

## An Integrated DRR Approach to Coping Disaster Governance and Building Community Resilience in Mountain Regions of Nepal

Chittaranjan Pandey\*, Meghanath Dulal\*\* and Prasuma Rawal\*\*\*

*Received: July 22, 2024*

*Revised: October 17, 2025*

*Accepted: February 12, 2026*

### Abstract

The recent incidents of avalanches and recent devastating earthquakes in Nepal highlight the necessity of an efficient Disaster Risk Reduction (DRR) strategy which is crucial for the instrumental to the conservation of biodiversity and the protection of the mountain settlements. Numerous documents from the United Nations on DRR also emphasize that DRR is a cross-cutting issue requiring a consolidated effort is necessary to develop effective coping mechanisms. This paper reviews the Yokohama Strategy, Hyogo Framework, Sendai Framework and integrated Ecosystem-based DRR and Community-based DRR approaches to develop a collaborative framework that can enhance the community resilience in mountain regions. Based on content analysis and case analysis of recent earthquakes in Nepal, the triple I framework comprising Innovation, Institution and Infrastructure to proposed in supporting the governance and resilience mechanism. It is anticipated that the collaborative efforts of the 3I approach could provide a complete package of biodiversity conservation, community resilience and sustainable livelihood the vulnerable mountainous communities and ecosystems worldwide.

**Keywords:** Integrated DRR, Natural Disaster, Community Resilience, Sustainable Development, Nepal.

\* Center for Research and Development, King's College Nepal Babarmahal, Kathmandu, 44600, NEPAL  
E-mail: chittaranjan@kingscollege.edu.np

\*\* Center for Research and Development, King's College Nepal Babarmahal, Kathmandu, 44600, NEPAL  
E-mail: meghanath@kingscollege.edu.np

\*\*\* Center for Research and Development, King's College Nepal Babarmahal, Kathmandu, 44600, NEPAL  
E-mail: prasuma@kingscollege.edu.np

## แนวทาง DRR แบบบูรณาการเพื่อรับมือกับ ภัยพิบัติและการสร้างความยืดหยุ่นของชุมชน ในพื้นที่ภูเขาของประเทศเนปาล

จิตตะรันจัน ปานดี\*, เมกานาถ ดูลาล\*\* และปราสุมา ราวัล\*\*\*

รับวันที่ 22 กรกฎาคม 2567

ส่งแก้ไขวันที่ 17 ตุลาคม 2568

ตอบรับตีพิมพ์วันที่ 12 กุมภาพันธ์ 2569

### บทคัดย่อ

เหตุการณ์หิมะถล่มและแผ่นดินไหวครั้งใหญ่ในเนปาลแสดงให้เห็นถึงความจำเป็นของกลยุทธ์การลดความเสี่ยงจากภัยพิบัติ (DRR) ที่มีประสิทธิภาพ ซึ่งจะเป็เครื่องมือสำคัญในการอนุรักษ์ความหลากหลายทางชีวภาพควบคู่ไปกับการตั้งถิ่นฐานบนภูเขา เอกสารจำนวนมากที่องค์การสหประชาชาติส่งต่อเกี่ยวกับ DRR ยังสะท้อนให้เห็นว่า DRR เป็นประเด็นที่ตัดขวางอย่างไร และจำเป็นต้องมีความพยายามร่วมกันในการพัฒนากลไกการรับมือ บทความนี้จะทบทวนกลยุทธ์โยโกฮามา กรอบงานเฮียวโกะ กรอบงานเซนได และ DRR ตามระบบนิเวศแบบบูรณาการ และ DRR ตามชุมชน เพื่อพัฒนารอบการทำงานร่วมกันที่สามารถเพิ่มความยืดหยุ่นของชุมชนในพื้นที่ภูเขา จากการวิเคราะห์เนื้อหาและการวิเคราะห์กรณีแผ่นดินไหวที่เกิดขึ้นในเนปาลเมื่อเร็ว ๆ นี้ กรอบการทำงาน Triple I ซึ่งประกอบด้วยนวัตกรรม สถาบัน และโครงสร้างพื้นฐาน ได้รับการเสนอเพื่อสนับสนุนกลไกการกำกับดูแลและความยืดหยุ่น มีการคาดการณ์ว่าความพยายามในการทำงานร่วมกันตามแนวทาง 3I สามารถก่อให้เกิดการอนุรักษ์ความหลากหลายทางชีวภาพ ความยืดหยุ่นของชุมชน และการดำรงชีวิตที่ยั่งยืนสำหรับชุมชนภูเขาและระบบนิเวศที่เปราะบางทั่วโลก

**คำสำคัญ:** DRR แบบบูรณาการ ภัยพิบัติทางธรรมชาติ การฟื้นฟูของชุมชน การพัฒนาที่ยั่งยืน เนปาล

\* ศูนย์วิจัยและพัฒนา วิทยาลัยคิงส์ ประเทศเนปาล บาบาร์มาฮาล กาฐมาณฑุ 44600, เนปาล  
อีเมล : chittaranjan@kingscollege.edu.np

\*\* ศูนย์วิจัยและพัฒนา วิทยาลัยคิงส์ ประเทศเนปาล บาบาร์มาฮาล กาฐมาณฑุ 44600, เนปาล  
อีเมล : meghanath@kingscollege.edu.np

\*\*\* ศูนย์วิจัยและพัฒนา วิทยาลัยคิงส์ ประเทศเนปาล บาบาร์มาฮาล กาฐมาณฑุ 44600, เนปาล  
อีเมล : prasuma@kingscollege.edu.np

## Introduction

Nepal is a country with around 30 million people in its area of 147,181 sq. km. bordered by India to its east, west and south and China to its north. Nepal is known to be a mountainous country as she has eight of the fourteen peaks that exceed 8000 m above sea level. Approximately 83% of the land area in Nepal is covered by mountain landscapes (CBS, 2006). In terms of land above sea level, the country has an altitude ranging from 60 meters to 8848 meters and thus features a range of climatic zones, such as tropical, meso-thermal, micro-thermal, taiga and tundra each full of aesthetic beauty (CBS, 2019). The Himalayas in Nepal cover approximately 800 km of the total extension of more than 3500 km of the Hindu Kush range beginning from Byasrishi Himal in the west to the Kanchenjunga in the east (Upadhayaya & Upreti, 2008; Upadhayaya & Upreti, 2011).

