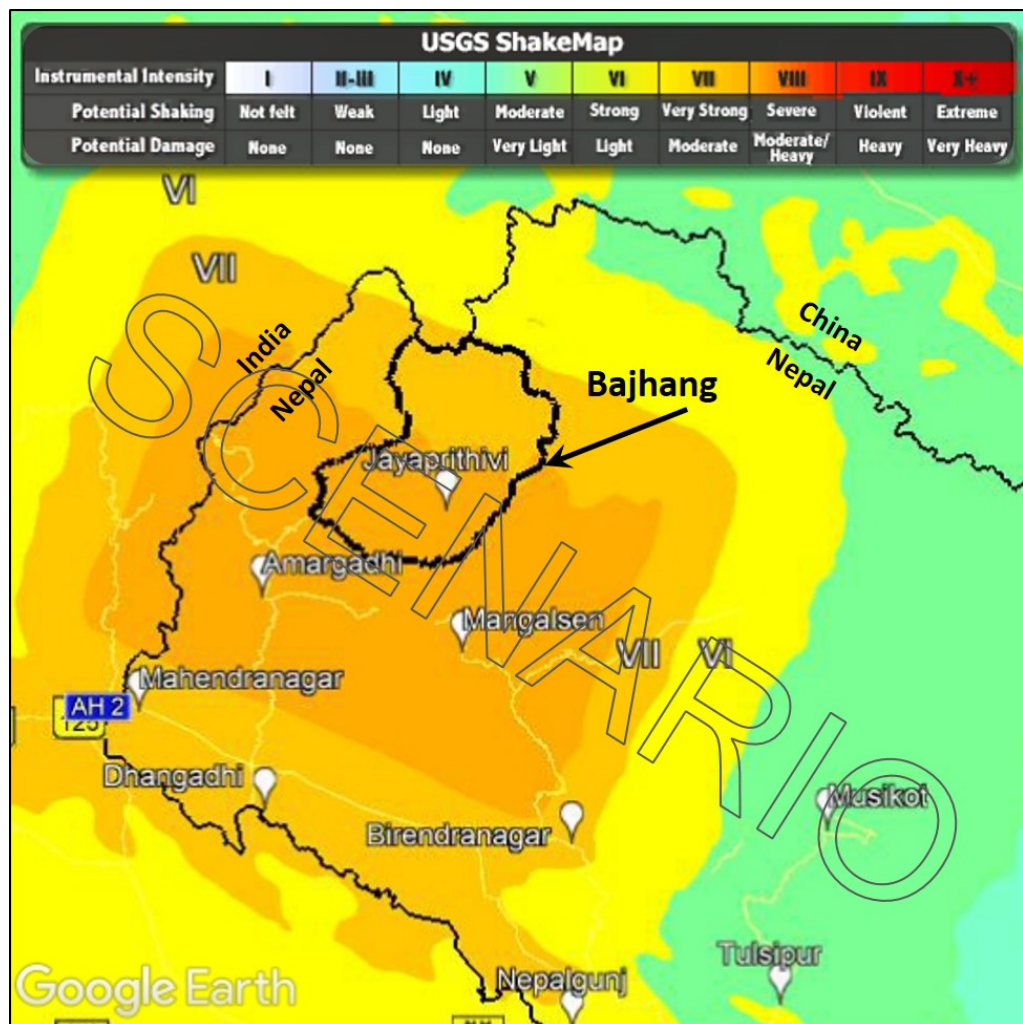
Earthquakes happen without warning. As you read the narrative, imagine living through the scenario. Consider how this event would affect your family, your community, and your livelihood. With co-workers and colleagues, you can decide how to improve the situation. Even small measures can make a big difference.

How Scientists Estimate Size and Location of Future Earthquakes

Over many years, energy builds up in the earth around an earthquake fault until the fault suddenly releases the energy. This produces an earthquake. The cycle repeats. To determine about how many years pass between large earthquakes, scientists study when the fault last produced a large earthquake and how often earthquakes have occurred in the geologic past. The earth is not predictable enough to forecast the precise location, time and size of future earthquakes. However, understanding the fault's behavior enables scientists to estimate the size and general location where large earthquakes are most likely to occur.

The Scenario: An Earthquake Strikes in Bajhang

Bajhang looks beautiful on a very sunny weekday in May. At 1:35 pm the ground starts to tremble. Within a few seconds, shaking intensifies and people have difficulty standing. Some people freeze, some call out, and some run toward home or family members. They think that the world is ending or that this is a curse bestowed by some evil. When the shaking stops after about 40 seconds, they realize that it was an earthquake, similar to what struck Gorkha a few years back. Those old enough quickly recall the earthquake that struck Bajhang in BS 2037 / 1980 AD.



This ShakeMap shows the shaking intensity expected to occur during the hypothetical M7.8 scenario earthquake. The darker orange colors represent very strong to severe shaking, the yellow and green colors represent strong and moderate shaking. Overall, shaking is anticipated to be very strong for Bajhang (thick black line) and much of Sudurpashchim Pradesh. Yellow lines are major roads, and the thin black line is Nepal's international border. Source: David Wald, U.S. Geological Survey.

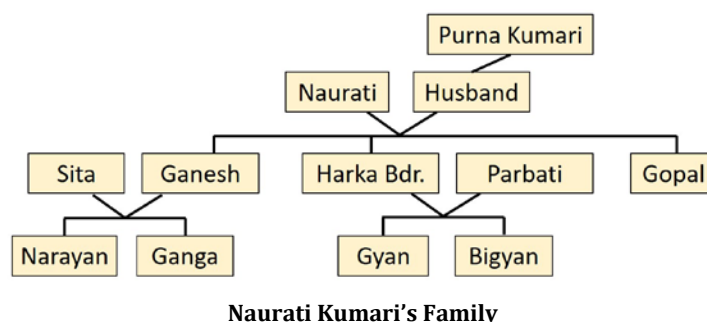
The earthquake enormously changes Bajhang. In Jayaprithivi Municipality, in less than a minute, the intense shaking brings down some 2,600 buildings out of about 4,400. The shaking causes about 300 landslides on slopes in the municipality, and some buildings slide downhill. Fallen debris buries people and livestock, and blocks roads. Heavy dust fills the air. In villages, the scene is repeated: collapsed and damaged homes and businesses; houses, farms, and paths

destroyed by landslides. Across the district, more than 23,000 buildings collapse, about two-thirds of the district's buildings. More than 6,000 landslides occur district-wide. People are stunned. Even livestock are traumatized by all that is happening around them.

In a stroke of good fortune, most schoolchildren are outside during recess and avoid the dangerous collapse of their classrooms. Other people are not so lucky. Many die in collapsed buildings or are trapped in damaged buildings. The electricity fails immediately. Water tanks are damaged. There is widespread damage to roads. Most mobile signals disappear. The District Hospital buildings in Jayaprithivi suffer damage, injuring staff and patients. The ground shakes again with aftershocks, bringing down more buildings and further terrifying people.

People Respond and Cope

The story below follows three fictional people and their families as they cope with the earthquake and its aftermath. The extended family of Naurati Kumari (49) farms and raises livestock in Maluwa, a locality on the highway between Jyapu, Baitadi and Jayaprithivi. There are



no elder men of the family in Bajhang. Naurati's husband died many years back, and her sons Ganesh Bahadur (35) and Harka Bahadur (33) work in India. Ganesh's wife, Sita (31), lives in an old two-storey house with son Narayan (12) and daughter Ganga (10). Next door, in a new two-storey house, live Naurati, her youngest son Gopal (16), her mother-in-law Purna Kumari (71), Harka Bahadur's wife Parbati (26), and their sons Gyan (7) and Bigyan (4). We follow two additional people not related to Naurati Kumari: Bijay works at the District Hospital in Jayaprithivi, and Binda works in the Jayaprithivi office of the Chief District Officer.

