

Landslide and flood disaster: Causes and its responses

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Abstract

This paper attempts to overview the practices of human responses and adaptation strategies to natural hazards, particularly from landslides and floods. Moreover, it also aims to find out the appropriate response measures for developing countries like Nepal. This paper is prepared by the systematic reviews of related articles published in different peer-reviewed and scientific journals. Initially, the relevant papers were selected using keywords like hazards, disasters and human response to natural disasters. Then, the 64 papers were chosen and this paper was developed. There are different factors to determine the occurrence of disasters on the earth such as geology, topography, climate, topographic aspects, slope and biological activities. Processes and causes contributing to landslides can be put into three categories such as geological/morphological, physical, and human/anthropogenic causes. This study will be very helpful to entire developing countries in general and Nepal in particular as well as agencies and organizations involved in disaster risk reduction and disaster management. The impact of disasters is exacerbated by the lack of appropriate measures for mitigating their impacts. Hence, it will be the foundation for disaster risk reduction in Nepal.

Keywords: Disasters, landslides, floods, risk management, responses and natural hazard

Introduction

Mankind is constantly interacting with the natural world to sustain their lives, and various events have been continuously emerging due to the interaction between man and nature. These all events are emerging due to the interaction between man and nature and the events caused by nature itself to isostatic adjustment. Kates (1971) argued that the coexisting state of adjustment in the human use system and the state of nature in the natural events system govern the interaction between man and nature that gives rise to natural hazards. A better understanding of natural hazards supports decreasing the impact of the disaster as well as helping to develop disaster prevention strategies (Ayala, 2002). Management of hazards is influenced by understanding particular disasters and practices that people have adopted. Beliefs, lifestyles and behaviors of people are influenced by what they know (ICIMOD, 2007). To understand the hazards, one must understand and account for people's ways, practices, beliefs, perceptions, and values. Understanding all these is crucial because it can explain why people do things the way they do.

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To understand the hazards, scholars initiated the research on natural hazards as a new discipline in the 1950s, however, the study of man and environment relationships was initiated globally during the 1960s-1970s (Bjonness, 1986). Shrestha (2005) and Mitchell et al. (2008) asserted that Gilbert F. White was the first person to investigate natural hazards in academic areas that pressed the geographic community on the matters of natural hazards with no ambiguous terms. In addition, disaster is recognized as discourse and the concept emerged in the second half of the 20th century although, it was sound rooted in the 1970s as indexed by the launch of the *Journal Disaster* in 1977 and the beginning of the *Journal of Natural Disaster Science* in 1979 in Japan then the term calamity and misfortune was replaced by disaster (Aguilar et al., 2016).

Natural hazards are those aspects of the natural world that may threaten human life or property (Hyandman & Hyandman, 2015). In other words, natural hazards are possibly damaging physical events and phenomena, that may cause the loss of life, injury or human life disruption, property damage, social, economic and political disruption, or environmental degradation (Zadeh & Cutter, 2016). Khanal (1996) argued that hazards mean danger or harm or risk. It is an extreme event and conditions in the natural environment causing harm to people or properties, however, not all extreme event is considered hazards unless they can cause damage. If the extreme events are not harmful to people and properties, it is considered only natural processes. If these events disrupt the lives and livelihood of people, it is considered a natural hazard. Ayala (2002) explained that natural hazards are the result of the human system and natural systems after they coincide these systems in the same space and time.

Natural hazards are a constant on the surface of the world, yet they are not all categorized as disasters. Only when an incident seriously threatens people's lives or property can it be considered a disaster (ICIMOD, 2007). A disaster is an adverse situation that surpasses people's ability to maintain their lives and means of living, and most of the time, it requires external help to mitigate the losses (Practical Action, 2010). Zadeh & Cutter (2016) argued that a disaster is a serious disturbance of the functioning of a community or a society involving common human, material, economic, or environmental losses and impacts that surpass the ability of the affected community or society to cope using its resources. Birkmann (2011) also explained the disaster as the product of the complex relationship between the physical environment and society. He further argued that it is a social system where the normal functioning of the social system has been interrupted by the levels of loss, damage and impact suffered. All disasters have affected the normal life, health, well-being and livelihood of people negatively. The United Nations Office for Disaster Risk Reduction (UNDRR, 2017) defined the disaster as;

A serious disruption of the function of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts.