Nepal is a vulnerable and disaster-prone country, however. Vulnerability is a state that helps us better understand the exposure and susceptibility of an individual or a community to disaster as well as their responsive capacities to it (Maikhuri, et al., 2017). People and the immediate environment are the two integral components besides cultural values and practices; therefore, a multidimensional approach must be considered when discussing community resilience to vulnerabilities (Gregory, Ingram, & Brklacich, 2005). Due to the pristine nature of the country in the form of high mountain ranges; the presence of active tectonic processes and the monsoon cycle make the country prone to natural disasters like floods, landslides, glacial lake outburst floods (GLOF) and earthquakes (MOHA and DPNet-Nepal, 2015). In terms of the vulnerability to climate change and earthquakes, Nepal ranks 4<sup>th</sup> and 11<sup>th</sup> respectively in the world. According to MOHA-GoN (2017), Nepal is among the 20 most disaster-prone countries in the world, and more than 80 percent of the population is at the risk of natural hazards. According to Bankoff (2004), not only the exposure to hazards but also constrained access to resources and the marginality of the communities are equally responsible for the increase in vulnerability to natural disasters. According to Klein, et al. (2019), mountains are characterized by complex topography and the communities in these mountains are often far from power centers, with many indigenous peoples (socially, economically, and politically marginalized) reside in the regions.

### Sustainable Livelihood of People in Mountains

There are numerous definitions and understandings of sustainable development, which is why the ambiguity and normative complexity of the phrase remains quite prevalent (Meadowcroft, 2000; Newig, Voß, & Monstadt, 2007). To clarify the concept of sustainable development, two primary concepts formulate sustainable development-development and sustainability. According to Sharpley (2000), “development and sustainability are in juxtaposition”- both concepts could have counterproductive effects, whereas neoclassical economist like Lele (1991) argued that a contradiction between development and sustainability does not exist. Sachs (2010) has also argued that they have a very symbiotic relationship, i.e., development cannot be envisioned without sustainability and vice versa. Often development is also linked to economic development; therefore the term “underdeveloped areas”, introduced by then US President Harry Truman, was used for places with significant population and lower standard of living (Estevo, 2010).

Mountain people, irrespective of the extent of urbanization, are highly prone to numerous natural hazards. Often, it is the perilous lifestyle that mountain communities lead that makes them incapable of coping with upcoming natural disasters. The increasing incidence of natural hazards is only worsening the vulnerability and fragility in mountain regions, where they are hit with above-average warming that causes GLOF, a reduced area of permanent snow and negative mass balance (Yao, et al., 2012). mountains cover 22% of the total land area across all continents, and 10% of the global population reside in the mountains (Klein, et al., 2019). According to FAO (2015), transitional or developing countries are home to ninety percent of the mountain population. Due to worldwide, over 20% of the total population has been affected, resulting in a human death toll of more than 700,000 and more than \$1.4 trillion in damage (Klein et al., 2019; UNISDR, 2015; UNDRR, 2016). Of this toll, More than 500,000 deaths have occurred in the mountainous countries. Research has shown that compared to non-mountainous areas, mountains are vulnerable to natural disasters due to high kinetic energy in steep vertical landscapes (Zimmermann & Keiler, 2015). The risks have further escalated because of global warming (Beniston, 2003; Keiler, Knight, & Harrison, 2010) particularly in the mountains (IPCC SR15, 2018). DRR is also important because every USD 1 invested in risk reduction can yield up to USD 15 during the post-recovery, while an investment of USD 1 in constructing disaster-resilient infrastructure can save up to USD 4 during reconstruction and rehabilitation (UNDRR, 2020).

Undoubtedly, climate change is only worsening the situation. Studies have clearly shown that climate change has not only altered the magnitude and frequency of natural hazards but also their locations, ultimately undermining the gains achieved from development initiatives (Basher, 2006; IPCC, 2012; IPCC, 2014; Kelman, 2015). Disaster Risk Management (DRM) is not a new concept; however, it has become evident that, for effective of impacts from natural hazards, the integration of Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) is essential (Glantz, Baudoin, de la Poterie, Naranjo, & Pierce, 2014; Kelman, Gaillard, & Mercer, 2015). The Mid-Term Review of the Hyogo Framework for Action also recognized DRR as a development issue (UNISDR, 2011), making DRR a multi-faceted and cross-cutting issue in development initiatives.

#### **CB-DRR and Eco-DRR and Community Resilience**

Community-based DRR approaches are known as one of the major techniques for combating the impacts of natural hazards and building the resilience in communities, which can local participation and the incorporation of indigenous techniques and knowledge (UNISDR, 2005, 2015) These techniques are generated through local actors and community involvement in planning and executing DRR projects. Studies (Arnstein, 1969; Pretty, 1995; White, 1996; Chambers, 2008), show that community input in DRR ranges from priority setting during the planning process to decision-making during project execution. Several studies (Cooke & Kothari, 2001; Manikutty, 1997; Hickey & Mohan, 2004; White, 1996; Parfitt, 2004; Chhotray, 2004; Cornwall & Brock, 2005; Mosse, 2004; Leal, 2007) also that the community participation is not always beneficial and that can be challenging for project completion. However, researches has consistently demonstrated the importance of community-based DRR, which are well established in practice (Carr & Owusu-Daaku, 2015; Roncoli, et al., 2008; Carr, 2014).

Ecosystem-based DRR, which is popularly known as nature-based solutions, mainly refers to the conservation, restoration and management of ecosystems for DRR, aiming at sustainable development and building community resilience (Estrella & Saalismaa, 2013; Moos, et al., 2018). There are several strategies for Eco-DRR, but some of the most notable ones, especially in mountainous regions, include the conservation of forests in the steep environments, which usually mitigate mass movements, river renaturation, and (re-)plantation on slopes owing to address possible landslides (Murti & Buyck, 2014; Copper & McKenna, 2008;

Borsje, et al., 2011; Temmerman, et al., 2013). Forests are the most important instance of Eco-DRR in the mountainous regions, as they protect the infrastructures, people and the settlements from gravitational natural hazards, such as landslides (Bathurst, Bovolo, & Cisneros, 2010; Schwarz, Lehmann, & Or, 2010); avalanches (Teich, Bartelt, Grêt-Regamey, & Bebi, 2012; Anderson & McClung, 2012) or floods (Jones & Perkins, 2010; Forbes & Broadhead, 2007). Because these forests protect people and their assets from natural hazard risks, they are often referred to as protection forests (Sakals, Innes, Wilford, Sidle, & Grant, 2006).