The First Hours, Day of the Earthquake: 1:35 pm to 4:00 pm

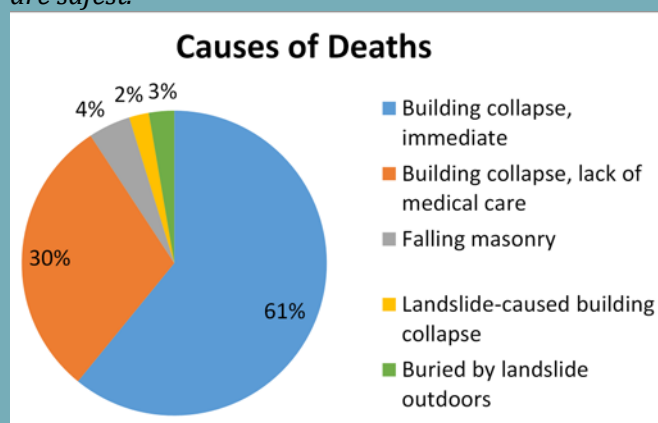
Naurati at Home

In Maluwa, on this beautiful day, people are following their usual pattern: some working in the fields, elderly people and a few ladies talking together, and children busy at school. Naurati is working in her kitchen garden with her daughter-in-law, Sita, when the shaking begins. By the time they realize this is a large earthquake and not a dream, they panic about the children. They hold hands and grab a small tree for support. Naurati watches as the hills all around thunder with falling rocks. Dust rises as a newly constructed building collapses in seconds—that neighbor's home had been a dream house of everyone! Then she realizes, with a sick feeling, that her mother-in-law is inside her house.

Only when the strong shaking stops can she and Sita run toward the house. The old house has completely collapsed, and entire parts of the new house's walls have fallen out into the yard. She calls out to Purna Kumari many times but hears no reply. The entrance is covered by heavy rubble, which they clear frantically with bare hands. Inside they find Purna Kumari lying unconscious on the floor. They pull her outside, and after a few minutes she revives but has a terrible headache. The cattle-shed on the ground floor of the old house has collapsed. Sita had sold her cow just 5 days before. She planned to buy two calves with that money and the money sent by her husband. Fortunately, Naurati's three buffalo and goats were not harmed.

Casualties:

Although many people are outdoors when the earthquake strikes, about 4,000 people are killed in buildings, either in structural collapse or by debris falling from buildings. Lack of rescue or timely medical care accounts for 30% of these deaths. More than 10,000 are seriously injured. Casualties would increase during the monsoon due to more landslides. An earthquake at night, or when students are inside classrooms, would kill thousands more than in this scenario. Because they are so numerous, buildings of unreinforced stone masonry with mud mortar cause 93% of fatalities. Poorly built reinforced concrete frames collapse also. Timber frames with light roofs are safest.



and does not find a way to cross. She tries her best, but falls and injures her ankle. Slowly she limps home. Purna Kumari consoles her and says not to cry, everything will be okay. But how? She sees men and women trying to rescue a family trapped under a house. People talk about the end of the world and that it was all some retribution from God. As the time passes, Sita grows more anxious about her daughters. She hopes Ganga, who is hearing impaired, is with Narayan.

Gopal in Chainpur Bazaar

After passing class 10, Naurati's son Gopal has been working in his maternal uncle's garment shop in Chainpur Bazaar. When the shaking starts, he is playing a game on his mobile phone inside the one-room shop. It is a small wood-framed building with corrugated iron walls adjoining similar shops on both sides. All the clothes and things placed in the cupboards fall. His mobile phone drops from his hand. He never knew that an earthquake could be this intense and last this long. Unable to move at first, he sees through the shop opening that houses are crumbling, and landslides and big boulders are moving down the hillsides. He sees people running and falling. When he hears a loud thud nearby—the sound of the gas cylinder falling on the floor of the tea shop next door—he reflexively sprints outside to a

They all stay in the front yard. Other families gather in the open space near the house. All of them are anxious about those who are not with them. Sita takes her mobile phone out from her *patuki* and tries calling her sister-in-law, Parbati, who works an hour walk away at the school. However, there is no mobile signal. All the children of the family are at school except for Bigyan, who is visiting his maternal grandmother's house in Dhangadhi.

Sita's house has totally collapsed. Though all her belongings are buried, she cares most about her children. Since Naurati can look after Purna Kumari, Sita heads toward the school. After walking on the path for a little while, she encounters a large landslide on the steep, narrow trail



Landslides:

Shaking triggers more than 6,000 landslides throughout the district, all at once. About 200 people are killed in landslides and landslide-damaged homes. Landslides severely block the highway along the Seti River. Other roads are blocked, and some roadbeds collapse. Landslides may dam rivers, causing flooding. If the earthquake were to occur during monsoon season, the number of landslides could more than double.

safe spot near the road. The leaking gas ignites and explodes, causing a fire in the tea shop, his uncle's shop, and the shop on the other side of the tea shop. He realizes how close he had been to getting killed.

Gopal tries running to the shop to help the old man out of the fire, but other men pull him off and stop him from going inside. He is very frightened. People throw water and sand on the shops but cannot stop the fire. More people come with buckets of water. Only after half an hour do they put the fire out from the 5 shops packed tightly together. They cannot save the old man in the tea shop, and the young woman next to the tea shop is injured.

Gopal's uncle had gone to Dhangadhi two nights before, so Gopal hopes that he is safe. In the shop, he finds only ashes and things damaged by fire. His mobile was lost there, so he borrows a boy's phone and tries repeatedly to call home but cannot connect. He sees people moving toward the nearby open land and follows them. Gopal cannot help thinking of his niece and nephews, his mother, and sisters-in-law back home. He decides to walk home the next morning.

Naurati's Older Sons Ganesh and Harka Bahadur in Bangalore, India

When news of the earthquake reaches Ganesh and Harka Bahadur in India, they cry with the frustration of not knowing if the family survived. They cannot connect to family or anyone who knows what happened in



Schools:

The buildings at all schools, including 458 government schools, are each affected by the shaking. Stone walls collapse at some and injure people nearby. Other buildings collapse completely. Schools may be closed for weeks or months during repairs.

their home town. With varying numbers of victims mentioned on different news channels, they grow more fearful that all of their family may have perished in such a devastating earthquake. They decide that one of them will go to check on the family and help with rebuilding, while the other stays to continue earning money that they now need more than ever. Ganesh catches a night train to Delhi to begin the long journey back home.

At School

Just before the shaking starts, Narayan and Ganga are in their classroom at the public school enjoying *khaja* (snacks). Ganga is talking enthusiastically about her new syllabus when Gyan comes running to take them out to play for recess. Just as they all reach the playground, the shaking starts. The school building collapses in front of their eyes,

pushing a huge cloud of dust skyward. They fear that it is impossible to survive such a collapse. When the dust finally clears, they see so much chaos. Children outside cry and yell, and so do the three cousins. They had heard on the radio to "Drop, Cover and Hold On" but do not know what to do outside.



Gas, Fuel, Fire:

Natural gas and kerosene canisters throughout the district fall and leak. Fires ignite in some kitchens and shops. Fighting the fires with little water pressure is a challenge. Petrol needed for generators and vehicles dwindles quickly. Delivery trucks can re-supply only when the highway is cleared, perhaps taking weeks or a month.