Wisner et al. (2004) argued that disaster emerged due to an interaction between human actions and natural hazards. Every year, various disasters occur all over the world which kill massive human and animal lives as well as destroy millions of physical properties. However, Aguilar et al. (2016) claimed that all disasters are not always harmful, whereas they also work as catalysts for different changes in society, the state and science. They presented some examples of the 2004 tsunami that occurred in the Indian Ocean which ended the insurgency in Aceh. Similarly, the earthquakes that struck during the Spanish Colonial era brought changes in architectural styles and practices in building regulation. Birkmann et al. (2010) also have similar views about disasters to Aguilar et al. (2016) and described that disasters have both negative as well as positive aspects. They argued that disaster also provides a window of opportunity to strengthen the social, economic, environmental, legal systems and it is also helpful to changes in organizational structures, creation of disaster management centers and social policy, leading to relocation or migration. They further argued that disasters may generate huge resource inflows that provide an opportunity for financing and supporting structural development activities.

The type, frequency, and other socioeconomic elements of the disaster, as well as the general level of preparedness in the area, may all influence the impact of the event (Gajanayake et al., 2018). Khanal (1996) claimed that the loss of hazards has increased threefold in the world in the last two decades. Lerory (2006) argued that the events of natural hazards have been increasing in the past 50 years. The average annual cost of natural hazards has increased dramatically over the last several decades (Hyndman & Hyndman, 2015). Keller et al. (2015) reported that since 1974, about 2.4 million people have died caused by natural disasters. In addition, an estimated 243 million people have been affected yearly due to natural hazards worldwide (Groschal & Steinwachh, 2017). Since 2008, natural disasters have caused the displacement of almost 265 million people, with over 17 million of those migrating internally in 2018 alone (Francis, 2020). The yearly average for both fatalities and financial losses has been approximately 150,000 and \$50 billion, respectively (Keller et al., 2015). These numbers indicate that the number of disasters and losses are increasing in the world.

Over the last 10 years, significant progress has been strengthening to disaster preparedness, response and early warning capacities and reducing specific risks according to Hyogo Framework for Action (HFA) framework 2005-2015. However, this advancement has been confined in most countries when it comes to managing the underlying risk. As such, new risks have been generated and accumulated faster than existing risks that have been reduced (Zhou et al., 2016). Despite the strong efforts to reduce the likelihood of hazards, over the last quarter-century, the number of natural disasters and their impact on human and economic development worldwide has been increasing yearly (Pelling et al., 2004). Salvati (2018) argued that geo-hydrological hazards (i.e., landslides and floods) cause significant societal and economic damage and a large number of fatalities worldwide. Floods are probably the most frequent natural hazards in the world. Lehmann (2015) estimated that river flooding affects annually 21 million people globally and that the number is expected to

rise to 54 million by 2030. Among the various natural disasters, landslides and floods are considered the most frequent destructive hazards resulting in high mortality and significant economic losses in both agriculture and urban infrastructures (Pham et al., 2019). Gaire et al. (2015) claimed that landslides and flood events will increase continuously if proper intervention is not taken and concluded there is a positive correlation between natural-induced disasters and the number of deaths in Nepal.

Objective

The objective of this paper is to give an overview of the practices of human response and adaptation strategies to natural hazards, especially from landslides and floods.

Methods and Materials

This paper is prepared by a systematic review focusing mainly on natural hazards and their responses by human beings. Related papers were extracted from different scientific and electronic databases such as Google Scholar, Crossref, Scopus, Springer, JSTOR and PubMed. The primary search was based on the keywords: human response, natural hazards, disaster, human adaptation and coping strategy from natural hazards. The search included no time and locational restrictions. In this study, the relevant papers for the analysis were selected in three phases: In the first phase, articles were searched based on the topic i.e., natural hazards, disasters and human response. It displayed huge numbers of articles and these all were not relevant for this study. Hence, the papers were reduced based on their abstracts in the first phase then based on the full articles and the references, the remaining papers were reduced in the second phase. Lastly, the articles were finalized based on the relevancy and authenticity of publishers and the selected articles were used for this review process. Altogether, 64 papers were reviewed and this present paper is prepared. The methodology of this paper is based on constructive criticism of the paper available on disasters, human response to natural hazards. Hence, this paper is based on qualitative interpretivism.