### Scope, Limitations and Methods

This study is primarily review-based. For this study, we have reviewed the existing literature on mountain communities, community-based disaster risk reduction, and ecosystem based disaster risk reduction strategies within the three available frameworks (Yokohama Strategy, Hyogo Framework and Sendai Framework). The criteria that were used to identify documents were relevance to the topic, geographical and contextual diversity and the interdisciplinary relevance. The document directly addressed key issues related to DRR, such as risk assessment, mitigation strategies, resilience building, emergency preparedness, climate change adaptation, or policy frameworks. Also, It focused on the application or research of DRR in specific geographical areas similar to Nepal. Documents focusing on different types of hazards (e.g., earthquakes, floods, hurricanes, droughts) were included for a well-rounded analysis of DRR efforts. We examined the shift in their strategies and propose an an integrated approach for sustainable development in mountains regions with a focus on Nepal. We conducted a basic content analysis (e.g., frequency of keywords such as community, indigenous knowledge, participation,) and compared it with major mountain-specific DRR issues (derived from the literature). The word count method quantifies term frequency to identify dominant DRR themes. Documents are systematically selected, coded, and analyzed to track recurring concepts. This objective approach highlights research priorities but requires qualitative triangulation for context (Neuendorf, 2017; Krippendorff, 2019). One of the major limitations of this study is that it is based on the review of available texts rather than first-hand information gathered brought from the fields implementation of the frameworks. Based on the content analysis and case analysis of recent natural disasters in Nepal, we recommend the 3I collaborative governance approach for DRR. The scope for testing the model and providing further suggestions for its improvement remains open for future studies.

## Mountain-Specific DRR Issues

Steep slopes, variations in hydroclimatic systems, ecosystems and geography along with high geodiversity, are the major features of mountain areas. Similarly, communities in the mountains are vulnerable to geophysical processes (volcanic eruptions and earthquakes), snow and glacial hazards as well as hydro-meteorological hazards and floods (Beniston, 2003). For many developing and least developed countries, chronic poverty and population growth intensify the vulnerability and threats faced by mountain communities (Kohler, Wehrli, & Jurek, 2014; Keiler, et al., 2006; Gardner & Dekens, 2012). Other important issues include:

a. *Multihazardous Environment* - According to Kappes, Keiler, & Glade, (2010), a mountain community or location is very likely to be affected by snow avalanches, debris flows and floods, which can influence each other. The Kashmir Earthquake in October 2005 demonstrated that earthquakes can trigger many other geomorphological processes (EERI, 2006).

b. *Tedious Mobility* - In mountains, due to the topographical difficulties, it is very hard for people to move from hazard-prone areas to relatively safer areas, as was evident during the Gorkha of Earthquake 2015. As suggested by Espizua & Bengochea (2002), mountain countries should ensure that they map hazard-prone areas precisely so that sustainable development in the mountain can be planned and future losses can be prevented.

c. *Climate Change* - According to Basher (2006), IPCC (2012, 2014), and Kelman (2015), climate change is worsening the impact of natural disasters in the mountains. Due to climate change, glaciers melt and increase the instances of avalanches, debris flows, and landslides, which poses a threat to many mountain settlements. An avalanche in the Annapurna region of Nepal illustrated this phenomenon.

d. *Limited Space* - There is no question that infrastructure, agricultural lands, and the settlements are highly exposed to natural hazards. The land in the mountains is minimally suitable for housing and human settlements; however, studies have shown that the majority of urban population growth has actually taken place in areas between 500 m and 1500 m above the sea level which presents further challenges due to urbanization (Kohler, Wehrli, & Jurek, 2014).

e. *Interdependence with lowlands* - Mountains require a supply of food and other life-supporting supplies, which is more costly than in other landscapes on earth. To mitigate this challenge, actions taken in border areas between of lowland and highland can worsen the situation. For instance, urbanization attempts in the highlands of Gorkha and excessive land use in the lowlands have caused changes in the riverbed, thereby increasing the chances of disasters.

f. *Indigenous Knowledge* – Every human settlement has its own forms of local and indigenous knowledge to cope with nature and its changes. Since mountain people are more prone to experiencing natural disasters due to their frequency, they develop more ways to cope with disasters, given their high dependence on nature compared to other landscapes (Wisner, Gaillard, & Kelman, 2012).

## International DRR Policy Frameworks

In this section, we present the summary table of the analysis, focused on the three international frameworks for DRR in chronological order: the Yokohama Strategy and Plan of Action for a Safer World; the Hyogo Framework for Action 2005-2015 (HFA); and the Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR).

### The Yokohama Strategy

The Yokohama Strategy, was document was produced during the International Decade for Natural Disaster Reduction (1990-2000), specifically when the World Conference on Natural Disaster Reduction was held in 1994. This document was the first to acknowledged the importance of DRR and provided the guidelines for disaster mitigation at an international level.

**Table 1:** Summary of Major Contents in The Yokohama Strategy

| Activities Recommended      | Keywords in Reference to Recommended Activities                                                                                |
|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| Action Plan, Recommendation | Political Commitment; Legislation; Policy Decisions; Progressive Implementation of Disaster Assessment and reduction           |
| Action Plan, Recommendation | Genuine community involvement; women empowerment; Capacity Building                                                            |
| Action Plan, Recommendation | Usage of traditional knowledge, beliefs and tenets of local community; Empowerment of local communities; Enhancing cooperation |

Source: Based on Documents of Yokohama Strategy

This document, as seen in the table above, addresses the importance of community and local participation for the first time. The table also demonstrates how political commitment can affect DRR strategies. Legislation and policy decisions are, equally influential for sustainable development and sustainable disaster management strategies. Moving from this decade to the 2000s, special attention was drawn to risk-preparedness and prevention, in addition to coping and government interventions (Baudoin & Wolde-Georgis, 2015).

### **The Hyogo Framework for Action 2005-2015**

After the disastrous tsunami in 2004, this framework was developed at World Conference for on Disaster Reduction held in Kobe, Hyogo, Japan in mid-January 2005, when serious questions were being raised about disaster risk preparedness and the significant impacts they can have. Scholars also note the shift in focus to risk preparedness and prevention (Holloway, 2003; Vermaak & van Niekerk, 2004), along with the major organizations operational in the field of DRR at the time (UNISDR, 2012; USAID, 2012).

Looking back in history, the HFA was adopted as a part of ISDR (International Strategy for Disaster Reduction) and was coordinated and implemented by UNISDR (United Nations International Strategy for Disaster Reduction). HFA is also a pioneering document that detailed processes for reducing the impact of disaster risks across multiple sectors. The HFA is also a pioneering document that detailed processes for reducing the impact of disaster risks across multiple sectors. The HFA identifies five priorities for action and suggests guiding principles and strategies to meet these priorities. The HFA aimed to “substantially reduce disaster losses by 2015 by building the resilience of nations and communities to disasters”, according to the website of UNDRR (UNDRR, 2020). In addition to the adoption of the framework, various tools were developed to measure the impact of disasters and knowledge platforms were created where DRR experience could be shared globally; monitoring processes was also established, reporting mechanisms were developed, which completing the framework’s implementation cycle (Olowu, 2010).