Without any disaster training, the surviving teachers find it difficult to manage the situation. They were not prepared at all for such a catastrophe. They tell children to stay together, and not to go toward the collapsed buildings. Some run home, not listening to the teachers. Naurati's daughter-in-law, Parbati, was outside when the earthquake occurred so she too survived, with painful bruises on her leg from stones that fell off one of the buildings. The three girls find Parbati. Knowing that the children are physically fine but shaken, she tries to call home to reassure the family but is unable to connect. She asks the children to stay together and help others who are in need. Though Parbati is very worried about the family at home, she has other responsibilities and cannot leave the school to check on them.

Teachers dig frantically in the rubble of the collapsed buildings, searching for survivors. Neighbors take a few severely injured students to the health post. A few rescued children are unconscious and badly injured, but alive. Consoling other students who are extremely frightened is a big challenge, as there are not enough adults. Older students try to comfort the younger ones. Since several students ran home, the school staff are not sure how many children are left and how many are buried inside the building. A few teachers and staff members also ran home to check on family. Parbati stays to help the children and wishes that they had practiced or at least developed an emergency plan. A few parents who reside nearby come for their children, and some of them also help to treat the injured with first aid. Bandages quickly run out. Parbati wonders if unskilled treatment will lead to infection. Fortunately, she had the chance to take first aid training, and her skills come in handy despite the lack of supplies. Children are thirsty and also need water to wash wounds, but within hours the school's water runs out.

The teachers wonder whether to send students home on their own or to wait for families to pick them up. Some students must cross trail bridges or walk along steep cliffs, which would be especially dangerous with aftershocks. They think it is best to stay with the children on the school ground, but they worry about their own families.

Mr. Bijay at the District Hospital

Mr. Bijay has been in charge of medical equipment and general maintenance at the hospital for a year and a half. He studied bio-tech engineering in Kathmandu, his home town, and his scholarship mandated rural service, which is how he came to Bajhang District Hospital. He lives in a rented accommodation in Chainpur Bazaar. On this ordinary day, he finished afternoon tea and went to the nurse's station to talk with Kabita, a nurse who joined the staff at almost the same time. She shared some kheer. Then Bijay went to the District Health Office to check the generator. A vaccination camp would happen in two days, and medicines would arrive that need refrigeration. The medical refrigerator needs generator power, as the electricity supply is intermittent. Just as Bijay passes the open waiting area, the ground shakes violently, and he freezes.



Water:

Damage to the Jayaprithivi water systems leaves residents without water. The water tanks above the city crack or leak at the connections. Some need to be entirely rebuilt. Pipes that supply water from springs are damaged. Many household water tanks have fallen, and people must collect water from rivers or local springs. Smaller water systems in other municipalities are similarly affected. Repairs will take weeks to months.

A portion of the old hospital building collapses. He hears screaming from inside. His eyes fill with dust and he cannot see much, but it appears that the District Health Office (DHO) is still standing. The entrance is blocked with fallen debris, so he runs along the side, where he sees the side building seriously damaged and the roof leaning forward. Some patients are being helped out through where the wall collapsed. Bijay runs to the central courtyard and finds a few people wailing for relatives inside. He sees Kabita sitting, dazed, next to the garden tap, still holding the food container she was washing. She is crying because she knows two friends were inside. They call out and try to search for the two, but the wooden roof is too heavy for them to move.

The acting Medical Superintendent (MS) comes out of the hospital building with a cut above his left eye, looking dazed. He tells Bijay to take as much medicine as possible to the DHO building. While Bijay and Kabita hurry in to fill a trolley with medicines, Bijay's heart sinks as he sees the x-ray room. Walls have collapsed, and the machine is in pieces on the ground. The Operation Theatre is also damaged and unusable. Kabita brings the trolley out, but fallen stones prevent her from taking it very far. She recruits several local people who have come to help, and they carry armloads of medicines the rest of the way. Bijay retrieves more medicines from the nursing station cupboard, which has fallen down, and puts them in a makeshift bedsheet backpack. They are glad to get out of the damaged building.



Health Facilities:

All 49 facilities in Bajhang suffer some damage. Doctors and nurses at the District Hospital in Jayaprithivi are quickly overwhelmed by the number of injured. They set up temporary treatment outside in an open area, although they lack power, medical gas, adequate blood and medicines. Helicopter transport is not available the first day for the severely injured, and few of them survive.

Bijay's phone has lost signal, but he types a message to his mother in Kathmandu. He experienced the Gorkha earthquake, and he knows that SMS might work later. He tells Kabita she should text rather than call her parents in Dadeldhura.

The hospital staff assembles, and the acting MS tells them to set up a treatment area outdoors. Some of them run to the north boundary wall to look out on Chainpur Bazaar, worried and crying about their families. Landslides can be seen in every direction, and the road between the hospital and bazaar is blocked. The hill south of the bazaar has slid and may have blocked the Seti river. Already, the Bahuli River is muddy, indicating landslides upstream. Someone says that the river flow is really low, also indicating that landslides have blocked the river. Most staff want to go home to check on their families but realize that they will be needed here.

Bijay checks the water supply line. It is down to a trickle, and he hurries to check on the hospital's tanks. One tank has fallen from a building, and water is leaking from the broken pipe above. Bijay shuts off the valve and checks for leaks in all places. He moves to the equipment area and manages to pull out two oxygen concentrators from the rubble, even though he knows that these need electricity to function. He is tempted to join those rescuing people from the ward, but he is needed to set up the treatment area. Bijay and Kabita are among the few staff members who do not have families in town and can carry on helping at the hospital without worrying about their families' welfare.

The two-storey guard cabin with a heavy slate roof has collapsed onto the road and blocks access to the hospital. Patients have to be carried over the rubble. Bijay remembers the

earthmover machine that had been working down the road, and he asks volunteers to direct it to clear the guard cabin and the rest of the road to the bazaar. The two injured people pulled from the hospital building are the first to be treated outside the DHO building. Kabita and other nurses are treating patients but do not have enough bandages and other supplies. The pharmacy cabin has collapsed. Bijay and another staff member try to retrieve as much medicine as possible from the rubble, but there are no splints or gauze bandages.

Mrs. Binda at the District Administration Office (DAO)

Mrs. Binda, who works for the Chief District Officer (CDO), likes to tell everyone of the need for disaster preparedness. Binda is on the phone with a colleague from Baitadi when the earthquake strikes. She hears her friend shout and the line goes dead. Things fall around her. She wants to get under the table but notices many electric wires there. A shelf with files falls close to her and blocks the doorway. She climbs over it and goes out to the open space in front of the office. Many people are coming out, some are injured.

As soon as the shaking stops, Binda realizes that this is a major emergency and she needs to help the CDO with the situation as best she can. She goes inside briefly to get her mobile phone. Even though there is no signal, she hopes it will come back soon. She notices that the electricity has failed and switches off all lights to conserve the inverter's battery. The CDO had gone out for an inspection. Binda notices that the CDO left his mobile phone charging at his desk. She retrieves it and the megaphone, then sends these with a runner to find the CDO. Binda also asks the runner to report back on major damage he sees. The police officer on duty comes in with his VHF radio, and Binda collects as much information as possible through their networks within the district. She also tries to talk to the police counterparts by radio in Dadeldhura, Baitadi and Kailali to understand the status of the roads and power. There is no response from Baitadi. The Kailali unit informs there is some damage there and in Dhangadhi, and the electrical department is trying to restore power to Kailali.