Results and Discussions

It deals with the results and discussions regarding disasters, especially landslides and floods. The changing concept of disaster, opinions on the causes of landslides and floods and associated factors for the landslides and floods are described in this section.

Changing the concept of disaster

Natural disasters are not a new phenomenon on Earth; they have happened since humanity started to develop and will continue to do so in the future, causing damage and fatalities that will last for many years across the world (Lone & Subramani, 2016). Bankoff (2004) argued disasters have always been common since the very beginning of human society. Natural hazards and disasters have a long history of study and debate and policies on managing the impacts have been in existence for decades (Haque & Burton, 2005). Most scholars such as Eckholm (1975) and Johnson et al. (1982) blamed to the activity of humans and modern techniques for occurring disasters and they claimed that human beings are either the prime

cause of or at least a significant role in the emergence of different disasters. However, natural disasters like earthquakes and floods have also occurred since history when humans were far from modernization. Therefore, it would not be just to consider modernization responsible for the same, even though many have seen an increase in modernization and growth and some natural disasters have been brought on by man's increasing understanding and technology.

The concept of disaster has changed over time, until the middle of the eighteenth century, western civilization regarded hazards as 'acts of God' in the strict biblical sense, as punishment for people's sins (Bryant, 2005). Almeida (2021) agreed with the opinions of Bryant (2005) and added various disastrous events were perceived as inevitable or demonstrations of divine anger. Bryant (2005) and Almeida (2021) claimed that after the Lisbon earthquake on 1 November 1755, the scientific study of the earthquake was initiated by John Mitchell, a professor of Geology at the University of Cambridge and it is the pioneering work to change the concept of hazard from acts of God to natural/human process, especially in late 20th century. The perception of disasters changed substantially over time, and they are increasingly recognized as social phenomena rather than natural.

Landslide and flood: Causes and factors

Natural disasters that can have devastating effects on the environment and humanity include floods and landslides. For efficient risk management and mitigation, it is essential to know their causes and contributing aspects. Several studies provide an insightful explanation about the causes/factors of hazards occurrences which are as follows;

Supernatural Explanation

Some scholars have attempted to depict the natural and supernatural explanations for natural hazards. Bjoness (1986) explained the importance of invisible forces from the perspective of Buddhist culture. He found that the Sherpa people claimed that the hazards occurred due to the act of gods. They believed that the earthquake occurred due to the movements of *Satak Towuche*, the big demon that holds the earth. One legend still exists related to flood and torrent events, the local Sherpa was upset after the angry discussion with Lama and he killed the animals then Lama consulted with Khumbu Yul-Lha and immediately Khumbu Yul-Lha sent a flood from the mountain which killed the whole family and now there are only the ruins of his house. Johnson et al. (1982) carried out research in the Mountains of Nepal and they also found that most people interweave supernatural explanations for the hazards occurrence. The most common feature of the supernatural is the snake, which is seen to cause a landslide. Farmers perceived that lightning hits in hills; the snake emerges; a landslide occurs. Ives & Messerli (1981) also claimed that the sudden slump is a supernatural explanation however, the gradual deterioration is due to the combination of human and natural causes.

Geological/Morphological causes/factors

Dahal (2012) argues that different factors such as uneven topography, unstable geological structures, soft and fragile rocks and unstable geological structures along with heavy rainfall collectively contribute to severe landslide problems, especially in the Himalayan region. Salvati (2018) claimed that landslides are caused by rugged topography, the geological structures' complexity and fragility, the soft soil cover, the monsoon season's intense rainfall, and the regular earthquakes. Another view by Ayala (2002) stated that geomorphology has contributed largely to natural hazards. According to him, 84 percent of disasters occurred which were related to geomorphological studies from 1990-1999. Gerrard (1994) explained that the landslide is the function of the nature of rock materials. He argued that road construction techniques especially blasting caused structure weakness in rock structure and it made it easier for the landslide. The Scholars that explained the geological/Morphological causes for the the occurrences of landslides and floods are as follows;