**Table 2:** Summary of Major Contents in The Hyogo Framework

| Activities in Priority                                                                                                           | Key Words in Reference to Recommended Activities                                                                                                      |
|----------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. “Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation” | The Importance and specificity of local risk patterns and trends,; decentralization of responsibilities                                               |
|                                                                                                                                  | Promote community participation, develop DRR - specific policies, foster networking, manage volunteers, and provide essential authority and resources |
| 2. “Identify, assess and monitor disaster risks and enhance early warning”                                                       | A. Develop, update and widely disseminate risk maps and info                                                                                          |
|                                                                                                                                  | B. Develop reporting mechanism of disaster risk and vulnerability                                                                                     |
|                                                                                                                                  | C. Develop people-centered EWS, identify major demographic indicators                                                                                 |
| 3. “Use knowledge, innovation and education to build a culture of safety and resilience at all levels”                           | A. Relevant traditional and indigenous knowledge                                                                                                      |
|                                                                                                                                  | B. Community-based Trainings                                                                                                                          |
|                                                                                                                                  | C. Equality for training and educational opportunities                                                                                                |
| 4. “Reduce the underlying risk factors”                                                                                          | Integrating DRR with cross-cutting sectors                                                                                                            |
| 5. “Strengthen disaster preparedness for effective response at all levels”                                                       | A. Specific mechanisms to promote active participation and ownership of stakeholders and communities                                                  |
|                                                                                                                                  | B. Strengthening all levels                                                                                                                           |

*Source:* Based on Documents of The Hyogo Framework

From the table above, we can see that the focus is on identifying major disasters, understanding their trends, analyzing them and then making preparations accordingly. The framework emphasizes the importance of community involvement, specifically in training and how the trained communities can work together for disaster preparedness. The HFA also, like the Yokohama strategy, also addresses political commitments and legislative system but this is reflected in document preparations and the establishments of EWS. Community engagements and the importance of indigenous knowledge are also highlighted, similar to the Yokohama strategy. However, as discussed above, the focus has shifted from disaster prevention to preparedness.

### The Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR)

As discussed above, HFA was a 10-year plan that was coming to an end in 2015 and there was a dire need of continuation of DRR strategies, not only to ensure that the efforts of the last two decades did not go in vain but also because the world had faced even more disasters and the implementation was essential with some updates (Nicholson, 2014; World Bank, 2012; Hellmuth, Moorhead, Thompson, & Williams, 2007; Guha-Sapir, Hoyois, & Below, 2014).

**Table 3:** Summary of Major Contents in The Sendai Framework for Disaster Risk Reduction

| Activities in Priority                                                                                                               | Key Words in Reference to Recommended Activities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Understanding disaster risk                                                                                                       | A. Traditional, indigenous and local knowledge and practices; Cross-sectoral approach and Contextualized<br>B. Collaboration - People, CB organizations and NGOs                                                                                                                                                                                                                                                                                                                                                                                          |
| 2. Strengthening disaster risk governance to manage disaster risk                                                                    | A. Appropriate, clear roles and tasks to community representatives; Comprehensive public and community consultations; Law development and implementation<br>B. Empower local authorities, Regulatory and financial means; Coordination among civil society, communities and indigenous peoples and migrants                                                                                                                                                                                                                                               |
| 3. Investing in disaster risk reduction for resilience                                                                               | A. Inclusion of local level<br>B. More money to community-engagement projects                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 4. Enhancing disaster preparedness for effective response, and to “Build Back Better” in recovery, rehabilitation and reconstruction | A. Empower women and persons with different abilities; Promote gender equality, Enhance recovery rehabilitation and reconstruction approaches<br>B. Prepare or review disaster preparedness and contingency policies, plans and programmes; Stakeholders and Institutions engagement<br>C. Investment and development of people-centred multi-hazard; Multi-sectoral forecasting and early warning systems; Emergency communications mechanisms; Social and indigenous technologies; Hazard-monitoring telecommunications systems. Participatory approach |

Source: Based on documents of The SFDRR

When the HFA came to an end in 2015, the SFDRR was established as a commitment document finalized in Sendai, Japan. This document represents a complete cycle builds upon the theories and practices informed by lesson learned from the HFA's implementation. This document includes targets and indicators aimed at enhancing the resilience capacities among institutions and communities and increasing preparedness for future, unforeseen disasters. In addition to incorporating data and strategies carried over from HFA and the Yokohama's strategy, this document also addresses recent challenges such as climate change, technological dependence on Early Warning Systems (EWS), and escalating globalization (Zia & Wagner, 2015). As this framework is still in operation, its results are yet to be fully realized.

### The Summary of Content Analysis

As mentioned earlier, we carried out a content analysis of all the three documents and attempted to identify and consolidate major words emphasized by the three frameworks. Several things are clear when we see all the frameworks mentioning participation, community engagement, and collaborations. However, other words are listed in the table below:

**Table 4:** Major Word Counts in All the Three Frameworks

| Words                               | Yokohama | Hyogo | Sendai |
|-------------------------------------|----------|-------|--------|
| Participation                       | 3        | 4     | 7      |
| Technology/Technology Transfer      | 8        | 5     | 24     |
| Research                            | 5        | 7     | 14     |
| Indigenous                          | 1        | 1     | 4      |
| Gender and Inclusion                | 0        | 5     | 9      |
| All levels (including Institutions) | 3        | 18    | 19     |
| Innovation/Traditional knowledge    | 4        | 6     | 11     |
| Community                           | 5        | 6     | 11     |
| Collaboration                       | 4        | 12    | 21     |

From the documents of the three frameworks we analyzed, the words mentioned in the above table are the emphasized words.

## Collaborative Governance Framework for DRR

Based on the content analysis and the keywords emphasized in all the three frameworks, we have developed a framework called the 3I framework. 3I stands for Infrastructure, Institutions and Innovations. The infrastructures can be divided into physical, socio-economic, and political categories. Since mountain regions are usually deprived of easy access to resources and materials, which are crucial for the sustainable development of the DRR framework, it is essential to ensure that sufficient roadways and other means of transportation are built so that the mountain communities do not feel left out. Similarly, health and communication infrastructure needs significant improvement. In the case of disasters in mountain regions, there have been instances are cases where people lost their lives because they couldn't communicate with to their loved ones or reach health institutions on time. We have discussed the scope of knowledge generation and transfer and several trainings, also highlighted by the internationally accepted frameworks for DRR; therefore, educational infrastructures is equally essential. Political commitments and legislative requirements are important (UNDRR, 2020) along with the strengthening of communities, which that focuses on the political and socio-economic infrastructure required for building resilience in mountain communities.