Thinking about what she should do next, Binda wishes that there had been more time to clarify roles and responsibilities between the district and municipalities in times of disaster. As it is, she realizes that the CDO will need to coordinate the response to this disaster, as District Disaster Management Plans indicate, In future disasters, roles might shift toward municipality officials once the Local Disaster Management Committees are fully formed and things have been clarified. The runner returns with instructions from the CDO that Binda collect details of losses from all parts of the district. She keeps checking her mobile for signal, but there is none. Landline phones are not working either. Without another way to communicate, Binda wonders how she is going to get information from rural municipalities.

She requests that the Armed Police deploy, to manage logistics and organize search and rescue. Amid all of this activity, Binda thinks about her husband and son. Are they safe? Their family has a plan to follow in a disaster: her husband will go to their son's school after locking the house, and their son will wait for him at the open ground in front of his school.



Electrical Power:

Power is disrupted by damage to the micro-hydro stations, transmission lines and transformers. Locally, there are not enough replacement parts. New supplies can come only after roads are cleared. Minor repairs should take days, but major repairs will take weeks to months.

Meanwhile, the CDO returns. He uses the police radio to relay messages to the National Emergency Operations Center in the Ministry of Home Affairs. He requests medical teams and other assistance. He then decides to visit the hospital to learn about conditions there. As he gets toward the Bahuli River bridge, he sees that across the river landslides have completely buried the road to the hospital. He decides to walk to the hospital across the pedestrian bridge to avoid the landslide area.

Day of the Earthquake: 4 pm to 10 pm

At Naurati's House

Naurati, Purna Kumari and Sita stay outside the house. They still do not know about Parbati and the children. People gather to talk, and they describe the collapsed school building, which causes great distress. Naurati also worries about her son, Gopal. Naurati's and Sita's phones are still without signal, and their batteries are dying. They know that the men in India must be trying to call.

Neighbors talk about what happened at their houses and what they know about a large earthquake in the time of their grandfathers' fathers. Naurati remembers the BS 2037 / 1980 AD earthquake well, and Purna Kumari and a few older neighbors remind them of the BS 2023 / 1966 AD earthquake. This recent earthquake seems like it is worse.²

Finally, the children and Parbati come home, bringing great relief to the waiting women. There is no electricity and the neighborhood quickly darkens. Since they have lived most of their lives without electricity, they are not too concerned. Aftershocks continue. The women fear further damage to the house and decide it is safest to sleep outside under the sky. They are scared to go inside the house for food and eat only from the kitchen garden. The children are cranky with not much food.

Gopal in Chainpur Bazaar

Gopal sleeps outside, along with other people in the bazaar whose buildings are partially or severely damaged. Many take bedding and carpets from their houses and set up in a small open place nearby. Gopal, having nothing, sleeps on bare grass in a blanket someone gives him. With scarce water and lack of proper sanitation, the place already smells bad.



Communication:

Towers are damaged throughout the district. Also, antennas require power, which is out, and there is not enough solar backup. Mobile phone services fail in Jayaprithivi. In the few areas of the district where service remains, the number of people making calls overloads the system. Repairs will take weeks or months. The District Administration Office is able to communicate via radio with the National Emergency Operations Center and those in nearby districts.

² Bajhang has experienced a few particularly notable earthquakes in the past century: (1) BS 1973 / 1916 AD M7.0 about 50 km west of Jayaprithivi, (2) BS 2023 / 1966 AD M6.3, (3) BS 2037 / 1980 AD M6.5, and (4) BS 2068 / 2011 AD M5.3. These earthquakes are smaller than the scenario earthquake, and are discussed in Appendix A. The earthquake in BS 1562 / 1505 AD that caused widespread damage in western Nepal is also discussed in Appendix A.

At the Hospital

Although several small landslides block the only road between the hospital and the bazaar, more and more injured people arrive at the hospital on foot. Many come from the bazaar via the pedestrian bridge. The staff attempts to implement a system to treat the most serious cases first, but tempers flare among family members of the injured who do not want to wait. Doctors and nurses treat patients outdoors, in front of the DHO, but space is getting cramped. Some patients urgently need surgery at a bigger hospital, but it is unclear when a helicopter will arrive for transport.

The CDO arrives to find chaos. He requests help from the Nepal Armed Police, and a team is coming with medical supplies. The CDO tells the Medical Superintendent (MS) and Bijay that a helicopter, with a few medical personnel and essential medicines, is expected to arrive the next morning at the airport. He also promises a tent and an additional generator.

The MS sends a staff person to the town pharmacy, hoping the building still stands and can provide essentials. Bijay assigns a staff person to ration water usage while he sets up lights (with generator power) in the parking lot. He also runs a wire and bulb to the entrance where people are bringing in the injured. Bijay informs the MS that diesel is needed to keep the generator running. The MS sends a runner to collect fuel. The medical staff really needs supplies to treat the critically injured. Relatives take the dead home, and Bijay realizes there will soon be many cremations.

At the CDO's Office

After leaving the hospital, the CDO goes on to inspect the airport, and finds the road blocked between the hospital and the airport. He arranges for the nearby earthmover to clear that road next. He then returns to his office and manages operations from outside the building. He asks the local tent supplier to set up tents and another small generator at the hospital and outside the DAO. His family has not suffered any serious injuries, but is staying outside their home for now.

The CDO calls an emergency meeting of available members of the District Disaster Management committee (DDMC) and activates the humanitarian response clusters.³ He requests a helicopter from the Ministry of Home Affairs to carry out a reconnaissance of damage in the district. This will include a survey of rural areas and landslides, and assessments of the Khodpe-Chainpur road and electrical transmission lines and facilities. Helicopters are scarce, and there are requests from other affected districts and many medical evacuations needed. Nepal Telecom is arranging for teams from eastern districts to deploy for repair work. Earthmoving equipment from a construction project in Jayaprithivi is requisitioned for searching under buildings, but the operators are not used to the delicate work of rescuing people. Binda was given a radio and is tasked to maintain all the records of loss and damage in coordination with the police office and urban/rural municipalities. She now gives the National Emergency Operations Center hourly reports via radio.

³ Clusters used in Nepal: 1) Communication, Information and Coordination, 2) Search and Rescue, 3) Emergency Shelter and Non-food Relief Items, 4) Health and Nutrition, 5) Water Supply, Sanitation and Hygiene Promotion, 6) Food Security and Livelihood, 7) Emergency Education, 8) Re-habitation, Reconstruction and Logistics Management, and 9) Conservation. See more detail in Appendix H.

Much to Binda's relief, her husband and child arrive in the evening, uninjured but tired and traumatized by what they have seen. She gives them water and asks them to stay nearby. She feels it is her duty to help and is relieved that her family understands.

Other Impacts

In Chainpur Bazaar, search and rescue teams, some organized by the police and military, and some formed organically by neighbors, labor heroically to find and rescue people even in the dark, using a few generators that survived the disaster and are in workable condition. In rural areas, villagers do what they can to dig out loved ones and help others in need. With roads and some trail bridges impassable, trained search and rescue teams and equipment, even if available, cannot access remote regions. Most people want to stay outside their own houses and do not feel comfortable leaving their belongings behind, so they camp nearby. The water system is cut off, so they collect water from streams and springs. They cook stored grain if they are able to retrieve it.

One or more landslides have blocked the Bahuli River, reducing the water downstream. The river water ponds up behind the landslide dams. This water floods farms and homes near the river. If a landslide dam suddenly fails, a flooding disaster will occur downstream. In Chainpur Bazaar, the CDO sets someone to watch the river for any changes.