Table 1

Geological/Morphological causes/factors

Scholars	Geological/Morphological causes of landslides and floods
Johnson et al., (1982)	Types of soils and slope of ground. Road construction and the overflow of streams.
Gerrard, 1994	Landslide is the function of the nature of rock materials. Road construction techniques especially blasting caused structure weakness in rock structure and it made it easier for the landslide.
Ayala, 2002	Geomorphology has contributed largely to natural hazards. According to him, 84 percent of disasters occurred which were related to geomorphology during 1990-1999.
Ghimire, 2011	Role of structures and the rock strengths. Steep slopes aggravated the landslides specifically in the Siwaliks of Nepal. Aspects and land use and land cover.
Dahal, 2012	Rugged topography, unstable geological structures, soft and fragile rocks, unstable geological structures along with heavy rainfall.
Prasad et al., (2016)	Population growth and mobility on fragile land or hazardous areas have largely increased the natural disasters due to younger geological formations and tectonically very active.
Salvati, 2018	Rugged topography, the complex and fragile nature of the geological structures, soft soil cover, high-intensity rainfall in the monsoon season and frequent earthquakes

Kumar et al. (2020) Unplanned and inappropriate land use planning and practices, higher rate of development activities and lack of proper drainage facilities.

Physical causes/factors

Gaire et al. (2015) claimed that heavy and continuous rainfall, outbursts of floods, infrastructure failure and deforestation are the major factors in floods and landslides. Geest & Schindler (2016) claimed that the Jure landslides of Nepal were caused by two days of torrential rainfall (141 mm) in that location. In addition, other factors for this landslide are caused by unsustainable land use, the lack of effective water controlling systems, weak geology and vertical slopes. Similarly, the more intense monsoon rainfall led to more frequent landslides (Petley et al., 2007). Hyndman & Hyndman (2015) claimed that heavy and prolonged rainfall are the leading causes of landslides. In addition, Upreti & Dhital (1996) agreed with the views of Hyndman & Hyndman (2015) and also claimed that rainfall is the major factor that influences the incidence of landslides. The sizes of the landslide depends upon climatic conditions, the landscape of the area, the geological features of the slope and the permeability of rocks. Kumar et al. (2020) argue that high-intensity of rainfall, steep slopes and fragile rocks caused landslides. Following scholars have described the the physical causes/factors which are as follows;

Table 2

Physical Causes/factors of landslides and floods

Scholars	Physical causes of landslides and floods
Upreti & Dhital, 1996	Rainfall
Petley et al. (2007)	More intense monsoon rainfall
Gaire et al. (2015)	Heavy and continuous rainfall, outbursts of floods, infrastructure failure, and deforestation
Hyndman & Hyndman, 2015	Heavy and prolonged rainfall
Geest & Schindle, 2016	Jure landslides were caused by two days of torrential rainfall (141 mm) in Nepal. Unsustainable land use, lack of effective water channeling mechanism, weak geology and steep slopes.
Kumar et al. (2020)	High intensity of rainfall, steep slopes, fragile rocks

Anthropogenic causes/factors

Pokhrel et al. (2009) claimed that most of the disasters had occurred due to human actions in the environment. Inappropriate planning, construction of roads without considering

topography, irrigation and other infrastructure in the unstable terrain caused property and environmental damage mostly in Nepal. Human encroachment of the land, conversion of forest land for agriculture and urbanization are the main factors that help to increase disasters and environmental damage. Salvati et al. (2014) agreed with the view of Pokhrel et al. (2009) and claimed that in Italy, land management was the main significant factor for landslides and floods followed by illegal infrastructural building, abandonment of the territory and climate change. Salvati (2018) argued that one of the main causes of landslides is the fast-growing infrastructure construction, which includes building roads, irrigation canals and dams without properly taking into account the potential for natural disasters. Gurung (1989) claimed that the inhabitants have widespread knowledge of managing the environment although farmers often wanted to upgrade the productivity so, they converted *pakho* (grazing land) to *bari* (rain-fed dry terraces) and *bari* to *khet* (wet terrace) which helped to exacerbate for hazards. The scholars and major factors for the occurrences of landslides and floods associated with anthropogenic causes are as follows;

Table 3

Anthropogenic causes/factors of landslides and floods

Scholars	Anthropogenic causes of landslides and floods
Gurung, 1989	Land use and land cover change, People converted <i>pakho</i> (grazing land) to <i>bari</i> (rain-fed dry terraces) and <i>bari</i> to <i>khet</i> (wet terrace) which helps to exacerbate hazards.
Dixit, 2003	The pressure of population growth and modernization. After the 1950s, modern development and technology have entered which poses challenges to natural disasters, particularly in Nepal.
Pokhrel et al., (2009)	Encroachment of land, conversion of forest land for agriculture and urbanization.
Riuex et al., (2013)	Combination of high population density, high population growth rate, low income and steep terrain.
Salvati et al., (2014)	The primary significant element causing floods and landslides was poor land management. Climate change, physical construction done without permission, and territory abandonment.
Salvati, 2018	Building of infrastructure, such as roads, irrigation canals, and dams, is expanding quickly without proper consideration for natural hazards.