The frequency of words across the Yokohama, Hyogo, and Sendai frameworks highlights an evolving emphasis in Disaster Risk Reduction (DRR). In the Institutional domain, terms like "All levels (including Institutions)" rise sharply from 3 in Yokohama to 18 in Hyogo and 19 in Sendai, showing growing recognition of governance, policy, and multi-level institutional engagement. Similarly, "Gender and Inclusion," absent in Yokohama but present in Hyogo (5) and Sendai (9), reflects institutional broadening to inclusivity. In the Infrastructure dimension, the prominence of "Technology/Technology Transfer" peaks in Sendai (24), underscoring the critical role of physical and socio-economic resilience mechanisms. Meanwhile, the Innovation sphere is visible in "Community," "Collaboration," and "Innovation/Traditional knowledge," which increase notably in Sendai (11, 21, and 11, respectively), signaling a shift toward community-driven and knowledge-based innovation. Overall, the progression across the three agreements illustrates how DRR strategies increasingly integrate infrastructure, institutional strengthening, and innovation to build sustainable resilience.

**Institutions:** “All levels (including Institutions)” (18.4%) dominates, showing governance and multi-level coordination as a central theme. Infrastructure: “Technology/Technology Transfer” (17.1%) also takes a significant share, highlighting the reliance on tools, systems, and infrastructure that enhance resilience. Innovation: “Collaboration” (17.1%), “Community” (10.1%), and “Innovation/Traditional knowledge” (9.7%) together emphasize the increasing importance of social networks, co-production of knowledge, and local innovation. Emerging themes, including gender and inclusion (6.5%) and Indigenous knowledge (2.8%), are present but relatively underrepresented, highlighting areas that require stronger integration into DRR strategies.

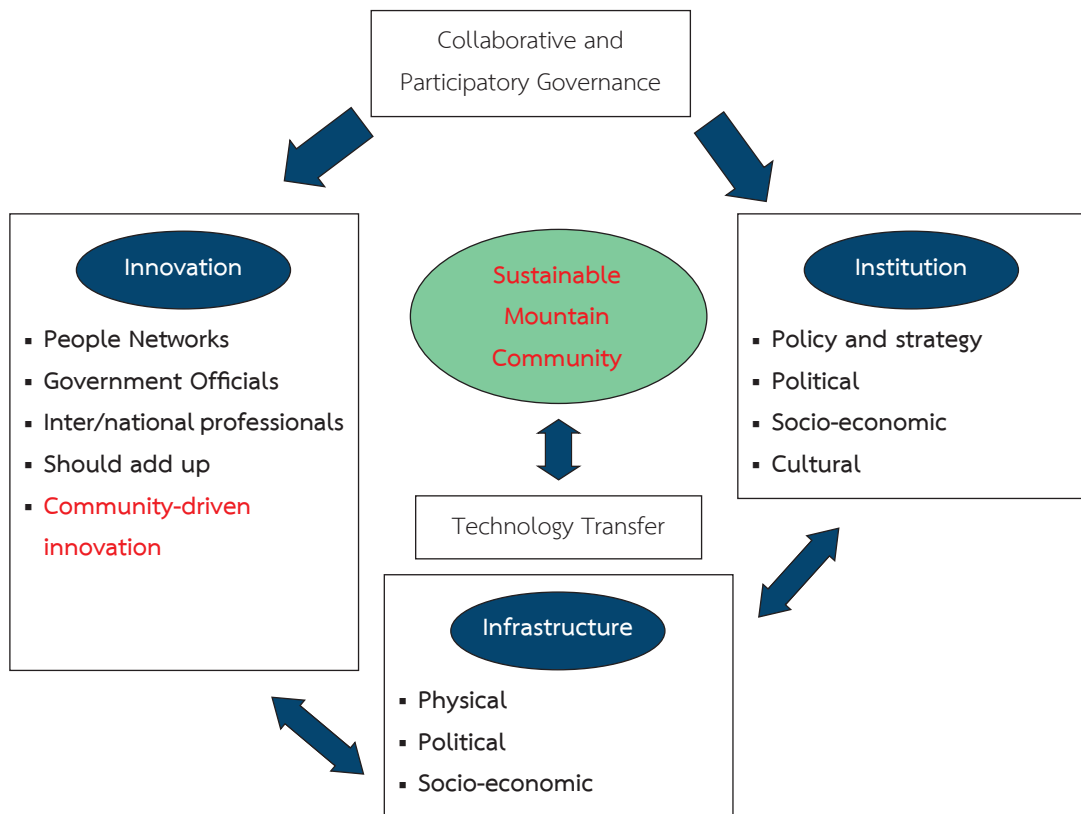


**Figure 1:** Conceptual Framework for Sustainable DRR Approach

We have placed Technology at the center of the triangular framework as it has become the backbone for current livelihood, and neither infrastructure, nor innovation, nor institutions can stand without the support of technology. However, technology is also at the intersection of Community and collaborative networks, which signifies that technology must be acceptable and implementable by communities, require collaboration between communities and other relevant stakeholders. When we talk about innovation, it is both citizens and bureaucrats who are responsible for bringing innovative approaches to their actions. According to Doruk & Söylemezoğlu, (2014), bureaucratic hassles are very dominant to discouraging innovation; therefore, bureaucrats should be made aware of their importance in the system and how crucial it is for them to be updated and innovative.

A major role is played by the International Professionals that we have highlighted in the model. From the content analysis above, we can see how Research and Collaboration have been emphasized in the frameworks. These professionals are those who can work directly and in close consultation with both national and international development agencies, as well as implementing agencies. They will also be important to drive the collaboration between political institutions and the bureaucrats of implementing agencies. Collaboration also requires technology, as research studies and cross-country researchers work together on a common agenda with the help of technological platform. Thus, in the model above, we have tried to conceptualize every major aspect that is emphasized in the DRR frameworks.

Policymakers and Institutions should establish enabling environments through inclusive policies, strategies, and regulations that integrate political, socio-economic, and cultural dimensions. Their responsibility is to align national and local agendas, ensure gender equity, and provide funding mechanisms.

Educators, Researchers, and Professionals must drive innovation by fostering community-driven solutions, connecting people networks, and promoting knowledge exchange at local, national, and international levels. Their role is to strengthen capacity-building, introduce context-relevant technologies, and ensure continuous learning.

Community Leaders and Local Stakeholders are central to infrastructure and practice. They must mobilize grassroots participation, identify context-specific needs, and support physical, political, and socio-economic infrastructure development.

Collaborative and participatory governance ensures accountability and inclusiveness, while technology transfer bridges innovations and practices across regions. Together, these roles create resilient, empowered, and adaptive mountain communities.