The Day After the Earthquake

Naurati's Family

Gopal returns home from Chainpur Bazaar by way of the usual trails. He is overwhelmed by the suffering he witnesses on the way: heavy damage to homes, and people injured and killed. Landslides of all sizes have damaged homes, farms, and even the paths. The family is thankful and relieved that Gopal is with them again, though problems of finding food, water and shelter remain. It is evident that all is not well with Purna Kumari. Naurati wants her to be treated for her terrible headache, but the journey seems too difficult.

They see families grieving and taking steps to cremate the dead. Aftershocks continue, and occasionally one of them startles with its intensity. All through this, they keep checking their mobile phones for signal and some means of contacting Ganesh and Harka Bahadur.

Meanwhile, Ganesh is on a crowded train ride to Delhi, from where he will have to decide how to get home. He alternates thinking that his family has perished or that they are safe and waiting for his call. He worries that Ganga is disoriented or particularly fearful. It was to earn enough money for her hearing aids that he sought work in India.

At the hospital

There have been two strong aftershocks during the night. People injured in villages make their way to the hospital. The hospital staff tries to conserve what water they have left, and local



Buildings:

Approximately 23,000 buildings collapse across the district. This is a little more than two-thirds of all buildings. In Jayaprithivi Municipality, nearly 60% of buildings collapse; an additional 30% are unsafe. The extent of damage and collapses is similar in the rest of the district's municipalities and rural municipalities. Unreinforced stone masonry buildings are common and prone to collapse. Though fewer in number, some reinforced concrete frame buildings collapse, and many are damaged.

volunteers from the community are dispatched to collect more. Doctors and nurses are concerned about poor sanitation and the spread of infection. The dead are given to wailing relatives. People with minor injuries stay in the parking areas simply because they no longer have safe homes. They are persuaded to leave as there are not enough resources to serve everyone.

Limited supplies come in from private pharmacies. Local volunteers from the Red Cross and other agencies try to provide as much support as possible to affected people at the hospital. Late in the night, the next staff shift comes on duty, and some who have worked long hours go home to check on their families. The generator and fuel requested by the CDO arrives, and Bijay takes charge of these. However, at the first sign of the morning sun, he will turn off the generator to conserve fuel. Two employees from the water supply department arrive and consult with Bijay before trekking along the water line, to try to repair it with the materials they have available.

Instructed by the CDO, an engineer from the DTO comes to assess the hospital buildings. He says all the buildings are dangerous, except the new one which is still under construction. Anticipating more injured, the MS has a second tent put up in front of the new building. Fortunately, there is enough open space. The hospital is overwhelmed and in dire need of medical supplies, doctors and paramedics. When an outside medical team arrives by helicopter from Dhangadhi, two seriously injured persons are transported out. They are carried by stretcher across building rubble and landslide debris. The helicopter cannot carry relatives, which upsets the patients and relatives. The MS briefs the new medical team, who have spent a sleepless night coming from Kathmandu by special flight with several other teams. They are given accommodations in a tent outside the DHO.



Transportation Network:

The Khodpe-Chainpur road is impassable due to extensive landslide debris and road collapses, particularly along the Seti river. In addition, more than 30 sections of the highway have suffered damage from Amargadhi to the Terai, causing extensive delays in truck deliveries. Reopening the road will take many weeks or months. Repairing it to be passable during monsoon rains will take much longer. Damaged trail bridges mean that many people are isolated in rural areas.

The incoming team brings news of damages in other districts. Kabita's heart sinks on hearing about the losses in Dadeldhura, and Bijay and her colleagues are at a loss to comfort her. Bodies of five people, including two of Kabita's friends, are extricated from a collapsed building, which adds much distress. It is evident that even with today's reinforcements, the hospital will not be able to handle the number of patients who will come in from across the district. A field hospital is requested from the Ministry of Health.

At the CDO's Office

Binda is exhausted the next morning, but wants to stay nearby and help. She and her family are permitted to camp in a tent near the office. Coordination meetings continue through the day, with the Deputy CDO taking over duties so the

CDO can rest. Local response and recovery teams (District police, Armed Police and Nepal Army personnel) are traumatized by the scenes they encounter. Time is running out to rescue people alive. Search and rescue teams are spreading out in several areas.

Reports come in that the Khodpe-Chainpur road is impassable due to extensive landslide debris and road collapses. The roadway along the Seti River is blocked in so many places that it seems there is more damaged road than clear road. In addition, more than 30 landslides block the Mahakali highway between Amargadhi and Attariya. Trucks cannot bring supplies from outside the district via the road. Road clearance is initiated by local people; external support cannot reach most of the sections. With so many landslides, difficult communications, and limited equipment, it is unclear how long it will take to make the road passable. Initial estimates are one month, probably more.

By the end of the day, the activated shelter team and local agencies begin setting up shelters and a few temporary toilets in Jayaprithivi. Some trail bridges are reportedly down, which isolates communities from help. FM radio works briefly with limited power supply, but halts by the end of the day. A generator is arranged so that one of the channels can continue to broadcast, but the fuel supply to run the generator is very limited.

The CDO coordinates with the Nepal Army on aid delivery. Supplies and assistance need to be brought to the region via small planes and helicopters. The Dhangadhi airport was at first closed due to runway cracks but reopened several hours later after repairs. Helicopters begin to ferry relief. Smaller helicopters are brought from throughout Nepal to the airports at Dhangadhi and Nepalgunj, and from there they will be sent to parts of Bajhang and other affected districts. A few support teams from the Ministry of Home Affairs and other concerned ministries fly in. National teams from the food cluster (World Food Programme, etc.) begin to distribute water and food, but many rural areas cannot yet be reached. The World Food Programme is setting up warehouses in Dhangadhi and in the affected districts.

The Nepal Red Cross Society district chapter starts an initial rapid assessment of needs, making a rough assumption of damages in different municipalities, which will be helpful to deploy response teams in the coming days. Teams from Kathmandu and international assistance begin to arrive in larger numbers by dusk. Medical teams bring equipment for preparing temporary health camps to treat victims, especially in the city and larger settlements. The Government of Nepal declares Sudurpashchim Pradesh a Disaster Emergency Area. The prime minister appeals to the public to contribute to a relief fund. International funds are pledged.

First Week After the Earthquake

Naurati's Family

Naurati's family is struggling to revive their livelihood. The new house that Naurati and Purna Kumari were hoping to repair has collapsed in an aftershock. The only news they receive is from a radio shared with 10 neighboring families. The news is dire, with information on widespread damage and loss, but there are promises of aid. Purna Kumari's headaches are slowly decreasing. She keeps working to help the family despite repeated sad news of family and friends' deaths.

The family no longer has a house, so they sleep in a tent provided by the shelter team. It is very hard for them living all in one tent, but they somehow manage. They survive on whatever grains they have stored and can harvest from their damaged crops. They use wood from the nearby forest as fuel, and wait for the roads to be cleared so that they can get food and critical supplies. The family hopes that Ganesh and Harka Bahadur will be able to come home, and they really need the men's presence. Their fields and store of seeds are damaged, and they will struggle to

harvest and plant this year. Fortunately, Naurati's buffalo survived, but they are not eating much, and milk production is only half the usual.

One of the richest men of the village had all his money in the cooperative, but with the earthquake damage the cooperative cannot operate. The man lives like the rest of the people in the village – his home was damaged extensively, too. Everyone is going through the same fate. Meanwhile, Ganesh arrives in Dhangadhi and waits for the road to be clear so that he can go home. He has heard that it may take another week to open the road only to Khodpe. Opening the road to Jayaprithivi may take much longer.