Kumar et al., (2020) Unplanned and inappropriate land use planning and practices, higher rate of development activities and lack of proper drainage facilities.

Human responses to landslides and floods

Human actions include planning, mitigating risks, responding to emergencies, and recovering from floods and landslides. The goal of these solutions is to reduce the effects on the environment, infrastructure, and communities. An extensive summary of how people have responded to these natural calamities is dealt with here.

Disaster management: Brief historical account

Since the start of mankind, human beings have had to confront natural as well as man-made events that caused widespread suffering. Until the 20th century, disaster management was characteristically responsive and split in nature (Almeida, 2021). In this situation, the United Nations General Assembly declared the 1990s as the International Decade for Natural Disaster Reduction (IDNDR). This declaration promoted the coordination to lessen the human, physical and socio-economic impact of natural disasters and culminated with the development of the Yokohama Strategy and Plan of Action for a Safer World in 1994 (Coppola, 2015). The Yokohama Strategy consists of 10 core principles and is focused on enhancing coping and recovery mechanisms as well as valuing the knowledge and experience of local communities (Olowu, 2010). After the completion of IDNDR, the foundation of reducing the impact of the disaster was not complete and adopted Hyogo Framework for Action 2005-2015 (HFA).

United Nations (UN) argued that HFA was the first international document describing the detailed processes necessary to reduce disaster risk in various sectors. During the implementation of HFA, some weaknesses were revealed including a lack of standardized definitions, measurable targets and guidelines for implementation hence, the next concrete attempt the Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR) was started globally where the lesson learned from HFA were incorporated. SFDRR has seven voluntary targets and four priority actions.

Prasad et al. (2016) argued the hazards cannot be prevent; however, their catastrophic impacts can be minimized through the proactive use of a diversity of planning measures, support infrastructure and implementation of the risk transfer mechanism. Pearce (2008) claimed that the disaster management approach has shifted from response and recovery to sustainable hazard mitigation. Disaster management planning has only emerged since the 1950s by retired police officers and the members of the military. After that, various academic institutions began to offer degrees in this field. He recommended that the following four options be considered for sustainable hazard mitigation such as the participation of stakeholders, planning components, types of plans and mitigation strategy. In the context of Nepal, Gautam (2017) claimed that the investigation of hazards and related

studies only happening in Nepal in 1982 after the Natural Calamity Relief Act (1982) was promulgated which is the first time in South Asia. Similarly, since 2000, earthquakes have been an extensively discussed issue in Nepal at the policy level, however, landslides, floods and other hazards are not equal emphasis at the academic research and policy level. Natural disasters have killed thousands of people and inflicted billions of dollars in economic losses. It is an inevitable process to fully control the disasters however, the death toll and the economic losses might be decreased through effective and efficient disaster risk management. The scientific and technological advances of the last half-century have provided unprecedented opportunities for responding to the urgent need to mitigate the impact of natural hazards (National Research Council, 1991).

Practices of responses to hazards

Hunter (2005) stated that migration is a response to natural hazards. Groschl & Steinwachs (2017) investigated the migration trend and highlighted the relationship between natural hazards and migration. Gray & Muller (2012) studied the long-term population mobility in rural Bangladesh and found that natural disaster was the major cause of the long-term population mobility. Hence, among various methods of response to disasters, migration is one of the major responses.