### Concluding Remarks and Way Forward

The trend has slightly changed from the Yokohama strategy to SFDRR. Local communities and traditional/indigenous knowledge were valued under the Yokohama strategy but they have now become an integral component of the SFDRR. It is indisputable that the participation and collaboration of relevant stakeholders are crucial for making DRR actions and strategies for DRR successful (Holloway, 2003; Manikutty, 1997; Mercer, Kelman, Lloyd, & Suchet-Pearson, 2008). The shift and trend pattern are important to note because they determine the flow of resources in the developing countries, including mountainous regions.

The model we have provided is very conceptual and there is ample scopes to further improv the model after testing it in the mountain regions. However, what we can assure is that this is represents an integrated multi-hazard approach and an amalgamation of both community-based and ecosystem-based DRR frameworks.

### References

- Anderson, G., & McClung, D. M. (2012). Snow avalanche penetration into mature forest in timber harvested terrain. *Canadian Geotechnical Journal*, 49(4), 477-484. <https://doi.org/10.1139/t2012-018>
- Arnstein, S. (1969). A ladder of citizen participation. *Journal of the American Institute of Planners*, 35(4), 216-224. <https://doi.org/10.1080/01944366908977225>
- Bankoff, G. (2004). *The historical geography of disaster: 'Vulnerability' and 'local in Western Discourse*. Taylor & Francis Group. <https://doi.org/10.4324/9781849771924>
- Basher, R. (2006). Global early warning systems for natural hazards: Systematic and people-centered. *Philosophical Transactions of the Royal Society A*, 364(1845), 2167-2182. <https://doi.org/10.1098/rsta.2006.1819>
- Bathurst, J. C., Bovolo, C. I., & Cisneros, F. (2010). Modelling the effect of forest cover on shallow landslides at the river basin scale. *Ecological Engineering*, 36(3), 317-327. <https://doi.org/10.1016/j.ecoleng.2009.05.001>

- Baudoin, M.-A., & Wolde-Georgis, T. (2015). Disaster risk reduction efforts in the Greater Horn of Africa. *International Journal of Disaster Risk Science*, 6(1), 49-61. <https://doi.org/10.1007/s13753-015-0041-x>
- Beniston, M. (2003). Climatic change in mountain regions: A review of possible impacts. *Climatic Change*, 59, 5-31. <https://doi.org/10.1023/A:1024458411589>
- Beniston, M. (2003). Climatic change in mountain regions: A review of possible impacts. In H. F. Diaz (Ed.), *Climate variability and change in high elevation regions: Past, present & future Advances in Global Change Research*, 15, pp. 5-31. Springer.
- Borsje, B. W., van Wesenbeeck, B. K., Dekker, F., Paalvast, P., Bouma, T. J., van Katwijk, M. M., & de Vries, M. B. (2011). How ecological engineering can serve in coastal protection. *Ecological Engineering*, 37(2), 113-122. <https://doi.org/10.1016/j.ecoleng.2010.11.027>
- Carr, E. R. (2014). From description to explanation: Using the livelihoods as intimate government (LIG) approach. *Applied Geography*, 52, 110-122. <https://doi.org/10.1016/j.apgeog.2014.04.012>
- Carr, E. R., & Owusu-Daaku, K. N. (2016). The shifting epistemologies of vulnerability in climate services for development: The case of Mali's agrometeorological advisory programme. *Area*, 48(1), 7-17. <https://doi.org/10.1111/area.12179>
- Central Bureau of Statistics. (2006). *Statistical Pocket Book Nepal 2006*.
- Central Bureau of Statistics. (2019). *Statistical Pocket Book Nepal 2019*.
- Chambers, R. (2008). *Revolutions in development inquiry*. Earthscan. <https://doi.org/10.4324/9781849772426>
- Chhotray, V. (2004). The negation of politics in participatory development projects, Kurnool, Andhra Pradesh. *Development and Change*, 35(2), 327-352. <https://doi.org/10.1111/j.1467-7660.2004.00354.x>
- Cooke, B., & Kothari, U. (2001). *Participation: The new tyranny?* Zed Books.
- Copper, J., & McKenna, J. (2008). Working with natural processes: The challenge for coastal protection strategies. *Geographical Journal*, 174(4), 315-331. <https://doi.org/10.1111/j.1475-4959.2008.00302.x>
- Cornwall, A., & Brock, K. (2005). What do buzzwords do for development policy? A critical look at “participation”, “empowerment” and “poverty reduction”. *Third World Quarterly*, 26(7), 1043-1060. <http://www.jstor.org/stable/4017803>

- Doruk, Ö. T., & Söylemezoğlu, E. (2014). The constraints of innovation in developing countries: Too many barriers to start ups? *Procedia - Social and Behavioral Sciences*, 150, 944-949. <https://ssrn.com/abstract=2541065>
- Earthquake Engineering Research Institute. (2006). *The Kashmir earthquake of October 8, 2005: Impacts in Pakistan*. [www.eeri.org/lfe/pdf/kashmir\\_eeri\\_2nd\\_report.pdf](http://www.eeri.org/lfe/pdf/kashmir_eeri_2nd_report.pdf)
- Espizua, L. E., & Bengochea, J. D. (2002). Landslide hazard and risk zonation mapping in the Río Grande Basin, Central Andes of Mendoza, Argentina. *Mountain Research and Development*, 22(2), 177-185. [https://doi.org/10.1659/0276-4741\(2002\)022\[0177:LHARZM\]2.0.CO;2](https://doi.org/10.1659/0276-4741(2002)022[0177:LHARZM]2.0.CO;2)
- Estrella, M., & Saalismaa, N. (2013). Ecosystem-based DRR: An overview. In F. Renaud, K. Sudmeier-Rieux, & M. Estrella (Eds.), *The Role of Ecosystems in Disaster Risk Reduction* (pp. 26-47). United Nations University Press.
- Food and Agriculture Organization of the United Nations. (2015). *Mapping the Vulnerability of Mountain Peoples to Food Security*. <http://www.fao.org/resources/infographics/infographics-details/en/c/358116/>
- Forbes, K., & Broadhead, J. (2007). *The role of coastal forests in tsunami mitigation*. Food and Agriculture Organization of the United Nations.
- Gardner, J., & Dekens, J. (2012). Mountain hazards and the resilience of social ecological-systems: Examples from India and Canada. In D. Etkin & C. Haque (Eds.), *Disaster Risk and Vulnerability: Mitigation Through Mobilizing Communities and Partnerships* (pp. 108-132). McGill-Queen's University Press.
- Glantz, M., Baudoin, M.-A., de la Poterie, A., Naranjo, L., & Pierce, G. (2014). *Working with a changing climate, not against it—Hydro-meteorological disaster risk reduction: A survey of lessons learned for resilient adaptation to a changing climate*. Consortium for Capacity Building.
- Gregory, P. J., Ingram, J. S., & Brklacich, M. (2005). Climate change and food security. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 360(1464), 2139-2148. <https://doi.org/10.1098/rstb.2005.1745>