At the Hospital

On the sixth day after the earthquake, Bijay develops a fever and is advised to rest. He stays in a tent nearby, and two volunteers take over his duties. Kabita is worried about her parents in Dadeldhura, but still cannot get signal on her mobile. She waits for the road to be clear so she can go home.

Many of the severely injured could not be saved. The World Health Organization (WHO) runs a field hospital on the hospital campus. Health camps are set up outside all health facilities in the district, but people are still brought to the hospital from across the district. Medical supplies trickle in to the hospital and health camps. Though water supply to the hospital has been repaired, doctors are now concerned there will be widespread disease from contaminated water consumption in the community.

At the CDO's Office

Binda has been given coordination support, as the National Emergency Operations Center has deployed a communication officer, by helicopter, from another district. Three specialized search and rescue teams (one each from Nepal, India, and China) reach Bajhang and are deployed to different parts of the district accompanied by Nepal Army personnel. Additional search and rescue efforts are ongoing, some with security forces and social workers in the rural areas.

Road clearance progresses slowly. The Khodpe-Chainpur road will take several more weeks or longer to be passable. Smaller roads are being cleared by hand until large equipment can arrive. Critical supplies and food relief are brought in by air to the Jayaprithivi airport, with limited amounts brought to other parts of the district. Many rural areas are still waiting for aid to arrive.

People in temporary shelters have enough water and food, but fuel is scarce and there is no power. Schools remain closed. People are on edge and more desperate. Some, especially the young, risk their safety to retrieve belongings from damaged buildings.

Estimated damage and impacts by jurisdiction

Jurisdiction	Building Collapses	Additional Unsafe Buildings	Landslides		Serious Injuries	Deaths
			Dry	Monsoon		
Biththadchir Rural Municipality	1,850	800	150	400	700	300
Bungal Municipality	3,700	1,550	800	2,000	2,700	1,020
Chabbis Pathibhara Rural Municipality	2,000	800	200	500	700	290
Durgathali Rural Municipality	1,600	700	100	300	500	230
Jayaprithivi Municipality	2,650	1,300	300	750	1,600	660
Kanda Rural Municipality	250	100	2,600	6,600	90	30
Khaptad Channa Rural Municipality	2,150	900	350	900	680	270
Kedarsyu Rural Municipality	2,500	1,000	200	500	900	380
Mashta Rural Municipality	1,700	700	200	500	600	260
Surma Rural Municipality	1,000	400	500	1,200	380	150
Talkot Rural Municipality	1,400	550	600	1,500	500	190
Thalara Rural Municipality	2,200	900	200	450	750	320
Total for District	23,000	9,700	6,200	15,600	10,100	4,100

First Month After the Earthquake

Naurati's Family

The family unites with Ganesh 19 days after the earthquake. He had to walk the last 30 km, in difficult conditions, as the Khodpe-Chainpur road was still closed. When mobile service returns, he is in touch with Harka Bahadur as well as his employers and assures them that he will return after one month. With constant aftershocks, he is becoming less and less inclined to go back, but he also knows that the family needs his income. He sets about repairing his house with whatever materials he can find. Relief agencies bring in staple foods, but vegetable prices soar. Few people have money to buy supplies, and fewer still can afford to properly rebuild their homes. These conditions are stressful for everyone. The monsoon season brings heavy rain and many more landslides than in previous years, closing sections of the road that had previously been cleared. Homes not yet repaired leak, and stored goods are damaged.

At the Hospital

Bijay continues his work and is grateful that the surge of injured patients has passed. Kabita is back at work after going home and learning that her sister died at school. With the number of trauma patients and their needs decreasing, the hospital staff plans how to serve its normal patient volume. The DHO building is repaired and is functioning as the emergency ward. Temporary sheds are put up for other services. The WHO field hospital is still functioning.

Though water supply to the hospital has been repaired, and water is treated now, doctors are still concerned there will be widespread disease from people drinking contaminated water in the community. They encourage people to boil river water or only use bottled water. Doctors and nurses note that maternal and infant mortality, stillbirths, and miscarriages have increased compared to before the earthquake.

At the CDO's Office

Activities shift from response to recovery. A specialized communications team comes in from Kathmandu and sets up in a tent outside the CDO's office. They handle all the communications with the National EOC and also similar teams in the other affected districts. Binda and her colleagues continue to coordinate the deployment of relief within the district. Their families now live in tents near their own houses. The highway between Attariya and Khodpe is open, but the road to Jayaprithivi and many district and village roads are still being cleared. The micro-hydro plant powering Jayaprithivi is functioning again, but other hydropower plants have not restarted. The Jayaprithivi water system is using plastic tanks to provide temporary storage until the damaged tanks are rebuilt.

Six Months After Earthquake

Six months after the devastating earthquake, aftershocks still occasionally startle. Relief and recovery assistance is still needed. During the monsoon, many more landslides than usual block the roads again, and epidemics arise. Relief and recovery assistance is still needed. People in cities have received most of the aid, because it is easier to reach cities with supplies, and there are more people who can be helped at once. Rural communities are angry and feel abandoned. Health and sanitation in cities and rural areas have become worse.

Electrical power is restored to much of the district. Communication systems have not recovered completely from both earthquake and monsoon damage. The Jayaprithivi water system continues to use plastic tanks to provide temporary storage while restoration of the permanent system is underway. New water projects have been started in rural areas. Due to livestock and farm damage, agricultural production, both for subsistence and for taking to market, will be significantly less this year. The people and economy of Bajhang will suffer for a long time.



Agriculture and Food:

It is harder for everyone to make a living. Farmers have lost animals, crops, seed stores, and even fields. With roads and trail bridges damaged, they are unable to transport products to market. Shopkeepers cannot resupply goods. Prices rise. Many men have sacrificed jobs abroad to return home, where work, if any, pays much less.

One Year After Earthquake

Things have improved after a year, but people face more hardship now than before the earthquake. Those who felt optimistic with the promised efforts have become discouraged by the slow pace of reconstruction. More and more men are leaving home to work in the lowlands and other countries. Women in the family have even more responsibilities and are struggling. Schools are still being rebuilt and repaired, which affects many children. The school drop-out rate is higher this year than last.

High Priority, Key Recommendations for Bajhang District

The following high priority recommendations emerged from discussions during the earthquake scenario development process. They address significant threats to people's physical safety and to the services they rely upon. More detailed technical recommendations, organized by topic, follow in the next section. Additional perspectives on the recommendations are critical as the district develops its plan of action.

The recommendations can be used in an action planning process to clarify high priority actions, identify responsible parties and resources, and set timelines for completing the actions. Becoming more resilient to earthquakes and landslides needs everyone's efforts. An important beginning is to make sure that investments in buildings and infrastructure increase resilience rather than increase risk. Incorporating hazard resilience during design and construction adds minimal extra cost, but protects the investment and increases residents' safety and resilience.

Listed in suggested priority order, the key recommendations are:

- Prepare for roads within the district and important access roads outside of the district to be blocked by earthquake-induced landslides for up to a month. Revise response plans to address how to meet urgent human needs without road access, and how to rapidly reopen roads. Store sufficient fuel and supplies, as well as parts for emergency repairs to water, power and communications systems.
- Ensure all new buildings are constructed to be earthquake resistant. Accelerate local mason training; improve building bye-law adoption and enforcement capacity in municipalities by training and supporting municipal staff; build capacity of local engineers and architects to follow building bye-laws, and educate owners and builders about the importance of earthquake-resistant construction to improve compliance with bye-laws.
- Identify the five most critical buildings or services in the district that will be needed for post-disaster response, and create a plan to assess them. Seismically retrofit or replace facilities likely to perform poorly in an earthquake, or provide redundancy.
- Create municipality Master Plans that focus growth in areas with a lower level of hazard. Provide resilient, redundant infrastructure for water, electrical power, and communications. Investing in resilient new development is an important way to make people safer in the long term.
- Develop a health facilities plan in which the hospital has at least one building designed to have minimal earthquake damage in strong shaking, so that it can continue to function. House all critical medical services (such as operation theatres) in this building. Seismically protect the backup water and power systems serving this building.