Johnson et al. (1982) found that the farmers were planting agave (*Ketuki*) trees at the sites of walls in Nepal to strengthen the stone walls. Besides it, the landslide is also controlled by allowing trees to grow adjacent to the watercourses. Farmers believe that the earth and stone levees are built between *Khet* terraces and rivers; bunds are built up higher than usual and bamboo fences are constructed to control riverbank erosion as well as to divert the flow of the water from the terrace walls. Hanse et al. (2015) found that improvement of homesteads, changes in farming calendars and crop species, changes in economic activities in the local area, investing in sending family members to go abroad for employment activities are the adaptation techniques. They further argued that comprehensive disaster analysis is necessary for developing adaptive capacities. Gurung (1989) found that the local farmers are planting fast-growing trees however they have short roots as a result these are easily uprooted by landslides although these small preventive works can control the large landslides in the future. She found that bamboo is a very appropriate plant that is very effective to protect landslides but planting bamboo is taboo because it is believed to become childless if somebody plants bamboo. Johnson et al. (1982) investigated the mountain hazards in Nepal and found that the local people, especially in the Kakani area, applied different three types of measures to respond to the landslides such as maintenance, repairs and reconstruction. Locally, they have perfectly leveled the terrace surface and reinforced it with stones or turned to the terrace wall. Moreover, local people planted a tree to control the erosion specifically adjacent to the watercourse.

Dhungana et al. (2020) explained the different adaptation practices in relation to climate change such as the construction of bioengineering, planning of different species that grow quickly which help to prevent landslides and floods. Marfai et al. (2015) identified that most

of the adaptation measures are adopted at the household level, especially raising the level of houses and buildings with additional floors. Similarly, the adaptation measures are determined by economic considerations. Pokhrel et al. (2009) suggested that public awareness and cooperation are essential to minimize the impact of disasters whereas they did not focus on any specific types of disasters. Kayastha et al. (2013) argued that a landslide susceptibility map is used for disaster management planning and this map will be helpful to reduce future disaster losses. Similarly, Gaillard (2007) claimed that the changes in the lifestyle of traditional societies are one of the important coping strategies for the loss of natural hazards. Haque (2020) claimed that after the promulgation of relevant laws, policies and procedures, there is a shift in the disaster paradigm in Bangladesh. The new paradigm alters the traditional relief and rehabilitation to disaster risk and this approach decreased the death and loss of properties in Bangladesh. He concluded that Bangladesh encourages preparedness through coordination and networking among various tiers of the local and the central government for risk reduction that helps to shift the paradigm in disaster. Gaire et al. (2015) blamed the Government of Nepal which focuses more on the response rather than the preparedness for disasters. They also argued that the existing Disaster Management Act seems to be insufficient and outdated. Nepal et al. (2018) also have similar views, and they claimed that most of the disastrous policies implemented in Nepal lack preparedness and mitigation, whereas it has given more emphasis on response and relief efforts. However, the new Disaster Risk Reduction and Management Act (2017) would be an important milestone in the disaster sector in Nepal and it has taken disaster risk management as a process focusing on various stages of disaster management cycles. Chan & Parker (1996) found that the use of stilts to raise the height of houses in Malaysia to respond to flood hazards. Raschky (2008) examines the relationship between economic development and vulnerability against natural disasters and he found that in those countries with better institutional experience, the economic losses and victims are both lower due to natural disasters. Ghimire (2011) argued that vegetation protects slopes by reducing erosion, strengthening soil and inhibiting landslides, which increases slope stability. Kumar et al. (2020) investigated the landslides of Mizoram and they found that the bamboo embankment along with wood logs are locally used to control soil erosion. They further argue that Indigenous knowledge-based solutions will significantly contribute to disaster risk prevention, preparedness and participation.

Conclusion

Natural disasters claim the lives of thousands of people and inflict billions of dollars in economic losses and it is an unavoidable process to fully control however, the death toll and economic loss might be decreased by applying effective and efficient disaster management policies. The accomplishment of response and relief efforts depends upon the understanding of disaster and practices of responses to coping with specific disasters. Hence, this paper shortly discussed the causes and their associated factors, especially landslides and floods. Broadly, landslides and floods are caused due to geological, morphological, physical and human causes. Moreover, it also highlighted the practices of mitigating to reduce the

adverse impact of landslides and floods worldwide. Mostly, local people are adapting to landslides and floods through changes in farming seasons and crop varieties, changes in economic activities in the local area, perfectly leveling the terrace surface and reinforcing it with stones to turn to the terrace wall, investing in sending family members to go abroad for employment, planting fast-growing trees are the adaptation techniques that prevent the landslides and floods effectively.

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