- Guha-Sapir, D., Hoyois, P., & Below, R. (2014). *Annual disaster statistical review 2013: The numbers and trends*. Centre for Research on the Epidemiology of Disasters. [http://www.cred.be/sites/default/files/ADSR\\_2013.pdf](http://www.cred.be/sites/default/files/ADSR_2013.pdf)
- Hellmuth, M. E., Moorhead, A., Thompson, M. C., & Williams, J. (Eds.). (2007). *Climate risk management in Africa: Learning from practice*. Columbia University's International Research Institute for Climate and Society.
- Hickey, S., & Mohan, G. (2004). Toward participation as transformation: Critical themes and challenges. In S. Hickey, & G. Mohan (Eds.), *Participation—From tyranny to transformation?* (pp. 3-24). Zed Books.
- Holloway, A. (2003). Disaster risk reduction in Southern Africa. *African Security Review*, 12(1), 29-38. <https://doi.org/10.1080/10246029.2003.9627568>
- Intergovernmental Panel on Climate Change. (2012). *Special report on managing the risks of extreme events and disasters to advance climate change adaptation*. Cambridge University Press.
- Intergovernmental Panel on Climate Change. (2007). *Climate change 2007: The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.
- Intergovernmental Panel on Climate Change. (2018). *Summary for policymakers. In Global warming of 1.5°C: An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. IPCC. <https://www.ipcc.ch/sr15/chapter/spm/>
- Jones, J., & Perkins, R. (2010). Extreme flood sensitivity to snow and forest harvest, western Cascades, Oregon, United States. *Water Resources Research*, 46(12). <https://doi.org/10.1029/2009WR008632>
- Kappes, M., Keiler, M., & Glade, T. (2010). From single- to multi-hazard risk analysis: A concept addressing emerging challenges. In J. Malet, T. Glade, & N. Casagli (Eds.), *Mountain risks: Bringing science to society* (pp. 351-356). CERIG Editions.

- Keiler, M., Knight, J., & Harrison, S. (2010). Climate change and geomorphological hazards in the eastern European Alps. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 368(1919), 2461-2479. <https://doi.org/10.1098/rsta.2010.0047>
- Keiler, M., Sailer, R., Jorg, P., Weber, C., Fuchs, S., Zischg, A., & Sauermoser, S. (2006). Avalanche risk assessment: A multi-temporal approach, results from Galtur, Austria. *Natural Hazards and Earth System Sciences*, 6(4), 637-651. <https://doi.org/10.5194/nhess-6-637-2006>
- Kelman, I. (2015). Climate change and the Sendai framework for disaster risk reduction. *International Journal of Disaster Risk Science*, 6(2), 117-127. <https://doi.org/10.1007/s13753-015-0046-5>
- Kelman, I., Gaillard, J., & Mercer, J. (2015). Climate change's role in disaster risk reduction's future: Beyond vulnerability and resilience. *International Journal of Disaster Risk Science*, 6(1), 21-27. <https://doi.org/10.1007/s13753-015-0038-5>
- Krippendorff, K. (2019). Content analysis: An introduction to its methodology (4<sup>th</sup> ed.). SAGE Publications. <https://doi.org/10.4135/9781071878781>
- Klein, J. A., Tucker, C. M., Steger, C. E., Nolin, A., Reid, R., Hopping, K. A., Yeh, E. T., Pradhan, M. S., Taber, A., Molden, D., Ghatge, R., Choudhury, D., Alcántara-Ayala, I., Lavorel, S., Müller, B., Grêt-Regamey, A., Boone, R. B., Bourgeron, P., Castellanos, E., Chen, X., Dong, S., Keiler, M., Seidl, R., Thorn, J., & Yager, K. (2019). An integrated community and ecosystem-based approach to disaster risk reduction in mountain systems. *Environmental Science and Policy*, 94, 143-152. <https://doi.org/10.1016/j.envsci.2018.12.034>
- Kohler, T., Wehrli, A., & Jurek, M. (Eds.). (2014). *Mountains and climate change: A global concern*. Centre for Development and Environment (CDE), Swiss Agency for Development and Cooperation (SDC), & Geographica Bernensia.
- Leal, A. (2007). Participation: The ascendancy of a buzzword in the neo-liberal era. *Development in Practice*, 17(4-5), 539-548. <http://www.jstor.org/stable/25548251>
- Maikhuri, R. K., Nautiyal, A., Jha, N. K., Rawat, L. S., Maletha, A., Phondani, P. C., Bahuguna, Y. M., & Bhatt, G. C. (2017). Socio-ecological vulnerability: Assessment and coping strategy to environmental disaster in Kedarnath valley, Uttarakhand, Indian Himalayan Region. *International Journal of Disaster Risk Reduction*, 25, 111-124. <https://doi.org/10.1016/j.ijdrr.2017.09.002>

- Manikutty, S. (1997). Community participation: So what? Evidence from a comparative study of two rural water supply and sanitation projects in India. *Development Policy Review*, 15(2), 115-140. <https://doi.org/10.1111/1467-7679.00029>
- Mercer, J., Kelman, I., Lloyd, K., & Suchet-Pearson, S. (2008). Reflections on use of participatory research for disaster risk reduction. *Area*, 40(2), 172-183. <http://www.jstor.org/stable/40346112>
- MOHA & DPNNet-Nepal. (2015). *Nepal disaster report 2015*. Ministry of Home Affairs (MOHA), Government of Nepal & Disaster Preparedness Network-Nepal (DPNNet-Nepal).
- MOHA-GoN. (2017). *Nepal disaster report 2017: The road to Sendai*. Ministry of Home Affairs, Government of Nepal. <http://drrportal.gov.np/uploads/document/1144.pdf>
- Moos, C., Bebi, P., Schwarz, M., Stoffel, M., Sudmeier-Rieux, K., & Dorren, L. (2018). Ecosystem-based disaster risk reduction in mountains. *Earth-Science Reviews*, 177, 497-513. <https://doi.org/10.1016/j.earscirev.2017.12.011>
- Mosse, D. (2004). Is good policy unimplementable? Reflections on the ethnography of aid policy and practice. *Development and Change*, 35(4), 639-671. <https://doi.org/10.1111/j.0012-155X.2004.00374.x>
- Murti, R., & Buyck, C. (Eds.). (2014). *Safe havens: Protected areas for disaster risk reduction and climate change adaptation*. International Union for Conservation of Nature.
- Neuendorf, K. A. (2017). *The content analysis guidebook* (2<sup>nd</sup> ed.). SAGE Publications.
- Nicholson, S. E. (2014). A detailed look at the recent drought situation in the Greater Horn of Africa. *Journal of Arid Environments*, 103, 71-79. <https://doi.org/10.1016/j.jaridenv.2013.12.003>
- Olowu, D. (2010). The Hyogo Framework for Action and its implications for disaster management and reduction in Africa. *Jàmbá: Journal of Disaster Risk Studies*, 3(1), 303-320. <https://doi.org/10.4102/jamba.v3i1.22>
- Parfitt, T. (2004). The ambiguity of participation: A qualified defence of participatory development. *Third World Quarterly*, 25(3), 537-555. <https://doi.org/10.1080/0143659042000191429>
- Pretty, J. (1995). Participatory learning for sustainable agriculture. *World Development*, 23(8), 1247-1263. [https://doi.org/10.1016/0305-750X\(95\)00046-F](https://doi.org/10.1016/0305-750X(95)00046-F)
- Roncoli, C., Jost, C., Kirshen, P., Sanon, M., Ingram, K. T., Woodin, M., ...Hoogenboom, P. (2008). From accessing to assessing forecasts: An end-to-end study of participatory climate forecast dissemination in Burkina Faso (West Africa). *Climatic Change*, 92(3-4), 433-460. <https://doi.org/10.1007/s10584-008-9445-6>