- Store sufficient medical supplies to last up to a week during a major disaster, especially supplies for treating earthquake-related injuries.
- Prepare plans for connecting outlying villages and areas as part of a larger development plan. Plan and construct all new roads in a manner that minimizes the risk of causing landslides on slopes. Locate new road alignments in areas less susceptible to landslides because development grows along roads. Dispose of excavated soil and rock in safe, designated areas rather than dumping it downhill of the excavation, which can add to slope instability. Road construction can be very difficult in this area, which is a function of geology, meaning that investments in construction should be made even more carefully so they are not lost in subsequent monsoons or an earthquake.
- Control excavations for buildings and roads on ridges and hillsides to avoid destabilizing slopes as settlements grow. This can include regulations and monitoring for safer slope-cutting, enforcing the regulations, and educating owners and builders on the dangers and costs of unsafe excavations to themselves and neighbors.
- Develop an earthquake safety plan for schools that prioritizes which schools to address first, with the goal to seismically retrofit or replace all schools at risk of collapse during an earthquake in the next 30 years, and 10% in the next 5-8 years.
- Support efforts by local elected officials to increase their knowledge of disaster risk and resilience issues affecting their jurisdiction, so that they can make better-informed decisions to keep their constituents safe.
- Clarify the division of disaster management authority, roles, and responsibilities among district and municipal officials. Sensitize, orient, and train district and municipal stakeholders on the Disaster Management Act of 2017; the National Disaster Risk Reduction Strategic Plan and Policy, 2017-2030; and emergency management procedures to prepare them for the likely demands during a disaster.
- Government offices and departments with critical post-disaster roles should develop and maintain all-hazards emergency plans. Consider specific earthquake impacts such as those described in this scenario. Describe actions to take in the event that access roads are blocked and phone connectivity is lost for an extended period. Train staff and conduct exercises/drills to keep people aware of the plan and ready to carry it out.
- Identify and establish a District Emergency Operations Center (DEOC) in a location that is not hazard-prone.
- Develop an emergency communications plan to coordinate sharing information between urban municipalities, rural municipalities, the district, and the departments in charge of roads, electricity, water, and others essential for response. Provide backup communications other than mobile phones, where needed, and train multiple people to use them so that there is redundancy. Practice regularly to ensure all involved are ready to fulfil their roles.
- Electrical power, water, and communications providers should develop an emergency service restoration plan and standard operating procedures that identify personnel assignments and resources. Plan how to quickly communicate damage and repair information to response coordinators, assuming phone connectivity is lost for an extended period.

- Encourage household level backup utility systems. To improve emergency water availability, encourage households to harvest rainwater, to anchor water tanks to prevent toppling during shaking, and to be prepared to decontaminate river water for household use after an earthquake. Encourage people to continue to use and maintain rooftop solar panels.
- Strengthen community-level preparedness for all hazards including earthquakes. Initiate awareness programs. Assist urban and rural communities to develop preparedness plans at the family, neighborhood, and community levels, so people know what to do and what to have on hand during a disaster. Increase school disaster preparedness education programs.

Detailed Recommendations for Bajhang District

Below are detailed recommendations by topic or resource. Key recommendations from above are reproduced in their respective categories below, along with other important technical recommendations.

1. Roads

- Prepare for roads within the district, and important access roads outside of the district, to be blocked by earthquake-induced landslides for up to a month. Revise response plans to address how to meet urgent human needs without road access, and how to rapidly reopen roads.
- Plan roads that serve outlying villages and areas as part of a larger development plan. Construct all new roads in a safer manner, considering the potential landslide-causing impacts of local geologic conditions and excavations on slopes. Locate new road alignments in areas less susceptible to landslides, because development grows along roads. Dispose of excavated soil and rock in safe, designated areas rather than dumping it downhill of the excavation. Placing excavated loose rock and soil material on a slope can: (i) add enough weight to the slope to result in a landslide, (ii) allow rainfall to mix with the material and form dangerous semi-liquid landslides called debris flows, and (iii) cause collapse of the roadway if the excavated material is improperly used to construct the base of a road. Road construction can be very difficult in this area because slopes are fragile; road construction should be done with technical input so the investments are not lost in subsequent monsoons or an earthquake.
- Prepare a detailed landslide-hazard map covering Chainpur Bazaar and similarly built-up areas in the district, as well as along both sides of the main highway and key access roads. This hazard map will identify landslide-vulnerable locations. For a start, this map can include current and past landslides/rock fall areas. Expand it to include vulnerable areas that have not failed historically, once expert geologist input is available. Later, extend mapping to cover additional important roads.
- Locate road restoration teams to respond to blockages based on the known vulnerable locations for landslides.
- Prepare plans for : (i) rapid road damage assessments along the main highway connecting Chainpur Bazaar to other districts, (ii) coordination between repair teams, supervisors, the CDO, and other response coordinators in the case that normal communications are not functioning, (iii) landslide debris removal with pre-allocated debris moving equipment; and (iv) requisition of additional road repair teams from other districts that are unlikely to be affected by the same earthquake, along with identified locations where the crews can camp during repair.

2. Buildings

- Identify the five most critical buildings or services in the district that will be needed for post-disaster response, and create a plan to assess them. Seismically retrofit or replace facilities likely to perform poorly in an earthquake.
- Ensure all new buildings are constructed to be earthquake resistant in all urban and rural municipalities. Accelerate and expand local mason training, improve building bye-law adoption and enforcement capacity in municipalities by training and supporting municipal staff, build capacity of local engineers and architects to follow building bye-laws, and educate owners and builders about the importance of earthquake-resistant construction to improve compliance with bye-laws.

3. Electricity

- Electrical power providers should develop an emergency service restoration plan and standard operating procedures that identify personnel assignments and resources. Plan how to quickly communicate damage and repair information to response coordinators, particularly the CDO's office, assuming phone connectivity is lost for an extended period.
- Encourage people to continue to expand the usage of rooftop solar panels.
- Plan to conduct rapid damage assessments of micro-hydro stations and the electrical system to Chainpur Bazaar. Plan how to quickly communicate damage and repair information to response coordinators.
- Prepare for grid and micro-hydro power outages in most parts of the district.
- Identify at-risk transmission towers and develop a plan for repairing them in emergencies. As roads are likely to be blocked by landslides, locally store repair parts that are likely to be needed for restoring electrical transmission.
- Design any new substations and power supply structures using applicable seismic design codes. Consider using components that are more resistant to earthquake damage, such as isolators made of composite materials (rather than ceramic).
- Develop pre-disaster mutual aid agreements with other provinces that are unlikely to experience damage during the same earthquake in order to extend repair and restoration capacities.
- Seismically protect or anchor new and existing critical equipment, such as large transformers and those placed atop poles.
- All electrical supply staff members should develop family preparedness plans.