- Sakals, M. E., Innes, J. L., Wilford, D. J., Sidle, R. C., & Grant, G. E. (2006). The role of forests in reducing hydrogeomorphic hazards. *Forest Snow and Landscape Research*, 80(1), 11-22.
- Schwarz, M., Lehmann, P., & Or, D. (2010). Quantifying lateral root reinforcement in steep slopes - from a bundle of roots to tree stands. *Earth Surface Processes and Landforms*, 35(3), 354-367. <http://dx.doi.org/10.1002/esp.1927>
- Teich, M., Bartelt, P., Grêt-Regamey, A., & Bebi, P. (2012). Snow avalanches in forested terrain: Influence of forest parameters, topography, and avalanche characteristics on runout distance. *Arctic, Antarctic, and Alpine Research*, 44(4), 509-519. <https://doi.org/10.1657/1938-4246-44.4.509>
- Temmerman, S., Meire, P., Bouma, T. J., Herman, P. M., Ysebaert, T., & de Vriend, H. J. (2013). Ecosystem-based coastal defence in the face of global change. *Nature*, 504(7478), 79-83. <https://doi.org/10.1038/nature12859>
- United Nations Office for Disaster Risk Reduction. (2016). *UNISDR strategic framework 2016-2021*. [https://www.preventionweb.net/files/51557\\_strategicframework.pdf](https://www.preventionweb.net/files/51557_strategicframework.pdf)
- United Nations Office for Disaster Risk Reduction. (2020). *About UNDRR: Our impact*. <https://www.undrr.org/about-undrr/our-impact>
- United Nations International Strategy for Disaster Reduction. (2005). *Hyogo framework for action 2005-2015: Building the resilience of nations and communities to disasters*. <https://www.undrr.org/publication/hyogo-framework-action-2005-2015>
- United Nations International Strategy for Disaster Reduction. (2011). *Hyogo framework for action 2005-2015 mid-term review*. <http://www.unisdr.org/we/inform/publications/18197>
- United Nations International Strategy for Disaster Reduction. (2012). *Disaster reduction in Africa: UNISDR informs—special issue on drought risk reduction 2012*. [https://www.unisdr.org/files/26438\\_isdrafricainformsspecialissuesondro.pdf](https://www.unisdr.org/files/26438_isdrafricainformsspecialissuesondro.pdf)
- United Nations International Strategy for Disaster Reduction. (2015). *Sendai framework for disaster risk reduction 2015-2030*. <https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030>
- United Nations International Strategy for Disaster Reduction. (2015). *The economic and human impact of disasters in the last 10 years*. [https://www.unisdr.org/files/42862\\_economichumanimpact20052014unisdr.pdf](https://www.unisdr.org/files/42862_economichumanimpact20052014unisdr.pdf)

- Upadhayaya, P. K., & Upreti, B. R. (2011). *Mountain tourism in Nepal: An overview on the sustainable inclusion of local communities*. [https://www.researchgate.net/publication/254201664\\_Mountain\\_tourism\\_in\\_Nepal\\_An\\_overview\\_on\\_the\\_sustainable\\_inclusion\\_of\\_local\\_communities](https://www.researchgate.net/publication/254201664_Mountain_tourism_in_Nepal_An_overview_on_the_sustainable_inclusion_of_local_communities)
- Upadhayaya, P., & Upreti, B. (2008). *Enhancing women's participation in mountain tourism, prospects and challenges*. <https://lib.icimod.org/records/a6hc5-wzk84>
- United States Agency for International Development. (2012). *Building resilience to recurrent crisis: USAID policy and program guidance*.
- Vermaak, J., & van Niekerk, D. (2004). Disaster risk reduction initiatives in South Africa. *Development Southern Africa*, 21(3), 555-574. <https://doi.org/10.1080/0376835042000265487>
- White, S. (1996). Depoliticising development: The uses and abuses of participation. *Development in Practice*, 6(1), 6-15. <https://doi.org/10.1080/0961452961000157564>
- Wisner, B., Gaillard, J. C., & Kelman, I. (2012). Framing disasters: Theories and stories seeking to understand hazards, vulnerabilities and risks. In B. Wisner, J. C. Gaillard, & I. Kelman (Eds.), *Handbook of Hazards and Disaster Risk Reduction and Management* (pp. 18-34). Routledge.
- World Bank. (2012). Disaster risk financing and insurance in Sub-Saharan Africa: Review and options for consideration. The World Bank. <https://doi.org/10.1596/26769>
- Yao, T., Thompson, L., Yang, W., Yu, W., Gao, Y., Guo, X., Yang, X., Duan, K., Zhao, H., Xu, B., Pu, J., Lu, A., Xiang, Y., Kattel, D. B., & Joswiak, D. (2012). Different glacier status with atmospheric circulations in Tibetan Plateau and surroundings. *Nature Climate Change* 2, 663-667. <https://doi.org/10.1038/nclimate1580>
- Zia, A., & Wagner, C. H. (2015). Mainstreaming early warning systems in development and planning processes: Multilevel implementation of Sendai framework in Indus and Sahel. *International Journal of Disaster Risk Science*, 6(2), 189-199. <https://doi.org/10.1007/s13753-015-0048-3>
- Zimmermann, M., & Keiler, M. (2015). *International frameworks for disaster risk reduction: Useful guidance for sustainable mountain development? Mountain Research and Development*, 35(2), 195-202. <https://doi.org/10.1659/MRD-JOURNAL-D-15-00006.1>