4. Water

- Water providers should develop an emergency service restoration plan and standard operating procedures that identify personnel assignments and resources. Plan how to quickly communicate damage and repair information to response coordinators, particularly the CDO's office, assuming phone connectivity is lost for an extended period.
- Encourage households to anchor water tanks to prevent toppling during earthquake shaking, and to be prepared to decontaminate river water for household use after an earthquake.
- Assess municipality and community water storage and distribution systems for earthquake vulnerabilities. Store sufficient parts for early repairs to main transmission and distribution lines.
- Develop a plan to make municipal water systems resist damage in an earthquake and create redundancy in the systems over time. One goal could be to replace two of the

oldest or most vulnerable parts of the system, such as local tanks or sections of transmission line, within 5 years.

- All water supply staff members should develop family preparedness plans.

5. Communications

- Assess seismic vulnerabilities of mobile communications system and develop a plan to improve redundancy and reduce vulnerabilities over time.
- Create a plan for rapid damage assessment, repairs, and assistance from areas unlikely to be affected by the same earthquake, such as central or eastern parts of the country.

6. Health facilities

- Develop a health facilities plan with a goal that the hospital has at least one building designed to have minimal earthquake damage in strong shaking, so that it can continue to function. House all critical medical services (such as operation theatre) in this building. Seismically protect the backup water and power systems serving this building.
- Store sufficient medical supplies to last up to a week during a major disaster, especially supplies for treating earthquake-related injuries, as roads are likely to be blocked by landslides.
- Store enough water to operate the hospital and rural health posts for three days. Secure water storage containers to prevent them from falling or being damaged in an earthquake.
- Develop emergency management plans and train staff members at all health facilities.
- Ensure that any new health facility construction is built to be earthquake resistant.
- Plan to operate rural health posts from outside of damaged buildings. Stockpile sufficient disaster supplies locally, assuming they will be isolated for days to weeks. Identify locations outside buildings where treatment procedures could be carried out.
- Develop hospital evacuation plans by floor as part of the hospital preparedness plan, with safe destinations identified for evacuees. Create or strengthen a district Hospital Emergency Operations Centre (HEOC) to coordinate healthcare during a disaster and communicate with other response coordinators, like the CDO's office. Use or customize an Incident Command System (ICS) and ensure personnel and backups are assigned and trained on their specific roles and responsibilities. Exercise/drill the hospital preparedness plan regularly.
- Ensure health facility staff develop family preparedness plans.

7. Response coordination

- Clarify the division of disaster management authority, roles, and responsibilities among district and municipal officials. Sensitize, orient, and train district and municipal stakeholders on the Disaster Management Act of 2017; the National Disaster Risk Reduction Strategic Plan and Policy, 2017-2030; and emergency management procedures to prepare them for the likely demands during a disaster.
- Develop an emergency communications plan to coordinate sharing information between urban municipalities, rural municipalities, the district, and the departments in charge of roads, electricity, water, and others essential for response. Provide backup communications other than mobile phones, where needed, and train multiple people to use them so that there is redundancy. Practice regularly to ensure all involved are ready to fulfil their roles.

- Identify and establish a District Emergency Operations Center (DEOC) in a location that is not hazard-prone.
- Anchor all large, heavy furniture and equipment in the DAO and CDO's office to keep it from falling, breaking, or blocking access during an earthquake.
- In addition to inverter power, procure generator backup power with fuel supplies for at least three days.
- Routinely test all emergency communication devices every two months.
- Train additional staff members from the municipalities and DAO office in DEOC functions and communication so that there are trained back-up personnel.
- Develop a detailed response plan for the CDO or the new DEOC including coordination with the uniformed forces, Nepal Red Cross, and other agencies needed during a disaster.
- Pre-arrange (contract) with tent suppliers to supply tents to the DAO, hospitals, and schools so that they can continue operations if buildings are damaged.
- Warehouses and buildings that store stockpiled materials should be made earthquake resistant.
- Identify areas of open ground, safe from landslides and floods, that people can access to establish temporary shelters with adequate space nearby for air-dropping supplies. Protect these open areas from future development.
- All response personnel should develop family preparedness plans.

8. Schools

- Develop a school earthquake safety plan that prioritizes which schools to address first (the most vulnerable), with the goal to seismically retrofit or replace all schools at risk of collapse during an earthquake over the next 30 years, and 10% over the next 5-8 years.
- Ensure all schools develop school preparedness plans and carry out periodic evacuation and preparedness drills. Increase school disaster preparedness education programs.
- Plan and conduct centralized training sessions for school staff members to raise awareness of earthquake basics and preparedness measures.
- Ensure that natural hazards and earthquake science, as well as measures to increase safety and reduce risk, are covered in the school curriculum.

9. Policies and practices for safer development

- All government offices and departments with critical roles after a disaster should develop and maintain an all-hazards emergency plan. Specifically consider earthquake impacts such as those described in this scenario. Describe actions to take in the event that access roads are blocked and phone connectivity is lost for an extended period. Train staff and conduct exercises/drills to keep people aware of the plan and ready to carry it out.
- Create municipality Master Plans that focus growth in areas with a lower level of hazard, and provide resilient, redundant infrastructure. Investing in resilient new development is an important way to make people safer in the long term.
- Control excavations on ridges and hillsides to avoid destabilizing slopes as settlements grow. This can include regulations and monitoring for safer slope-cutting, enforcing the regulations, and educating owners and builders on the dangers and costs of unsafe excavations to themselves and neighbors. The landslide hazard in Jayaprithivi and elsewhere in Bajhang is moderate or high on slopes, and unsafe excavations and road building into slopes can greatly increase the hazard.

- Support local elected officials to increase their knowledge of disaster risk and resilience issues affecting their jurisdiction, so that they can make more-informed decisions to keep their constituents safe. Sensitize and involve political leaders at all levels on risk-sensitive planning and mitigation.
- Plan for and initiate longer-term actions: build political will for improving building bye-laws (regulations), enforcing them, and finding ways to improve compliance such as enhanced review of building drawings submitted for permit applications and construction inspection.

10. Community Preparedness

- Strengthen community-level preparedness for all disasters including earthquakes, by initiating awareness programs and assistance to urban and rural communities in developing emergency plans at the family, neighborhood, and community levels. Ensure that people know what to do and what supplies to have in case of a disaster. Increase school disaster preparedness education programs.
- Encourage household-level backup utility systems. To improve emergency water availability, encourage households to anchor water tanks to prevent toppling during earthquake shaking, and to be prepared to decontaminate river water for household use after an earthquake. Encourage people to continue to use and maintain rooftop solar panels.
- Educate and involve community leaders in pre-disaster preparedness and mitigation planning rather than focusing only on post-disaster response.
- Strengthen local capacities by training local groups on first aid and light search and rescue.

Include all sections of society in inclusive, participatory planning processes to ensure their perspectives are included and their specific needs are met.

Bajhang's Future

Bajhang will always face a risk of earthquakes. This scenario provides a snapshot of the ways that people in both cities and rural areas are vulnerable to harm. **This is not an earthquake prediction. The story, and the study upon which it is based, are intended as an example of what may happen if a major earthquake strikes Bajhang in the near future.**

Appendices that follow provide additional information to assist in planning for a more resilient Bajhang. Recommendations come from a range of professionals in the district as well as from technical experts.

Earthquakes happen without warning. Before a real earthquake strikes, the knowledge presented here can be used to take action. Even small measures to prepare can protect lives, schools, hospitals, property, and livelihoods.

Appendices

A. Earthquake History and Seismic Hazard

B. Landslides, Liquefaction and Other Ground Failure

C. Building Damage: Methodology and Findings

D. Schools and Health Facilities Impacts

E. Transportation Impacts: Roads, Bridges and Trail Bridges

F. Utilities Impacts: Water, Electrical Power and Communications

G. Agriculture, Rural Isolation and Social Impacts

H. Emergency Preparedness and Response Considerations